



# *Gaither's Dictionary of Scientific Quotations*

Carl C. Gaither • Alma E. Cavazos-Gaither  
Editors

 Springer

# Gaither's Dictionary of Scientific Quotations

**A Collection of Quotations Pertaining to Archaeology, Architecture, Astronomy, Biology, Botany, Chemistry, Cosmology, Darwinism, Death, Engineering, Geology, Life, Mathematics, Medicine, Nature, Nursing, Paleontology, Philosophy, Physics, Probability, Science, Statistics, Technology, Theory, Universe, and Zoology**

**Carl C. Gaither**

*BA (Psychology), MA (Psychology), MA (Criminal Justice), MS (Mathematical Statistics)*

and

**Alma E. Cavazos-Gaither**

*BA (Spanish)*

**Volume I**

**Abortion – Medical Science**

 Springer

Carl C. Gaither  
502 Weiss Drive  
Killeen, Texas 76542

Alma E. Cavazos-Gaither  
502 Weiss Drive  
Killeen, Texas 76542

ISBN: 978-0-387-49575-0

e-ISBN: 978-0-387-49577-4

Library of Congress Control Number: 2007938494

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Printed on acid-free paper.

9 8 7 6 5 4 3 2 1

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***This book is dedicated to***

*Timothy M. Donovan, Jr.*  
*Aubree D. Moore-Woorley*  
*Liliana Noemi Lopez*  
*Annette Koth*  
*James and Sharon Smith*  
*Alice Pomeroy, USA (Retired)*  
*Laura Rodriguez, USNR*  
*Margaret Evans*

***And to the memory of***

*Rosa Cervantes (1952–1997)*  
*Clifford C. Gaither, LTC USAF (Retired) (1917–2000)*  
*Pearl Gaither, RN (1917–2002)*  
*Maurice Moore II (1983–2004)*  
*Magdalena Cavazos (1923–2004)*  
*Pedro T. Villaneuva (1925–2006)*

# Preface

In putting before you, the reader, this collection of 18,000 quotations it seems fitting to discuss how a book such as this came about. In 1995 I told a librarian friend that I was deeply frustrated in my attempts to find quotations on statistics. I told her that although there were a few books with some quotations available, it was quite clear that each author had very different opinions of how to approach the subject. For example, both Alan Mackay and Isaac Asimov wrote books of science quotations that were organized thematically, but in them the quotations were often misstated and the documentation sparse or nonexistent. The books were, however, the state of the art for that time. Another example, Maurice B. Strauss's book *Familiar Medical Quotations*, provided good documentation but, understandably, the quantity of quotations pertaining to science as compared to medicine was limited. As I explained the failings of the extant literature, my friend looked up from her desk and quietly asked, "Well, why don't you compile one?"

I took this idea to my wife, who agreed to work with me on this task. Over a ten-year period we wrote a series of books that contained quotations from several fields of science. These books came to be known as the Speaking Series (Institute of Physics Publishing, Bristol, UK) and were written, like the current revised and greatly expanded compendium, for a broad audience of scientists as well as lay people like ourselves who do not claim expertise in the many scientific fields.

Science is a dynamic force in virtually every sphere of life. At this the beginning of the twenty-first century, few readers will need to be convinced of the enormous impact of science on art, politics, literature, commerce, education, communications, entertainment, judiciary matters, and—often intensely—on religion, and ethics. It is our opinion that the average reader of this book—whether engineer or technician, architect or artist, doctor or nurse, physicist or astronomer, poet or novelist, mathematician or statistician, teacher or student, atheist or believer—should find a great number of quotations pertaining to his or her individual interest. Furthermore, the juxtaposition of the many views may be thought-provoking.

A dictionary normally consists of an alphabetical arrangement of words and their meanings. In this dictionary instead of words we give an alphabetical arrangement of over 2,000 *thematically* organized categories pertaining to science. Feedback from our previous books indicated that this format was preferred over an author-arranged selection of quotations. The presentation order of the quotations within each subject theme is alphabetical by author. Other quotations of a particular author can be found in the author index.

Our quotation choices were largely influenced by the availability of books, magazines, journals, and newspapers; in turn, to make it as simple as possible for the reader to obtain our sources, we provide our bibliographic references from what we hope are readily accessible sources. Also, for journal articles we strive to provide the actual page number where the quotation may be found, rather than

just the first page of the article in which the quotation appears. Brief biographical information (birth/death date and occupation) is given when at all possible. We were able to provide this contextual information because we were fortunate to have a publisher who did not deem the cost of including this information excessive.

The reader who needs to research a quotation in greater detail can use bibliographical information to find (1) other relevant data; (2) a fuller quote containing other interesting ideas; and (3) the context in which the quotation was used. Where we could not determine where a quotation was originally written we were obliged to use the quotation from a secondary source, and we list the reference where that has been done. Unfortunately, some very good quotations were bypassed and not included because we could not determine where they originated. As it is, about 100 of such quotations are included and have been credited, regrettably but by necessity, as “Author undetermined,” “Source undetermined,” or both. Despite unavoidable omissions, we hope that this book will provide a rich resource that allows you, the reader, to find relevant quotations or citations quickly, and will serve to inspire your search of the literature.

This dictionary, founded on the quotations from our nine previous books, contains over 7,000 additional quotations and provides by far the greatest number of scientific quotations that has appeared in any single published form to date. In addition, supporting information, such as source of the quotation and biographical information, are greatly expanded beyond any previously published effort.

Our three objectives in compiling this book were: First, to show the diversity and the richness of the various sciences from a variety of literary genres; second, to demonstrate that people from virtually every settled land and continent have given science a great deal of thought from 2000 BCE and earlier to the present time; and third, to provide a resource of thought-provoking ideas useful to anyone involved in just about any aspect of science or in any of the areas noted above, which are greatly influenced by the sciences.

In our attempt to fulfill these objectives we acted merely as collectors of quotations from many sources and from many areas of science. Here in this vast collection of quotations are the words of great philosophers and thought-influencers of science, past and present. Included are better known and lesser known thinkers of the classic Greek and Roman times, religious leaders, and philosophers from the Renaissance to the present. Many times an individual has spoken or written a statement pertaining to some aspect of science that was destined to live on and have meaning beyond the immediate context in which it was made. We hope you enjoy a pleasant and stimulating journey through the forest of ideas of scientists, laymen, politicians, novelists, playwrights, and poets about the human search for and attainment of scientific knowledge.

Max Delbrück, a physicist turned biologist, said in his Noble lecture “A Physicist’s Renewed Look at Biology: Twenty Years Later” that “the books of the great scientists are gathering dust on the shelves of learned libraries.” Somewhere else we read: “...often we rake in the litter of the printing press whilst a crown of gold and rubies is offered us in vain.” Unfortunately, these “gems”— these ideas — are often lost to us before they have time to become established in the collective memory of readers. It has been our concern that much of this wit and wisdom is read once and returned to the library shelf to be heard of no more. It seemed that these ideas, hidden within obscure chapters of books, both fiction and nonfiction, or on pages between covers of long forgotten articles in journals, should once again see the light of day. Apart from the practical day-to-day use of doing so, it is valuable that a new generation see lost or forgotten quotable maxims, proverbs, aphorisms, epigrams, jokes, poetry, songs, and quotations so the young may appreciate their charm and interest.

We extend our thanks to the many publishers and authors for their kind permission to use copyrighted material from their works. For any inadvertent violation of copyright we beg forgiveness.

We would especially like to thank David Packer of Springer for his editorial guidance, and Kathleen McKenzie for her copyediting and her many valuable comments and suggestions, and for her help with fact checking.

We also wish to thank the following libraries for allowing us the use of their collections:

The Perry–Castañeda Library of the University of Texas, Austin, Texas.  
The Physics-Math-Astronomy Library of the University of Texas, Austin, Texas.  
The Life Science Library of the University of Texas, Austin, Texas.  
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The Central Texas College Library, Killeen, Texas.  
The University of South West Texas Library, Georgetown, Texas.  
The McNeese State University Library, Lake Charles, Louisiana.  
The University of Richmond Library, Richmond, Virginia.  
The Killeen Public Library, Killeen, Texas.

No claim for completeness is made, for completeness is impossible in a book of this type; nor has any attempt been made to provide balance in the quotations between the needs of the general reader and the specialist. It would have been impossible for us to document each person's favorite scientific quotation, and thus we know that this book will suffer the fate of other literary, artistic, or musical works that attempt a broad overview: Stern critics will find fault with the omission of what they perceive as an important quotation from their respective fields. We must ask these critics to remember that our aim in compiling this book has been to save both great and not-so-great words pertaining to science and to add unmistakable value to that which can be retrieved from the Internet, regardless of the time and effort expended by any who searches there.

Within these works we found surprising and often incredible quotations pertaining to science. Just as certain views about science represented in quotes of years long past are not necessarily those of the authors, certain opinions that are stated therein concerning women, and persons of various nationalities, creeds, and races, are clearly not reasonable in an age when belief in the equality of all people—including a person's inherent capacity to contribute to scientific thought—is a shared ideal. Steven Skiena stated in his book, *The Algorithm Design Manual*, "It is traditional for the author to magnanimously accept the blame for whatever deficiencies remain. I don't. Any errors, deficiencies, or problems in this book are somebody else's fault, but I would appreciate knowing about them so as to determine who is to blame." While we are in sympathy with this, we still believe that any errors are our responsibility and we would appreciate having them called to our attention. For our critics we are sure you will be able to suggest improvements.

Carl C. Gaither  
Alma E. Cavazos-Gaither  
Killeen, Texas  
June 30, 2007

# Contents

ABORTION .....	1	AMNION .....	18
ABSORPTION LINE .....	1	AMPUTATION .....	19
ABSTRACTNESS .....	1	ANALOGY .....	19
ABSTRACTION .....	2	ANALYSIS .....	21
ABYSS.....	4	ANALYSIS OF VARIANCE.....	23
ACADEMIC MIND.....	4	ANALYST .....	23
ACCELERATOR .....	4	ANAPHYLAXIS .....	23
ACCIDENT .....	4	ANATOMIST.....	23
ACCOMPLISHMENT.....	4	ANATOMY .....	23
ACCURACY.....	5	ANEMIA.....	25
ACID .....	6	ANESTHESIA .....	25
ACTIVITY .....	6	ANESTHETIST .....	26
ACTUARY .....	6	ANIMAL.....	26
ADAPTABILITY .....	6	ANIMAL: AMPHIBIAN.....	30
ADDICTION .....	7	ANIMAL: AMPHIBIAN: FROG.....	30
ADDITION .....	7	ANIMAL: AMPHIBIAN: TADPOLE.....	30
ADENOID .....	8	ANIMAL: AMPHIBIAN: TOAD.....	30
ADHESIVE.....	8	ANIMAL: ANNELID.....	30
ADRENAL GLAND .....	8	ANIMAL: ANNELID: WORM.....	30
ADSORPTION .....	8	ANIMAL: BIRD.....	32
AESTHETIC.....	8	ANIMAL: BIRD: ADJUTANT .....	34
AFFINITY .....	10	ANIMAL: BIRD: ALBATROSS .....	34
AGE OF EARTH .....	10	ANIMAL: BIRD: BALD EAGLE.....	34
AGEING .....	11	ANIMAL: BIRD: BIRD OF PARADISE.....	34
AILMENT.....	12	ANIMAL: BIRD: BLACKBIRD.....	35
AIR.....	12	ANIMAL: BIRD: BLUE JAY .....	35
ALCHEMY.....	13	ANIMAL: BIRD: BLUEBIRD.....	35
ALGEBRA.....	14	ANIMAL: BIRD: BOBOLINK.....	36
ALGORITHM.....	17	ANIMAL: BIRD: CANARY .....	36
ALIENS .....	17	ANIMAL: BIRD: CONDOR.....	36
ALLERGY .....	18	ANIMAL: BIRD: CROW.....	36
ALTERNATIVE LIFE .....	18	ANIMAL: BIRD: CUCKOO.....	37
AMBITION.....	18	ANIMAL: BIRD: DODO.....	37
AMINO ACID .....	18	ANIMAL: BIRD: DOVE.....	37



ANIMAL: BIRD: DUCK .....	37	ANIMAL: BIRD: WARBLER .....	46
ANIMAL: BIRD: EAGLE.....	37	ANIMAL: BIRD: WHITE-THROAT .....	46
ANIMAL: BIRD: EMU.....	37	ANIMAL: BIRD: WHOOPING CRANE .....	46
ANIMAL: BIRD: FALCON.....	37	ANIMAL: BIRD: WOODPECKER.....	46
ANIMAL: BIRD: FLAMINGO .....	38	ANIMAL: BIRD: WREN.....	46
ANIMAL: BIRD: GOLDFINCH .....	38	ANIMAL: CHILERATA .....	46
ANIMAL: BIRD: GOOSE .....	38	ANIMAL: CHILERATA: MITE.....	46
ANIMAL: BIRD: GRACKLE.....	38	ANIMAL: CHILERATA: SCORPION .....	47
ANIMAL: BIRD: HAWK .....	38	ANIMAL: CHILERATA: SPIDER .....	47
ANIMAL: BIRD: HORNBILL .....	39	ANIMAL: CHILERATA: TARANTULA .....	48
ANIMAL: BIRD: HUMMING BIRD.....	39	ANIMAL: CHILERATA: TICK.....	48
ANIMAL: BIRD: JAY .....	39	ANIMAL: CHORDATA .....	48
ANIMAL: BIRD: LARK.....	39	ANIMAL: CHORDATA: OIKOPLEURA .....	48
ANIMAL: BIRD: LINNET .....	40	ANIMAL: CNIDARIA .....	48
ANIMAL: BIRD: LOON .....	40	ANIMAL: CNIDARIA: CORAL .....	48
ANIMAL: BIRD: LOUISIANA WATER THRUSH.....	40	ANIMAL: CNIDARIA: JELLYFISH.....	49
ANIMAL: BIRD: MARTLET.....	40	ANIMAL: CRUSTACEAN .....	49
ANIMAL: BIRD: MOCKING BIRD.....	40	ANIMAL: CRUSTACEAN: CRAB .....	49
ANIMAL: BIRD: MOUNTAIN QUAIL.....	40	ANIMAL: CRUSTACEAN: CRAWFISH.....	49
ANIMAL: BIRD: NIGHTINGALE .....	40	ANIMAL: CRUSTACEAN: LOBSTER .....	49
ANIMAL: BIRD: OSTRICH .....	41	ANIMAL: CRUSTACEAN: WOODLOUSE.....	50
ANIMAL: BIRD: OWL.....	41	ANIMAL: DUCK-BILLED PLATYPUS.....	50
ANIMAL: BIRD: PARROT .....	41	ANIMAL: FISH.....	50
ANIMAL: BIRD: PARTRIDGE.....	41	ANIMAL: FISH: BARRACUDA.....	51
ANIMAL: BIRD: PASSENGER PIGEON .....	41	ANIMAL: FISH: CODFISH .....	51
ANIMAL: BIRD: PEACOCK .....	41	ANIMAL: FISH: COELACANTH.....	51
ANIMAL: BIRD: PELICAN.....	42	ANIMAL: FISH: GUPPY .....	52
ANIMAL: BIRD: PENGUIN .....	42	ANIMAL: FISH: HERRING.....	52
ANIMAL: BIRD: PHEASANT.....	42	ANIMAL: FISH: KIPPER.....	52
ANIMAL: BIRD: PHOENIX.....	42	ANIMAL: FISH: PICKEREL .....	52
ANIMAL: BIRD: PIGEON.....	42	ANIMAL: FISH: SALMON.....	52
ANIMAL: BIRD: PURPLE FINCH.....	42	ANIMAL: FISH: SCULPIN.....	52
ANIMAL: BIRD: QUAIL .....	42	ANIMAL: FISH: SEA HORSE.....	52
ANIMAL: BIRD: RAVEN .....	42	ANIMAL: FISH: SEA SQUIRT.....	53
ANIMAL: BIRD: ROBIN .....	43	ANIMAL: FISH: SHARK .....	53
ANIMAL: BIRD: ROOK .....	43	ANIMAL: FISH: SMELT.....	53
ANIMAL: BIRD: RUKH .....	43	ANIMAL: FISH: STURGEON .....	53
ANIMAL: BIRD: SANDPIPER.....	43	ANIMAL: FISH: WHITING.....	54
ANIMAL: BIRD: SEA GULL .....	43	ANIMAL: EUGLENA VIRDIS .....	54
ANIMAL: BIRD: SEA-MEW .....	43	ANIMAL: INSECT .....	54
ANIMAL: BIRD: SEDGE-BIRD.....	43	ANIMAL: INSECT: ANT .....	57
ANIMAL: BIRD: SPARROW .....	43	ANIMAL: INSECT: BEDBUG.....	58
ANIMAL: BIRD: SWALLOW .....	44	ANIMAL: INSECT: BEE.....	58
ANIMAL: BIRD: SWAN .....	44	ANIMAL: INSECT: BEETLE .....	59
ANIMAL: BIRD: THROSTLE .....	44	ANIMAL: INSECT: BUTTERFLY.....	59
ANIMAL: BIRD: THRUSH.....	44	ANIMAL: INSECT: CATERPILLAR.....	60
ANIMAL: BIRD: TOUCAN .....	45	ANIMAL: INSECT: CENTIPEDE.....	61
ANIMAL: BIRD: TURKEY .....	45	ANIMAL: INSECT: CHIGGER.....	61
ANIMAL: BIRD: VULTURE .....	45	ANIMAL: INSECT: COCKROACH.....	61
		ANIMAL: INSECT: CRICKET .....	61

ANIMAL: INSECT: DAMSEL FLY .....	61	ANIMAL: MAMMAL: PANDA .....	73
ANIMAL: INSECT: DRAGON FLY .....	62	ANIMAL: MAMMAL: PANTHER .....	73
ANIMAL: INSECT: FIREFLY .....	62	ANIMAL: MAMMAL: PECCARY .....	73
ANIMAL: INSECT: FLEA .....	62	ANIMAL: MAMMAL: PIG .....	73
ANIMAL: INSECT: FLY .....	62	ANIMAL: MAMMAL: PIKAS .....	73
ANIMAL: INSECT: GNAT .....	63	ANIMAL: MAMMAL: POLAR BEAR .....	73
ANIMAL: INSECT: GRASSHOPPER .....	63	ANIMAL: MAMMAL: PORPOISE .....	73
ANIMAL: INSECT: KATYDID .....	63	ANIMAL: MAMMAL: PRAIRIE DOG .....	74
ANIMAL: INSECT: LADY BIRD .....	63	ANIMAL: MAMMAL: RHINOCEROS .....	74
ANIMAL: INSECT: LIGHTNING BUG .....	64	ANIMAL: MAMMAL: SHEEP .....	74
ANIMAL: INSECT: LOUSE .....	64	ANIMAL: MAMMAL: SHREW .....	74
ANIMAL: INSECT: MAGGOT .....	64	ANIMAL: MAMMAL: SKUNK .....	74
ANIMAL: INSECT: MILLIPEDE .....	64	ANIMAL: MAMMAL: SQUIRREL .....	75
ANIMAL: INSECT: MOSQUITO .....	64	ANIMAL: MAMMAL: TIGER .....	75
ANIMAL: INSECT: MOTH .....	64	ANIMAL: MAMMAL: WALRUS .....	75
ANIMAL: INSECT: PRAYING MANTIS .....	65	ANIMAL: MAMMAL: WHALE .....	75
ANIMAL: INSECT: TERMITE .....	65	ANIMAL: MAMMAL: WOLF .....	76
ANIMAL: INSECT: WALKING STICK .....	65	ANIMAL: MAMMAL: YAK .....	76
ANIMAL: INSECT: WASP .....	65	ANIMAL: MOLLUSK .....	76
ANIMAL: INSECT: WEEVIL .....	66	ANIMAL: MOLLUSK: CLAM .....	76
ANIMAL: MAMMAL .....	66	ANIMAL: MOLLUSK: GIANT SQUID .....	76
ANIMAL: MAMMAL: AARDVARK .....	66	ANIMAL: MOLLUSK: NAUTILUS .....	77
ANIMAL: MAMMAL: APE .....	66	ANIMAL: MOLLUSK: OCTOPUS .....	77
ANIMAL: MAMMAL: ARMADILLO .....	66	ANIMAL: MOLLUSK: OYSTER .....	77
ANIMAL: MAMMAL: BAT .....	66	ANIMAL: MOLLUSK: SLUG .....	77
ANIMAL: MAMMAL: BEAR .....	67	ANIMAL: MOLLUSK: SNAIL .....	78
ANIMAL: MAMMAL: BEAVER .....	68	ANIMAL: MOLLUSK: WHELK .....	78
ANIMAL: MAMMAL: BIGHORN SHEEP .....	68	ANIMAL: PROTOZOA .....	78
ANIMAL: MAMMAL: BUFFALO .....	68	ANIMAL: PROTOZOA: AMOEBA .....	78
ANIMAL: MAMMAL: CAT .....	68	ANIMAL: REPTILE .....	79
ANIMAL: MAMMAL: COW .....	68	ANIMAL: REPTILE: ALLIGATOR .....	79
ANIMAL: MAMMAL: COYOTE .....	68	ANIMAL: REPTILE: CROCODILE .....	79
ANIMAL: MAMMAL: DEER .....	69	ANIMAL: REPTILE: LIZARD .....	79
ANIMAL: MAMMAL: DOG .....	69	ANIMAL: REPTILE: LIZARD: CHAMELEON ..	79
ANIMAL: MAMMAL: DONKEY .....	69	ANIMAL: REPTILE: SNAKE .....	79
ANIMAL: MAMMAL: ELEPHANT .....	70	ANIMAL: REPTILE: SNAKE: ASP .....	79
ANIMAL: MAMMAL: GIRAFFE .....	70	ANIMAL: REPTILE: SNAKE: COBRA .....	80
ANIMAL: MAMMAL: GORILLA .....	70	ANIMAL: REPTILE: SNAKE: PYTHON .....	80
ANIMAL: MAMMAL: GUANACO .....	71	ANIMAL: REPTILE: TURTLE .....	80
ANIMAL: MAMMAL: HIPPOPOTAMUS .....	71	ANIMAL COMMUNITY .....	80
ANIMAL: MAMMAL: HORSE .....	71	ANIMALCULA .....	80
ANIMAL: MAMMAL: JACKAL .....	71	ANSWER .....	80
ANIMAL: MAMMAL: LEOPARD .....	71	ANTHROPOMORPHISM .....	82
ANIMAL: MAMMAL: LION .....	72	ANTHROPIC PRINCIPLE .....	82
ANIMAL: MAMMAL: LLAMA .....	72	ANTHROPOLOGIST .....	82
ANIMAL: MAMMAL: MAMMOTH .....	72	ANTHROPOLOGY .....	83
ANIMAL: MAMMAL: MANATEE .....	72	ANTIBIOTIC .....	84
ANIMAL: MAMMAL: MOUSE .....	72	ANTI-MATTER .....	84
ANIMAL: MAMMAL: OPOSSUM .....	72	ANTIQUITY .....	85
ANIMAL: MAMMAL: OTTER .....	73	ANTI-SCIENCE .....	86

APOTHECARY .....	86	AXIAL TILT .....	152
APPEARANCE .....	87	AXIOM .....	152
APPLICATION .....	87	AXIOMIZE .....	153
APPARATUS .....	87	BACK .....	154
APPROXIMATION .....	88	BACKBONELESSNESS .....	154
ARBITRARY .....	88	BACTERIA .....	154
ARCHAEOASTRONOMY .....	88	BACTERIOLOGIST .....	155
ARCHAEOLOGICAL RECORD .....	88	BALANCE .....	155
ARCHAEOLOGIST .....	88	BAYESIAN .....	155
ARCHAEOLOGY .....	91	BEACH .....	156
ARCHITECT .....	95	BEAUTY .....	156
ARCHITECTURE .....	97	BEGINNING .....	161
ARGYRIA .....	101	BELIEF .....	161
ARITHMETIC .....	101	BESSEL FUNCTION .....	162
ARROGANCE .....	104	BETA DECAY .....	162
ARTERY .....	104	BIBLIOGRAPHY .....	162
ARTIFACT .....	104	BIG BANG .....	162
ARTIFICIAL LIMBS .....	104	BINOMIAL EXPANSION .....	165
ASSERTION .....	104	BIOCHEMISTRY .....	165
ASSUMPTION .....	105	BIODIVERSITY .....	166
ASTEROID .....	106	BIOGENESIS .....	167
ASTROGEOLOGY .....	106	BIOGEOGRAPHY .....	167
ASTROLOGER .....	107	BIOINFORMATICS .....	167
ASTROLOGY .....	107	BIOLOGICAL .....	167
ASTRONAUT .....	107	BIOLOGIST .....	169
ASTRONOMER .....	108	BIOLOGY .....	172
ASTRONOMICAL .....	115	BIONIC ORGANS .....	178
ASTRONOMICAL TIME .....	116	BIOSTRATIGRAPHY .....	178
ASTRONOMY .....	116	BIRTH CONTROL .....	178
ASTROPHYSICIST .....	127	BLACK HOLE .....	179
ASTROPHYSICS .....	127	BLINDNESS .....	181
ASYMMETRY .....	127	BLOOD .....	181
ASYMPTOTE .....	128	BLOOD PRESSURE .....	181
ATMOSPHERE .....	128	BLUEPRINT .....	181
ATOM .....	128	BODY .....	182
ATOMIC .....	142	BONE .....	182
ATOMIC BOMB .....	142	BOOK .....	183
ATOMIC ENERGY .....	142	BOTANIST .....	184
ATOMIC LANDSCAPE .....	143	BOTANY .....	186
ATOMIC WEIGHT .....	143	BOWEL MOVEMENT .....	187
ATOMISM .....	143	BRAIN .....	188
ATTRACTION .....	144	BRIDGE .....	191
AURORA BOREALIS .....	144	BRUTES .....	192
AUTHORITY .....	145	BUBBLE .....	192
AUTONOMIC NERVOUS SYSTEM .....	146	BUG .....	193
AUTONOMY .....	146	BUILD .....	193
AUTOPSY .....	146	BUILDER .....	194
AVALANCHE .....	147	BUILDINGS .....	194
AVERAGE .....	147	BUTTERFLY NET .....	194
AWARENESS .....	152	CALCULATION .....	195

CALCULUS .....	198	COINCIDENCE .....	262
CALORIE .....	199	COLD.....	262
CANCER .....	199	COLD FUSION .....	263
CANDLE .....	200	COLEOPTERIST .....	263
CATALOGUE.....	200	COLLECTING .....	263
CATASTROPHE.....	200	COLONIZATION .....	263
CAUSALITY .....	201	COLOR .....	263
CAUSATION .....	201	COMBINATORICS .....	264
CAUSE AND EFFECT .....	201	COMET.....	264
CAVE .....	208	COMMON SENSE.....	270
CAVERN.....	208	COMMUNITY .....	274
CAVITY .....	208	COMPARISON.....	275
CELESTIAL .....	209	COMPLEXITY .....	275
CELESTIAL MOTION .....	209	COMPOUND.....	275
CELL.....	209	COMPREHENSION.....	276
CENTRAL LIMIT THEOREM .....	211	COMPUTER.....	276
CERTAINTY .....	211	COMPUTING.....	277
CHANCE .....	213	CONCEPT .....	277
CHANGE.....	222	CONCEPTION .....	278
CHAOS .....	224	CONCHOLOGY.....	278
CHEMICAL.....	227	CONCLUSION.....	278
CHEMICAL AFFINITIES .....	230	CONDUCTOR.....	280
CHEMICAL BOND .....	231	CONFIDENCE .....	280
CHEMICAL CHANGE.....	231	CONFUSION.....	280
CHEMICAL ENGINEERING .....	231	CONIC SECTION .....	281
CHEMIST .....	231	CONJECTURE.....	281
CHEMISTRY .....	236	CONQUEST .....	282
CHEMISTRY INSTRUMENTATION .....	253	CONSCIOUSNESS .....	282
CHEMOTHERAPY.....	253	CONSEQUENCE .....	282
CHEYNE–STOKES RESPIRATION.....	253	CONSERVATION.....	282
CHILDBIRTH.....	253	CONSERVATIONIST.....	284
CHITIN .....	253	CONSISTENCY .....	284
CHOICE.....	254	CONSTELLATION .....	284
CHOLERA.....	254	CONSTELLATION: ANDROMEDA .....	288
CHROMOSOME.....	254	CONSTELLATION: ARCTURUS.....	288
CHRONOLOGY.....	254	CONSTELLATION: ARIES .....	288
CIRCLE .....	255	CONSTELLATION: CANCER.....	289
CIRCULATION.....	255	CONSTELLATION: CANIS MAJOR .....	289
CIRCUMCISION .....	255	CONSTELLATION: CAPRICORNUS.....	289
CITY .....	256	CONSTELLATION: DRACO .....	289
CIVILIZATION .....	256	CONSTELLATION: LIBRA.....	289
CLARITY .....	256	CONSTELLATION: LOST PLEIAD.....	289
CLASSIFICATION.....	257	CONSTELLATION: ORION .....	289
CLIMATE CHANGE .....	259	CONSTELLATION: PISCES.....	290
CLINICIAN .....	261	CONSTELLATION: PLEIADES .....	290
CLITORIS.....	261	CONSTELLATION: SAGITTARIUS .....	290
CLONE .....	262	CONSTELLATION: SCORPIO .....	290
COCAINE.....	262	CONSTELLATION: SOUTHERN CROSS .....	290
COD LIVER OIL .....	262	CONSTELLATION: VIRGO .....	290
COHERENCE.....	262	CONSTIPATION .....	291

CONSTRUCT .....	291	DATING .....	322
CONSTRUCTION .....	291	DAWN .....	322
CONSULTANT .....	291	DEATH .....	322
CONSULTATION .....	291	DECAY .....	326
CONTAGION .....	292	DECIMAL .....	327
CONTINENT .....	292	DECISION .....	327
CONTINENTAL DRIFT .....	292	DEDUCTION .....	327
CONTINUITY .....	293	DEEDS .....	328
CONTINUUM .....	293	DEFINITION .....	328
CONTRACEPTIVE .....	294	DELIRIUM .....	331
CONTROL .....	294	DEMONSTRATION .....	331
CONUNDRUM .....	294	DENSITY .....	331
CONVALESCENCE .....	294	DENTIST .....	331
CONVICTION .....	294	DENTOPEDALOGY .....	333
COPERNICAN DOCTRINE .....	294	DENUICATION .....	333
CORRELATION .....	295	DEPLETION .....	334
COSMIC BALANCE .....	295	DERIVATIVE .....	334
COSMIC EVOLUTION .....	296	DERMATOLOGIST .....	334
COSMIC RAY .....	296	DESCRIBE .....	334
COSMOCHEMISTRY .....	296	DESCRIPTION .....	334
COSMOGONIST .....	296	DESERT .....	334
COSMOGONY .....	296	DESIGN .....	336
COSMOLOGICAL .....	297	DESTINATION .....	337
COSMOLOGIST .....	297	DESTINY .....	337
COSMOLOGY .....	297	DESTRUCTION .....	337
COSMOS .....	299	DETAIL .....	337
COUGH .....	300	DETECTION .....	338
COUNTING .....	301	DETECTOR .....	338
COURAGE .....	301	DETERMINANT .....	338
CRAZY .....	301	DETERMINISM .....	338
CREATE .....	301	DEVELOPMENT .....	338
CREATION .....	302	DIAGNOSIS .....	339
CREATIONISM .....	303	DIAGNOSTICIAN .....	340
CREATIONIST .....	304	DICE .....	340
CREATIVITY .....	305	DISCOVERY .....	341
CREDIT .....	308	DIET .....	341
CREED .....	308	DIETY .....	342
CRITICISM .....	308	DIFFERENCE .....	342
CRUST .....	309	DIFFERENTIAL .....	343
CRYSTALLOGRAPHY .....	309	DIFFERENTIAL EQUATION .....	343
CULTURE .....	309	DIFFICULTY .....	344
CURE .....	310	DIFFUSION .....	344
CURIOSITY .....	312	DIG .....	344
CURVE .....	315	DIGESTION .....	345
CYNIC .....	315	DIGESTIVE CANAL .....	345
DARK ENERGY .....	316	DIMENSION .....	345
DARK MATTER .....	316	DINOSAUR .....	347
DARKNESS .....	316	DINOSAUR: ALLOSAURUS .....	349
DARWINISM .....	316	DINOSAUR: ANKYLOSAURUS .....	349
DATA .....	318	DINOSAUR: ARCHAEOPTERYX .....	349

DINOSAUR: BRACHIOSAURUS.....	349	ELEMENT: ARSENIC.....	397
DINOSAUR: BRONTOSAURUS .....	349	ELEMENT: BISMUTH.....	397
DINOSAUR: ICHTHYOSAURUS.....	350	ELEMENT: CARBON .....	397
DINOSAUR: IGUANODON.....	350	ELEMENT: CHLORINE.....	397
DINOSAUR: LEPTOPTERYGIUS .....	350	ELEMENT: COBALT .....	398
DINOSAUR: PTERODACTAL.....	350	ELEMENT: GOLD.....	398
DINOSAUR: STEGOSAURUS.....	351	ELEMENT: HYDROGEN.....	398
DINOSAUR: TYRANNOSSAURUS.....	351	ELEMENT: IODINE .....	398
DISCHARGE.....	351	ELEMENT: LEAD .....	399
DISCONTINUITY .....	351	ELEMENT: MERCURY .....	399
DISCOVER.....	351	ELEMENT: NITROGEN.....	399
DISCOVERY .....	352	ELEMENT: OXYGEN .....	399
DISCUSSION .....	367	ELEMENT: PHOSPHORUS .....	400
DISEASE .....	367	ELEMENT: RADIUM.....	400
DISINFECTANT .....	371	ELEMENT: SODIUM.....	400
DISORDER.....	372	ELEMENT: SULPHUR.....	400
DISPERSAL .....	372	ELEMENT: TITANIUM .....	401
DISSECTION .....	372	ELEMENT: URANIUM.....	401
DISTANCE .....	373	ELEMENT: ZINC.....	401
DISTILL .....	373	ECLIPSE.....	401
DISTRIBUTION.....	374	ELLIPSE.....	402
DIVERGENCE .....	375	ELLIPTIC FUNCTION .....	402
DIVERSITY .....	375	EMERGENCE .....	402
DIVINE INTELLIGENCE .....	375	EMOTION .....	402
DIVISION .....	375	ENERGY .....	402
DNA .....	375	ENERGY STATE.....	407
DWARF PLANET: PLUTO .....	376	ENGINEER.....	408
EAR WAX .....	377	ENGINEERING .....	421
EARTH, DEATH OF.....	377	ENLIGHTENMENT.....	429
EARTHQUAKE.....	377	ENTOMOLOGIST .....	429
ECHINODERMATA .....	381	ENTOMOLOGY .....	430
ECLIPSE.....	381	ENTROPY .....	431
ECOLOGIST .....	383	ENVIRONMENT .....	432
ECOLOGY .....	383	ENZYME.....	434
ECONOMIST .....	385	EPILEPSY .....	434
ECOSYSTEM.....	385	EPILOGUE.....	434
EDIFICE .....	385	EPITAPH .....	434
EDUCATION.....	385	EQUATION.....	434
EFFECT .....	387	EQUILIBRIUM .....	436
EFFICIENT.....	387	EROSION .....	436
EGG .....	387	ERROR .....	436
EL NIÑO.....	387	ERUPTION .....	444
ELECTRICITY .....	387	ESCHATOLOGY.....	444
ELECTROCARDIOGRAM .....	389	ESOTERIC.....	444
ELECTRON.....	389	ESTIMATE .....	445
ELEGANCE .....	394	ETERNITY .....	445
ELEMENT.....	394	ETHER.....	445
ELEMENT: ALUMINUM .....	396	ETHER SPACE.....	446
ELEMENT: ANTIMONY .....	396	ETHICS.....	447
ELEMENT: ARGON.....	397	EUCLID .....	449

EUGENICS .....	450	FIRMAMENT .....	548
EUREKA .....	450	FISSION .....	548
EVAPORATION .....	450	FLATULENCE .....	548
EVENT .....	450	FLIGHT .....	548
EVIDENCE .....	451	FLOWER .....	549
EVOLUTION .....	451	FLU .....	553
EXAMINATION .....	484	FLUID .....	553
EXAMPLE .....	484	FLUOROCHEMISTRY .....	553
EXCAVATION .....	485	FLUXION .....	553
EXCEPTION .....	485	FLYING SAUCERS .....	553
EXCLUDED MIDDLE .....	485	FOCUS .....	553
EXISTENCE .....	485	FOOL .....	553
EXPAND .....	486	FOOTPRINT .....	554
EXPERIENCE .....	486	FORCE .....	554
EXPERIMENT .....	490	FORECAST .....	557
EXPERIMENTAL METHOD .....	502	FORESIGHT .....	559
EXPERIMENTER .....	503	FORETHOUGHT .....	559
EXPERT .....	503	FORM .....	559
EXPLANATION .....	504	FORMULA .....	559
EXPLICIT .....	505	FOSSIL .....	561
EXPLORATION .....	505	FOURTH DIMENSION .....	566
EXPONENTIAL .....	506	FRACTAL .....	566
EXPOSITION .....	506	FRACTION .....	567
EXTERNAL WORLD .....	506	FRACTURE .....	567
EXTINCTION .....	506	FREEDOM .....	567
EXTRATERRESTRIAL LIFE .....	509	FUNCTION .....	567
EYE .....	515	FUNDING .....	568
EYELID .....	516	FUNGI .....	568
FACE .....	517	FUSION .....	568
FACT .....	517	FUTURE .....	569
FACTOR .....	542	GAIA .....	571
FAILURE .....	542	GALAPAGOS .....	571
FAITH OF SCIENCE .....	542	GALAXY .....	571
FALLACY .....	543	GALL BLADDER .....	573
FAME .....	543	GAMBLING .....	573
FART .....	543	GARDEN .....	573
FAULT .....	544	GAS .....	574
FEE .....	544	GASTRULATION .....	574
FERMAT'S THEOREM .....	545	GENE .....	575
FERMENTATION .....	545	GENE POOL .....	576
FETUS .....	545	GENERA .....	576
FEVER .....	545	GENERAL PRACTICE .....	576
FIELD .....	546	GENERAL PRACTITIONER .....	576
FIELD STUDY .....	546	GENERAL RELATIVITY .....	576
FIELD THEORY .....	546	GENERALITY .....	576
FIELD WORK .....	546	GENERALIZATION .....	577
FIELDS .....	546	GENETIC .....	577
FIGURE .....	547	GENETIC THEORY .....	578
FILTER .....	547	GENETICS .....	578
FIRE .....	547	GENIUS .....	578

GENOME .....	580	HILBERT SPACE.....	636
GENUS .....	581	HISTORIAN .....	636
GEOLOGY .....	581	HISTORY.....	637
GEOLOGICAL TIME.....	591	HIVES.....	637
GEOLOGIST .....	593	HOLOTYPE.....	638
GEOMETER.....	597	HOMEOPATHY .....	638
GEOMETRY.....	598	HOMO SAPIEN .....	638
GEOMORPHOLOGY .....	605	HONORS .....	638
GEOPHYSICS.....	606	HORMONE .....	638
GERM PLASM.....	606	HOSPITAL.....	638
GEYSER .....	606	HUMAN BEINGS.....	639
GLACIAL DEBRIS.....	606	HUMAN BODY .....	640
GLACIER .....	606	HUMAN SPIRIT .....	640
GLAND.....	607	HURRICANE .....	640
GLASSWARE.....	608	HYBRID .....	640
GLUONS .....	608	HYDROLOGY .....	640
GOAL.....	608	HYPERBOLA .....	640
GOD.....	609	HYPERSPACE.....	641
GOUT .....	620	HYPOCHONDRIAC .....	641
GRAIN .....	620	HYPODERMIC NEEDLE .....	642
GRAPH.....	620	HYPOTHESIS .....	642
GRAVITATIONAL LENS .....	621	ICE.....	652
GRAVITY .....	621	ICE STORMS .....	652
GREATNESS .....	624	ICEBERG .....	652
GREENHOUSE WARMING .....	625	ICHTNOLOGY.....	653
GROUP .....	625	ICHTHYOLOGIST .....	653
GROUP THEORY .....	625	IDEA .....	653
GUESS.....	625	IDEOLOGY .....	664
GYNECOLOGIST.....	626	IGNORANCE.....	664
HAIR.....	627	ILLNESS.....	668
HAPPENING.....	627	ILLUSION .....	670
HAPPINESS .....	627	ILLUSTRATION .....	670
HARMONIC LAW .....	627	IMAGINATION .....	670
HEADACHE.....	627	IMMORTALITY .....	679
HEALING .....	627	IMMUNITY.....	679
HEALTH.....	628	IMMUNOLOGICAL DEFENSE .....	679
HEART .....	630	IMPOSSIBILITY.....	679
HEAT .....	631	IMPRESSION.....	681
HEAVENS .....	633	IMPROBABILITY.....	681
HEILIGENSCHIN .....	635	INADEQUACY .....	682
HEMATOCRIT.....	635	INCONCEIVABLILITY.....	682
HEREDITY.....	635	INDEPENDENCE.....	682
HERITAGE.....	635	INDEX FOSSIL.....	682
HERNIA .....	635	INDIGESTION .....	682
HERPES.....	635	INDIVIDUAL.....	682
HETEROCHRONIC CHANGE .....	636	INDIVIDUALITY .....	682
HETEROGENEITY.....	636	INDUCTION .....	683
HEXAGON.....	636	INERTIA .....	683
HIEROGLIPHICS .....	636	INFECTON .....	684
HILBERT .....	636	INFERENCE.....	684



INFINITE.....	684	KEY .....	711
INFINITESIMAL .....	688	KINGDOM .....	711
INFINITY .....	689	KNOT.....	711
INFORMATION .....	692	KNOWING .....	711
INGENUITY.....	694	KNOWLEDGE .....	711
INHERITANCE.....	694	LABEL.....	737
INNOVATION .....	694	LABORATORY .....	737
INORGANIC .....	695	LABYRINTH .....	739
INSANITY.....	695	LAKE.....	739
INSCRIPTION.....	695	LAND .....	739
INSIGHT.....	695	LANDSCAPE.....	740
INSOMNIAC .....	696	LANGUAGE.....	740
INSPIRATION.....	696	LATIN SQUARE.....	743
INSTINCT .....	696	LAVA.....	743
INSTRUMENT .....	696	LAVA BEDS .....	744
INSULIN.....	698	LAW .....	744
INTEGER .....	698	LAW OF GRAVITATION .....	754
INTEGRAL.....	699	LAW OF NATURE.....	754
INTEGRATION.....	699	LAW OF VARIATION .....	756
INTELLECT .....	699	LEARNING .....	756
INTELLECTUAL.....	700	LECTURE.....	758
INTELLIGENCE.....	700	LEMMA.....	759
INTELLIGENT DESIGN .....	701	LEPROSY .....	759
INTERACTION.....	701	LEVER.....	759
INTERDEPENDENCE.....	702	LIBERALITY .....	759
INTERN .....	702	LIFE .....	759
INTERNIST.....	702	LIGHT.....	774
INTERPRETATION .....	702	LIGHT YEAR.....	777
INTERSTELLAR MESSAGE.....	702	LIGHTNING.....	777
INTESTINE .....	702	LIKELIHOOD .....	778
INTUITION .....	703	LIMIT .....	778
INVALID .....	703	LINE .....	779
INVARIANCE .....	703	LITERATURE .....	779
INVARIANTS.....	703	LIVER.....	781
INVENTION.....	704	LIVING FOSSILS .....	781
INVENTOR .....	706	LIVING MATTER.....	782
INVESTIGATION .....	707	LIVING VERSUS DEAD .....	782
INVESTIGATOR.....	708	LOCATION.....	782
ION .....	708	LOGARITHM.....	782
IRRATIONALITY .....	708	LOGIC .....	782
IRREVERSABILITY.....	709	LOGICIAN .....	785
ISOMERISM .....	709	LONELINESS .....	786
ISOSTASY .....	709	LUCK.....	786
IT.....	709	LUNG .....	786
JAW.....	710	MACHINE.....	787
JEALOUSY .....	710	MACHINERY.....	788
JOURNAL .....	710	MACROEVOLUTION .....	788
JOURNEY .....	710	MAGIC .....	788
JUDGMENT .....	710	MAGMA .....	790
JUSTIFICATION.....	710	MAGNET.....	790

MAGNETISM .....	790	MARTYRDOM .....	803
MAGNITUDE .....	791	MASS.....	803
MAL DE MER .....	791	MATHEMATICAL SCIENCE .....	803
MALADY .....	792	MATHEMATICIAN .....	869
MALARIA .....	792	MATTER.....	883
MALARIOLOGIST.....	792	MAXWELL’S THEORY .....	889
MALPRACTICE .....	792	MEANING.....	889
MAN .....	792	MEASLES .....	889
MANDLEBROT SET.....	801	MEASUREMENT .....	889
MANKIND .....	801	MECHANICS .....	892
MAP.....	802	MEDIAN.....	894
MARINE BIOLOGY.....	803	MEDICAL SCIENCE.....	894
MARTIAN .....	803	INDEX .....	I-1

# Contents (Volume II)

MEDICINE AND ART .....	905	MINERAL: SALT .....	928
MEMORY .....	905	MINERAL: SANDSTONE .....	928
MENSTRUATION .....	905	MINERAL: SAPPHIRE .....	929
METAL .....	905	MINERALOGIST .....	929
METAPHOR .....	906	MINERALOGY .....	929
METAPHYSICS .....	908	MINING .....	929
METEOR .....	908	MIRACLE .....	930
METEORITE .....	911	MIRROR .....	930
METHOD .....	912	MISERY .....	930
METRICS .....	914	MISTAKE .....	930
MICROBE .....	915	MITOCHONDRION .....	931
MICROBIOLOGY .....	915	MIXTURE .....	931
MICROCOSM .....	915	MODEL .....	931
MICROPALEONTOLOGY .....	916	MOLAR SOLUTION .....	936
MICROSCOPE .....	916	MOLECULAR BIOLOGY .....	936
MIGRATION .....	917	MOLECULAR HYPOTHESIS .....	936
MILKY WAY .....	918	MOLECULE .....	937
MIND .....	920	MOMENTUM .....	940
MINERAL .....	924	MONKEYS AND TYPEWRITERS .....	940
MINERAL: ALABASTER .....	924	MONOGRAPH .....	941
MINERAL: AMBER .....	924	MONOPOLE .....	941
MINERAL: AMETHYST .....	925	MONSTER .....	942
MINERAL: CHALK .....	925	MOON .....	942
MINERAL: COAL .....	925	MOON LANDING .....	946
MINERAL: CRYSTAL .....	925	MORPHOLOGY .....	947
MINERAL: DIAMOND .....	926	MOTION .....	947
MINERAL: EMERALD .....	927	MOUNTAIN .....	950
MINERAL: FLINT .....	927	MUCOUS .....	952
MINERAL: GRANITE .....	927	MULTIPLICATION .....	952
MINERAL: JADE .....	927	MUON .....	953
MINERAL: LOADSTONE .....	927	MUSEUM .....	953
MINERAL: MARBLE .....	927	MUTATION .....	953
MINERAL: OPAL .....	928	MUTUALISM .....	954
MINERAL: PEARL .....	928	MYRMECOLOGIST .....	954

MYSTERY.....	954	ORGANIC CHEMISTRY .....	1052
MYSTICISM .....	957	ORGANISM .....	1053
MYTH.....	957	ORGANIZATION.....	1054
NAME.....	959	ORGANS .....	1055
NATURAL HISTORY .....	962	ORIGIN OF LIFE.....	1055
NATURAL LAW .....	963	ORIGINALITY.....	1055
NATURAL SCIENCE .....	963	ORNITHOLOGY .....	1056
NATURAL SELECTION .....	963	OSMOTIC PRESSURE.....	1056
NATURAL THEOLOGY .....	967	OSTEOPATH.....	1056
NATURALISM.....	967	OTHER WORLDS .....	1056
NATURALIST.....	968	OUTER SPACE .....	1057
NATURE.....	970	OUTLIER .....	1058
NEANDERTHAL.....	1006	PAIN.....	1059
NEBULA .....	1006	PALEONTOLOGIST.....	1060
NECESSITY .....	1007	PALEONTOLOGY .....	1061
NEURONS.....	1007	PANSPERMIA.....	1063
NEUROPHYSIOLOGY .....	1007	PARABOLA .....	1063
NEUROSCIENCE .....	1007	PARADIGM.....	1064
NEUTRINO .....	1007	PARADISE .....	1064
NEUTRON.....	1009	PARADOX.....	1065
NEWTONIAN MECHANICS.....	1009	PARASITE.....	1067
NIGHT .....	1010	PARKINSON'S DISEASE.....	1068
NOCTURNAL.....	1011	PARTICLE.....	1068
NONSENSE.....	1011	PAST .....	1070
NOTATION.....	1011	PATENT .....	1072
NOVAE .....	1012	PATENT MEDICINE .....	1072
NUCLEUS .....	1012	PATHOLOGY .....	1072
NULL HYPOTHESIS .....	1012	PATIENT.....	1073
NUMBER .....	1013	PATTERN .....	1074
NUMBER, FIBONACCI.....	1021	PAULI PRINCIPLE .....	1075
NUMBER THEORY .....	1021	PENDULUM .....	1075
NURSING.....	1022	PENICILLIN.....	1076
NUTRITION.....	1024	PERCENTAGE .....	1076
OBJECTIVITY .....	1025	PERCEPTION .....	1076
OBSCURATIONISM .....	1025	PERCUSSION .....	1077
OBSERVATION.....	1025	PERIODIC TABLE .....	1077
OBSERVATORY.....	1038	PERPETUAL MOTION .....	1078
OBSERVER.....	1039	PESSIMISM .....	1079
OBSTETRICS.....	1039	PEST CONTROL .....	1079
OCCAM'S RAZOR.....	1039	PESTILENCE .....	1079
OCEAN.....	1040	PETRIFICATION .....	1079
OCEANOGRAPHY .....	1045	PETROLOGY .....	1079
ODDS.....	1045	PH.D.....	1079
OMEGA POINT .....	1045	PHARMACIST .....	1079
OPINION .....	1046	PHARMACY .....	1080
OPIUM.....	1047	PHENOMENA.....	1080
OPTICS.....	1047	PHILOSOPHER .....	1081
ORBIT.....	1048	PHILOSOPHER'S STONE.....	1081
ORDER.....	1048	PHILOSOPHY.....	1081
ORGAN TRANSPLANT .....	1051	PHILOSOPHY OF SCIENCE.....	1084

PHOSPHORUS.....	1090	PRINCIPLE .....	1174
PHOTOELECTRIC .....	1090	PROBABILITY .....	1174
PHOTOGRAPHY .....	1091	PROBABLE ERROR.....	1188
PHOTON.....	1091	PROBLEM.....	1188
PHOTOSYNTHESIS.....	1091	PROGRESS .....	1197
PHYLOGENESIS.....	1091	PROOF.....	1200
PHYLOGENY .....	1091	PROPHECY.....	1203
PHYSIC .....	1092	PROPOSITION.....	1203
PHYSICAL LAW .....	1092	PROTON .....	1204
PHYSICAL SCIENCE .....	1093	PROTOPLASM .....	1204
PHYSICIAN .....	1093	PROVINCIAL REGION .....	1204
PHYSICIST .....	1108	PSEUDOSCIENCE .....	1204
PHYSICS .....	1117	PSYCHICAL CONSTITUTION.....	1204
PHYSIOGNOMY .....	1137	PUBLIC SPEAKING .....	1204
PHYSIOLOGIST .....	1137	PURITY .....	1204
PHYSIOLOGY .....	1137	PURPOSE.....	1204
PI.....	1138	PYRAMID .....	1205
PILL .....	1139	PYTHAGORAS .....	1205
PLANET .....	1139	QUACK.....	1206
PLANET: EARTH .....	1143	QUALITIES.....	1207
PLANET: JUPITER.....	1153	QUANTIFICATION .....	1207
PLANET: MARS.....	1153	QUANTUM MECHANICS.....	1208
PLANET: MERCURY.....	1155	QUARK.....	1214
PLANET: NEPTUNE.....	1156	QUASAR .....	1215
PLANET: SATURN.....	1156	QUATERNION.....	1215
PLANET: URANUS.....	1156	QUESTION.....	1215
PLANET: VENUS.....	1156	QUESTIONNAIRE.....	1221
PLANKTON .....	1157	QUOTATION .....	1221
PLANT.....	1157	RACISM .....	1222
PLATE TECTONICS.....	1160	RADIATION .....	1222
PMS.....	1161	RADICAL.....	1222
POINT.....	1161	RADIO ASTRONOMY.....	1223
POINT OF VIEW .....	1161	RAIN FOREST .....	1223
POLLUTION .....	1161	RAINBOW.....	1223
POPULATION .....	1163	RAMIFICATION .....	1224
POSITION .....	1163	RANDOMNESS .....	1224
POSITRON .....	1163	RANDOM DIGITS.....	1224
POSSIBILITY.....	1163	RANDOM NUMBER.....	1225
POSTULATE .....	1163	RATIOCINATION .....	1225
POWER.....	1163	REACTION .....	1225
PRAYER .....	1164	READING.....	1225
PRECISION.....	1165	REAL (BEING) .....	1225
PREDICTION.....	1165	REALITY .....	1226
PREHISTORIC MAN .....	1167	REASONING .....	1230
PREHISTORY .....	1167	RECOGNITION .....	1237
PRESCRIPTION.....	1168	RECORD .....	1237
PRESENT .....	1169	RECOVERY .....	1237
PRESERVATION.....	1169	RECTANGLE .....	1237
PRIME NUMBER .....	1169	RECURSION.....	1237
PRIMORDIAL.....	1174	RED SHIFT .....	1238

REDUCTIONISM .....	1238	SCIENCE AND ART .....	1369
REFEREE .....	1239	SCIENCE AND CIVILIZATION.....	1374
REFORM .....	1239	SCIENCE AND MORALS .....	1375
REGRESSION.....	1239	SCIENCE AND PHILOSOPHY .....	1377
RELATION.....	1240	SCIENCE AND POETRY.....	1379
RELATIVITY .....	1240	SCIENCE AND POLITICS .....	1381
RELIABILITY.....	1244	SCIENCE AND RELIGION .....	1382
RELIGION.....	1244	SCIENCE AND SOCIETY .....	1396
RENORMALIZATION .....	1244	SCIENCE AND STATE .....	1402
REPAIR.....	1244	SCIENCE AND SUPERSTITION.....	1403
REPLICA.....	1244	SCIENCE AND WOMEN.....	1404
REPORT .....	1245	SCIENCE CREED.....	1406
REPRODUCTION.....	1245	SCIENCE FICTION.....	1406
RESEARCH.....	1246	SCIENCE GEEK .....	1407
RESEARCH PLAN .....	1255	SCIENTIFIC COMMUNITY.....	1407
RESIDUAL.....	1256	SCIENTIFIC CRITICISM.....	1407
RESPIRATION .....	1256	SCIENTIFIC DOUBT .....	1408
RESPONSIBILITY.....	1256	SCIENTIFIC INQUIRY .....	1408
REST.....	1256	SCIENTIFIC INVESTIGATION .....	1409
RESULT.....	1256	SCIENTIFIC LITERACY .....	1411
RETROGRADE MOTION.....	1257	SCIENTIFIC METHOD.....	1411
REVOLUTION.....	1257	SCIENTIFIC MIND .....	1417
RIDDLE.....	1258	SCIENTIFIC PROGRESS.....	1420
RIEMANN HYPOTHESIS .....	1258	SCIENTIFIC PUBLISHING .....	1421
RIGHTS OF ANIMALS.....	1260	SCIENTIFIC SPIRIT.....	1425
RIGOR .....	1260	SCIENTIFIC TRENDS .....	1426
RISK .....	1260	SCIENTIFIC TRUTH.....	1426
RIVER.....	1260	SCIENTIFIC WORK.....	1429
ROBOT .....	1262	SCIENTIST.....	1430
ROCK.....	1262	SCRIBBLES .....	1452
ROCKET.....	1264	SEA .....	1452
ROCKFALL.....	1264	SEA SERPENT.....	1457
ROTATION OF EARTH.....	1265	SEA SICKNESS .....	1457
RUIN .....	1265	SEASIDE .....	1457
RULE .....	1266	SEDIMENT .....	1457
RUST .....	1266	SEED.....	1457
SAGACITY.....	1267	SEISMOGRAPH .....	1458
SAMPLE.....	1267	SEISMOGRAPHER .....	1458
SAND.....	1268	SEISMOGRAPHY .....	1458
SAVANT .....	1269	SELF .....	1459
SCATTERING.....	1269	SELF-AWARENESS .....	1459
SCAVENGER .....	1269	SELF-DELUSION.....	1459
SCENERY.....	1269	SEMINAR.....	1459
SCIATICA.....	1269	SENSES .....	1459
SCIENCE.....	1269	SERIES .....	1459
SCIENCE, AGE OF.....	1350	SET THEORY .....	1459
SCIENCE, APPLIED .....	1350	SEX.....	1460
SCIENCE, COMMUNICATION OF .....	1351	SEXUALITY .....	1460
SCIENCE, HISTORY OF.....	1354	SHADOW .....	1461
SCIENCE, MAN OF.....	1360	SHAPES.....	1461
SCIENCE, PROGRESS OF .....	1365	SHELL .....	1461

SHORE .....	1461	STREAM .....	1548
SICKNESS.....	1462	STREPTOMYCIN .....	1548
SIGHT.....	1464	STRING THEORY .....	1549
SIMPLICITY .....	1464	STRUCTURE .....	1549
SIMULTANEITY.....	1468	STUDENT .....	1549
SINGULARITY.....	1468	STUDY .....	1549
SITE.....	1469	STUPIDITY .....	1550
SIZE.....	1469	SUBSTANCE.....	1550
SKELETON .....	1469	SUBTERRANEAN.....	1550
SKEPTICISM .....	1469	SUN.....	1551
SKIN .....	1470	SUNSPOT.....	1555
SKY.....	1470	SUPERNOVA .....	1556
SLEEP.....	1472	SUPERSTITION.....	1556
SNOW .....	1472	SUPERSTRING.....	1557
SOIL.....	1473	SUPPOSITION.....	1557
SOLAR SYSTEM.....	1474	SURFACE TENSION.....	1557
SOLID STATE.....	1476	SURGEON.....	1557
SOLUBILITY .....	1476	SURGERY .....	1560
SOLUTION.....	1476	SURPRISE.....	1562
SOUL .....	1477	SURVEY .....	1563
SOUND.....	1477	SURVIVAL .....	1564
SPACE.....	1477	SYMBIONTICISM.....	1564
SPACE AGE .....	1482	SYMBIOSIS .....	1564
SPACE EXPLORATION.....	1482	SYMBIOTE .....	1565
SPACE FLIGHT .....	1490	SYMBOL.....	1565
SPACE SETTLEMENT.....	1491	SYMBOLIC LOGIC.....	1566
SPACE-TIME.....	1491	SYMMETRY .....	1567
SPECIALIZATION.....	1494	SYMPTOM.....	1569
SPECIES .....	1496	SYNTHESIS .....	1569
SPECIFICATION .....	1498	SYSTEM.....	1570
SPECTROSCOPE.....	1499	SYSTEMATICS.....	1571
SPECTRUM.....	1499	TABLE .....	1573
SPECTRUM ANALYSIS .....	1500	TACHYON.....	1573
SPECULATION.....	1500	TAXONOMIST .....	1573
SPIN.....	1501	TAXONOMY.....	1574
SPIRAL ARMS .....	1501	TEACHER .....	1575
SPONTANEOUS GENERATION.....	1501	TEACHING .....	1575
STAMP COLLECTING .....	1501	TECHNOLOGY .....	1579
STANDARD .....	1502	TEETH.....	1585
STAR.....	1502	TEKTITES .....	1586
STARLIGHT.....	1520	TELEOLOGY .....	1586
STATISTICAL TEST .....	1521	TELESCOPE .....	1587
STATISTICIAN .....	1522	TEMPERATURE.....	1591
STATISTICS .....	1526	TEMPLE OF SCIENCE.....	1591
STATISTICS AND MEDICINE.....	1545	TENSOR .....	1592
STATISTICS AND SOCIETY .....	1546	TESTING .....	1593
STETHOSCOPE.....	1547	THEOREM .....	1593
STOMACH .....	1547	THEORIST .....	1594
STONE.....	1547	THEORY.....	1595
STORM.....	1548	THEORY OF FUNCTIONS.....	1617
STRATIGRAPHY.....	1548	THERMODYNAMICS.....	1617

THERMOMETER .....	1620	VECTOR ANALYSIS .....	1708
THINKING .....	1620	VEGETARIAN .....	1708
THOUGHT .....	1621	VEGETATION .....	1708
THUNDERBOLT .....	1624	VENUS, TRANSIT OF .....	1708
TIDAL BORE .....	1624	VERNAL EQUINOX .....	1709
TIDE .....	1624	VERNIER .....	1709
TIME .....	1624	VERTEBRATE .....	1709
TIME TRAVEL .....	1636	VIBRATION .....	1709
TOOL .....	1637	VIEW .....	1709
TOOTH .....	1637	VIRUS .....	1709
TOOTHACHE .....	1638	VITALITY .....	1710
TRACK .....	1639	VITAMIN .....	1710
TRACKING .....	1640	VOID .....	1710
TRADITION .....	1640	VOLATILITY .....	1710
TRANSISTOR .....	1640	VOLCANO .....	1710
TREE .....	1640	VOLCANOLOGIST .....	1714
TREE OF LIFE .....	1647	VOLUME .....	1714
TREE RINGS .....	1647	WARNING .....	1715
TRIAL AND ERROR .....	1647	WATER .....	1715
TRIANGLE .....	1647	WAVE .....	1718
TRIGONOMETRY .....	1648	WAVE MECHANICS .....	1718
TRILOBITE .....	1648	WAVE-PARTICLE DUALITY .....	1718
TRUTH .....	1649	WEAPON .....	1718
TUNNELING .....	1662	WEATHER .....	1718
TURBULENCE .....	1662	WEED .....	1719
TYPHUS .....	1662	WEIGHT .....	1719
TYPOLOGY .....	1663	WEIGHTLESSNESS .....	1719
UFO .....	1664	WETLANDS .....	1719
UNCERTAINTY .....	1664	WHIRLPOOL .....	1720
UNCERTAINTY PRINCIPLE .....	1665	WHITE DWARF .....	1720
UNDERSTANDING .....	1665	WILDERNESS .....	1720
UNEXPECTED .....	1671	WILDLIFE .....	1721
UNIFIED FIELD THEORY .....	1671	WIND .....	1722
UNIFORMITARIANISM .....	1672	WISDOM .....	1722
UNIQUENESS .....	1672	WONDER .....	1724
UNITS .....	1672	WORD .....	1726
UNIVERSE .....	1673	WORK .....	1727
UNIVERSE AND COSMOGENESIS .....	1696	WORLD .....	1727
UNIVERSE, DEATH OF .....	1699	WRITING .....	1729
UNKNOWN .....	1702	WRONG .....	1731
UREA .....	1704	X-RAY .....	1732
URIC ACID .....	1704	YELLOW FEVER .....	1734
URINANALYSIS .....	1704	ZEEMAN EFFECT .....	1735
VACCINATION .....	1705	ZERO .....	1735
VACUUM .....	1705	ZETA .....	1735
VALUE .....	1706	ZETA FUNCTION .....	1736
VARIANCE .....	1706	ZOO .....	1736
VARIATION .....	1706	ZOOLOGIST .....	1737
VARIETY .....	1708	ZOOLOGY .....	1737
VECTOR .....	1708	INDEX .....	II-1



## A

### ABORTION

#### **Hachamovitch, Moshe**

American physician

By and large, legal or not, the procedure is still a pariah of our specialty.

In Louise Kapp Howe

*Moments on Maple Street*

Chapter Three (p. 21)

The Macmillan Company. New York, New York, USA. 1984

#### **Hippocrates** 460 BCE–377 BCE

Greek physician

...I will not give to a woman a pessary to produce abortion.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

The Oath (p. xiii)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

#### **Kennedy, Florynce** 1916–2000

American black activist and lawyer

If men could get pregnant, abortion would be a sacrament.

The Verbal Karate of Florynce Kennedy

*Ms.*, March 1973 (p. 2)

#### **Nolan, James Joseph**

No biographical data available

Physicians roasted on the spit;

Is learning the name of it?

For complications, spare no precaution;

To save a life think abortion.

On Renewed Maternal Mortality Reports

*The New England Journal of Medicine*, Volume 286, Number 17, April 27, 1972 (p. 952)

#### **Pope Pius XI** 1857–1939

Bishop of Rome and Italian scholar

However we may pity the mother whose health and even life is imperiled by the performance of her natural duty, there yet remains no sufficient reason for condoning the direct murder of the innocent.

*Casti connubii*

December 31, 1930

#### **Reagan, Ronald W.** 1911–2004

40<sup>th</sup> president of the United States

I've noticed that everybody that is for abortion has already been born.

Presidential campaign debate, Baltimore, Maryland, 21 September 1980

#### **Tertullian** ca. 162–224

North African theologian

It's a committing murder before hand, to destroy that which is to be born.

*Apologeticus*

IX, 197

Printed by Thomas Harper. London, England. 1655

### ABSORPTION LINE

#### **Bunsen, Robert Wilhelm Eberhard** 1811–99

German chemist

At the moment I am occupied by an investigation with Kirchoff which does not allow us to sleep. Kirchoff has made a totally unexpected discovery, inasmuch as he has found out the cause for the dark lines in the solar spectrum and can produce these lines artificially intensified both in the solar spectrum and in the continuous spectrum of a flame, their position being identical with that of Fraunhofer's lines. Hence the path is opened for the determination of the chemical composition of the Sun and the fixed stars.

*The Life and Experiences of Sir Henry Enfield Roscoe*

Letter from Robert Bunsen to H.E. Roscoe, November 1859 (p. 71)

London, England. 1906

### ABSTRACTNESS

#### **Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The root of these troubles seems to be the unimaginative lack of a clearly recognized objective. — If the aim is merely to create new theories which many find intensely interesting and even beautiful, then the abstract method keeps on reaching its goal.

*The Development of Mathematics* (p. 248)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

Abstractness, sometimes hurled as a reproach at mathematics, is its chief glory and its surest title to practical usefulness.

*Mathematics* (p. 19)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

#### **Einstein, Albert** 1879–1955

German-born physicist

Anyone who has ever tried to present a rather abstract scientific subject in a popular manner knows the great difficulties of such an attempt.

In Lincoln Barnett

*The Universe and Dr. Einstein*

Forward (p. 1)

William Sloane Associates. New York, New York, USA. 1948

#### **Gell-Mann, Murray** 1929–

American physicist

In our work we are always between Scylla and Charybdis; we may fail to abstract enough, and miss important

physics, or we may abstract too much and end up with fictitious objects in our models turning into real monsters to devour us.

Quarks

*Acta Physica Austriaca*, Supplement 9, 1972 (p. 760)

**Joubert, Joseph** 1754–1824

French moralist

How many people become abstract in order to appear profound! Most abstract terms are shadows that conceal a void.

Translated by H.P. Collins

*Pensées and Letters of Joseph Joubert*

Chapter XI (p. 88)

Books for Libraries. Freeport, New York, USA. 1972

**Kemeny, John** 1926–92

Hungarian-born mathematician

If you have a large number of unrelated ideas, you have to get quite a distance away from them to get a view of all of them, and this is the role of abstraction. If you look at each too closely you see too many details. If you get far away things may appear simpler because you can only see the large, broad outlines; you do not get lost in petty details.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 3)

Rigor Versus Intuition in Mathematics (pp. 226–227)

Wadsworth, Inc. Belmont, California, USA. 1984

## ABSTRACTION

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Although there is a most intimate connection, and almost an identity between the ways of human power and human knowledge, yet, on account of the pernicious and inveterate habit of dwelling upon abstractions, it is by far the safest method to commence and build up the sciences from those foundations which bear a relation to the practical division, and to let them mark out and limit the theoretical.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

Second Book, Section 4 (p. 137)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bagehot, Walter** 1826–77

English journalist

Nature does not wear her most useful lessons on her sleeve; she only yields her most productive secrets, those which yield the most wealth and the most “fruit,” to those who have gone through a long process of preliminary abstraction.

*Physics and Politics*

Chapter 6 (p. 196)

Ivan R. Dee, Publisher. Chicago, Illinois, USA. 1999

**Bohm, David** 1917–92

American physicist

All is process. That is to say “there is ‘no thing’ in the universe.” Things, objects, entities, are abstractions of what is relatively constant from a process of movement and transformation. They are like the shapes that children like to see in the clouds.

In C.H. Waddington (ed.)

*Towards a Theoretical Biology: An IUBS Symposium* (Volume 2)

Further Remarks on Order (p. 42)

Aldine Publishing Company. Chicago, Illinois, USA. 1968

**Boole, George** 1815–64

English mathematician

Of the many forms of false culture, a premature converse with abstractions is perhaps the most likely to prove fatal to the growth of a masculine vigor of intellect.

*A Treatise on Differential Equations*

Preface (p. vi)

Chelsea Publishing Company. New York, New York, USA. 1959

**Devlin, Keith** 1947–

English mathematician and writer

The increased abstraction in mathematics that took place during the early part of this century was paralleled by a similar trend in the arts. In both cases, the increased level of abstraction demands greater effort on the part of anyone who wants to understand the work.

*Mathematics: The Science of Patterns*

Chapter 2 (p. 55)

Scientific American Library. New York, New York, USA. 1994

**Dingle, Herbert** 1890–1978

English astrophysicist

Abstraction is the detection of a common quality in the characteristics of a number of diverse observations: it is the method supremely exemplified in the work of Newton and Einstein.... A hypothesis serves the same purpose, but in a different way. It relates apparently diverse experiences, not by directly detecting a common quality in the experiences themselves, but by inventing a fictitious substance or process or idea, in terms of which the experience can be expressed. A hypothesis, in brief, correlates observations by adding something to them, while abstraction achieves the same end by subtracting something.

*Science and Human Experience* (pp. 222–223)

Williams & Norgate Ltd. London, England. 1931

**Einstein, Albert** 1879–1955

German-born physicist

The theoretical scientist is compelled in an increasing degree to be guided by purely mathematical, formal considerations in his search for a theory, because the physical experience of the experimenter cannot lift him into the

regions of highest abstraction.

Translated by Alan Harris

*Essays in Science*

The Problem of Space (p. 69)

Philosophical Library. New York, New York, USA. 1934

**Haber, Fritz** 1868–1934

German physical chemist

The field of scientific abstraction encompasses independent kingdoms of ideas and of experiments and within these, rulers whose fame outlasts the centuries.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 8 (p. 174)

W.A. Benjamin. New York, New York, USA. 1965

**Huxley, Aldous** 1894–1963

English writer and critic

Knowledge is power and, by a seeming paradox, it is through their knowledge of what happens in this unexperienced world of abstractions and inferences that scientists and technologists have acquired their enormous and growing power to control, direct and modify the world of manifold appearances in which human beings are privileged and condemned to live.

*Literature and Science*

Chapter 3 (p. 9)

Harper & Row, Publishers. New York, New York, USA. 1963

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The power of using abstractions is the essence of intellect, and with every increase in abstraction the intellectual triumphs of science are enhanced.

*The Scientific Outlook*

Chapter III (p. 87)

George Allen & Unwin Ltd. London, England. 1931

**Sullivan, John William Navin** 1886–1937

Irish mathematician

Science, indeed, tells us a very great deal less about the universe than we have been accustomed to suppose, and there is no reason to believe that all we can ever know must be couched in terms of its thin and largely arbitrary abstractions.

*Beethoven, His Spiritual Development*

Art and Reality (pp. 21–22)

Alfred A. Knopf. New York, New York, USA. 1964

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

You know of course that a mathematical line, a line of thickness nil, has no real existence. They taught you that? Neither has a mathematical plane. These things are mere abstractions.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine, Chapter One (p. 449)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

It is this union of passionate interest in the detailed facts with equal devotion to abstract generalisation which forms the novelty in our present society.... This balance of mind has now become part of the tradition which infects cultivated thought. It is the salt which keeps life sweet.

*Science and the Modern World*

Chapter I (p. 4)

The Macmillan Company. New York, New York, USA. 1929

The point of mathematics is that in it we have always got rid of the particular instance, and even of any particular sorts of entities. So that for example, no mathematical truths apply merely to fish, or merely to stones, or merely to colours. So long as you are dealing with pure mathematics, you are in the realm of complete and absolute abstraction.... Mathematics is thought moving in the sphere of complete abstraction from any particular instance of what it is talking about.

*Science and the Modern World*

Chapter II (pp. 31–32)

The Macmillan Company. New York, New York, USA. 1929

...the utmost abstractions are the true weapons with which to control our thought of concrete fact.

*Science and the Modern World*

Chapter II (p. 32)

The Macmillan Company. New York, New York, USA. 1929

For mathematics is the science of the most complete abstractions to which the human mind can attain.

*Science and the Modern World*

Chapter II (p. 51)

The Macmillan Company. New York, New York, USA. 1929

...to be an abstraction does not mean that an entity is nothing. It merely means that its existence is only one factor of a more concrete element of nature.

*The Concept of Nature*

Chapter VIII (p. 171)

At the University Press. Cambridge, England. 1920

**Wilder, Raymond L.** 1896–1982

American mathematician

There is nothing mysterious, as some have tried to maintain, about the applicability of mathematics. What we get by abstraction from something can be returned!

*Introduction to the Foundations of Mathematics*

Chapter XII (p. 275)

John Wiley & Sons, Inc. New York, New York, USA. 1952

**Young, John Zachary** 1907–97

English zoologist

It is of our very nature to see the universe as a place that we can talk about. In particular, you will remember, the

brain tends to compute by organizing all of its input into certain general patterns. It is natural for us, therefore, to try to make these grand abstractions, to seek for one formula, one model, one God, around which we can organize all our communication and the whole business of living.

*Doubt and Certainty in Science: A Biologist's Reflections on the Brain*  
Eighth Lecture (p. 163)  
Oxford University Press, Inc. Oxford, England. 1960

## ABYSS

**Nietzsche, Friedrich** 1844–1900  
German philosopher

If you gaze long into an abyss, the abyss will gaze back into you.

*Beyond Good and Evil*  
Aphorism 146  
The Modern Library. New York, New York, USA. 1917

## ACADEMIC MIND

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

The academic mind, as we know, is sometimes capable of assuming an aggressive attitude. The official mind, on the contrary, is and has to be, expert in the art of self-defense.

Presidential address, First Indian Statistical Congress, 1938

## ACCELERATOR

**Lederman, Leon** 1922–  
American high-energy physicist

The accelerator laboratory became a service center with a variety of products. By the late 1980s, Fermilab's sales force advertised to potential customers that the following hot and cold running beams were available: protons, neutrons, pions, kaons, muons, neutrinos, antiprotons, hyperons, polarized protons (all spinning in the same direction), tagged photons (we know their energy), and if you don't see it, ask!

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 6 (p. 251)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

## ACCIDENT

**Davy, Sir Humphry** 1778–1829  
English chemist

...it requires a certain degree of knowledge and scientific combination to understand and seize upon the facts which have originated in accident.

*Consolations in Travel, or the Last Days of a Philosopher*  
Dialogue V (pp. 233–234)  
J. Murray. London, England. 1830

**Gregg, Alan** 1890–1957  
American medical educator and philosopher

One wonders whether the rare ability to be completely attentive to, and to profit by, nature's slightest deviation from the conduct expected of her is not the secret of the best research minds and one that explains why some men turn to most remarkably good advantage seemingly trivial accidents. Behind such attention lies an unremitting sensitivity...

*The Furtherance of Medical Research*  
Chapter III (p. 98)  
Yale University Press. New Haven, Connecticut, USA. 1941

**Gribbin, John** 1946–  
English science writer and astronomer

Our form of life depends, in delicate and subtle ways, on several apparent "coincidences" in the fundamental laws of nature which make the Universe tick. Without those coincidences, we would not be here to puzzle over the problem of their existence.... What does this mean? One possibility is that the Universe we know is a highly improbable accident, "just one of those things".

*Genesis: The Origins of Man and the Universe*  
Chapter 9 (p. 307)  
Delacorte Press. New York, New York, USA. 1981

**Lessing, Gotthold Ephraim** 1729–81  
German philosopher, dramatist, and critic

Nothing under the sun is coincidence.

*Emilia Galotti*  
Act V, Scene 3  
Frederick Ungar Publications Company. New York, New York, USA. 1962

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

What hope is there then of human improvement? According to the Neo-Darwinists, to the Mechanists, no hope whatever, because improvement can come only through some senseless accident which must, on the statistical average of accidents, be presently wiped out by some other equally senseless accident.

*Back to Methuselah*  
Preface (p. xvi)  
Constable & Company Ltd. London, England. 1921

## ACCOMPLISHMENT

**Berthelot, Marcellin** 1827–1907  
French chemist

What we are is due but in small measure to our own labor and to our personal individuality, for we owe it almost

entirely to our ancestors — ancestors by blood and ancestors of our character. If any of us add anything to the common good in the realm of science, of art, or of morality, it is because a long line of generations has lived, toiled, thought, and suffered before us.

In Camille Matignon

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Marcellin Berthelot (p. 684)

Government Printing Office. Washington, D.C. 1908

**Einstein, Albert** 1879–1955

German-born physicist

I refuse...to make money out of my science. My laurel is not for sale like so many bales of cotton.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 17)

## ACCURACY

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“How is bread made?”

“I know *that!*” Alice cried eagerly. “You take some flour — ”

“Where do you pick the flower?” the White Queen asked. “In a garden or in the hedges?”

“Well, it isn’t *picked* at all,” Alice explained: “it’s ground — ”

“How many acres of ground?” said the White Queen.

“You mustn’t leave out so many things.”

*The Complete Works of Lewis Carroll*

Through the Looking-Glass, Chapter IX (p. 254)

The Modern Library. New York, New York, USA. 1936

**Darwin, Charles Robert** 1809–82

English naturalist

...good heavens, how difficult accuracy is!

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Gray, June 3, 1874 (p. 457)

D. Appleton & Company. New York, New York, USA. 1896

...I value praise for accurate observation far higher than for any other quality...

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Hooker, December 11, 1860 (p. 148)

D. Appleton & Company. New York, New York, USA. 1896

Accuracy is the soul of Natural History. It is hard to become accurate; he who modifies a hair’s breadth will never be accurate.... Absolute accuracy is the hardest merit to attain, and the highest merit.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)

Darwin to Scott, July 2, 1863? (p. 323)

D. Appleton & Company. New York, New York, USA. 1903

**Fresenius, C. R.** 1818–97

German chemist

Knowledge and ability must be combined with ambition as well as with a sense of honesty and a severe conscience. Every analyst occasionally has doubts about the accuracy of his results, and also there are times when he knows his results to be incorrect. Sometimes a few drops of the solution were spilt, or some other slight mistake made. In those cases it requires a strong conscience to repeat the analysis and not to make a rough estimate of the loss or apply a correction. Anyone not having sufficient will-power to do this is unsuited to analysis no matter how great his technical ability or knowledge. A chemist who would not take an oath guaranteeing the authenticity, as well as the accuracy of his work, should never publish his results, for if he were to do so then the result would be detrimental, not only to himself, but to the whole of science.

In Ferenc Szabadváry

*History of Analytical Chemistry*

Chapter VII (p. 176)

Gordon & Breach Science. Langhorne, Pennsylvania, USA. 1992

**Gombrich, Ernst Hans** 1909–2001

English art historian and scholar

Everyone is acquainted with dogs and horses, since they are seen daily. To reproduce their likeness is very difficult. On the other hand, since demons and spiritual beings have no definite form, and no one has ever seen them, they are easy to execute.

*Art and Illusion*

Part II, Chapter VIII (p. 269)

Pantheon Books. New York, New York, USA. 1960

**Hume, David** 1711–76

Scottish philosopher and historian

Accuracy is, in every case, advantageous to beauty, and just reasoning to delicate sentiment. In vain would we exalt one by depreciating the other.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section I (p. 453)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huxley, Thomas Henry** 1825–95

English biologist

Accuracy is the foundation of everything else...

*Collected Essays* (Volume 3)

*Science and Education*

Section I, Address on Behalf of the National Association for the Promotion of Technical Education (p. 432)

Macmillan & Company Ltd. London, England. 1904

**Jevons, William Stanley** 1835–82

English economist and logician

Numerical precision is the soul of science....

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book III, Chapter XIII (p. 273)  
Macmillan & Company. London, England. 1887

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

He who has not made the experiment, or who is not accustomed to require rigorous accuracy from himself, will scarcely believe how much a few hours take from certainty of knowledge, and distinctness of imagery; how the succession of objects will be broken, how separate parts will be confused, and how many particular features and discriminations will be compressed and conglobated into one gross and general idea.

*A Journey to the Western Islands of Scotland* (pp. 239–240)  
Printed by Thomas Walker. Dublin, Ireland. 1775

**Kolthoff, I. M.** 1894–1993  
American chemist

**Sandell, E. B.**  
American chemist

Anyone who has acquired sufficient skill to make an exact analysis satisfactorily can adapt himself to the performance of a less accurate one — but the reverse is not true.

*Textbook of Quantitative Inorganic Analysis (Third Edition)*  
Introduction (p. 4)  
The Macmillan Company. New York, New York, USA. 1952

**Mitchell, Maria** 1818–89  
American astronomer and educator

The training of a girl fits her for delicate work. The touch of her fingers upon the delicate screws of an astronomical instrument might become wonderfully accurate in results; a woman's eyes are trained to nicety of color. The eye that directs a needle in the delicate meshes of embroidery will equally well bisect a star with the spider web of the micrometer. Routine observations, too, dull as they are, are less dull than the endless repetition of the same pattern in crochet-work.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter XI (pp. 237–238)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

## ACID

**Huheey, James E.**  
American chemist

In a very real sense, we can make an acid be anything we wish — the differences between the various acid-base concepts are not concerned with which is “right” but which is most convenient to use in a particular situation.

*Inorganic Chemistry: Principles of Structure and Reactivity*  
Chapter 6 (p. 207)  
Harper & Row, Publishers. New York, New York, USA. 1972

**von Liebig, Justus** 1803–73  
German organic chemist

It is no exaggeration to say, we may judge, with great accuracy, of the chemical prosperity of a country from the amount of sulphuric acid it consumes. In this point of view there is no manufacture worthy of greater attention on the part of the government.

*Familiar Letters on Chemistry and Its Relation to Commerce, Physiology, and Agriculture*  
Letter III (p. 30)  
Taylor & Walton. London, England. 1843

## ACTIVITY

**Pauli, Wolfgang** 1900–58  
Austrian-born physicist

Contrary to the strict division of the activity of the human spirit into separate departments — a division prevailing since the nineteenth century — I consider the ambition of overcoming opposites, including also a synthesis embracing both rational understanding and the mystical experience of unity, to be the mythos, spoken and unspoken, of our present day and age.

In Ken Wilbur (ed.)  
*Quantum Questions* (p. 175)  
Shambhala Publications, Inc. Boston, Massachusetts, USA. 2001

## ACTUARY

**Karpansky, L.**

No biographical data available

Analytical and graphical treatment of statistics is employed by the economist, the philanthropist, the business expert, the actuary, and even the physician, with the most surprising valuable results...

*High School Education*  
Chapter 6 (p. 134)  
New York. 1912

## ADAPTABILITY

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

Adaptability is an asset for biological survival, but paradoxically, the greatest threat to the quality of human life is that the human species is so immensely adaptable that it can survive even under the most objectionable conditions.

*Reason Awake*  
Chapter 5 (pp. 167–168)  
Columbia University Press. New York, New York, USA. 1970

One of the unique characteristics of man is that he does not live only in the present; at his best, he has a deep sense of continuity with the past and is concerned with

the future.... Adaptability must incorporate the needs of day-to-day existence subject to limitations and requirements created by the desire to preserve the past and modified by anticipations for the future.

*Man, Medicine, and Environment* (pp. 87–88)

Frederick A. Praeger. New York, New York, USA. 1968

Almost universally, man tries to eliminate the unpleasant effects of environmental forces instead of making the greater effort required to cope with them through his own adaptive physiological resources.

*Man, Medicine, and Environment* (p. 85)

Frederick A. Praeger. New York, New York, USA. 1968

## ADDICTION

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

Every form of addiction is bad, no matter whether the narcotic be alcohol or morphine or idealism.

*Memories, Dreams, Reflections*

Retrospect (p. 329)

Vintage Books. New York, New York, USA. 1970

**St. John, Nicholas**

Writer

Dependency is a marvelous thing. It does more for the soul than any formulation of doctor or material.

*The Addiction*

Film, 1995

## ADDITION

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“What’s one and one and one and one and one and one and one and one and one and one?”

“I don’t know,” said Alice. “I lost count.”

“She can’t do Addition,” the Red Queen interrupted.

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter IX (pp. 252–253)

The Modern Library. New York, New York, USA. 1936

**Dostoevsky, Fyodor Mikhailovich** 1821–81

Russian writer

Twice two makes four seems to me simply a piece of insolence. Twice two makes four is a pert coxcomb who stands with arms akimbo barring your path and spitting. I admit that twice two makes four is an excellent thing, but if we are to give everything its due, twice two makes five is sometimes a very charming thing too.

*The Short Novels of Dostoevsky*

Notes from Underground (p. 139)

Dial Press. New York, New York, USA. 1945

**Hardy, Thomas** 1840–1928

English poet and regional novelist

...is a woman a thinking unit at all, or a fraction always its integer? How do you argue that marriage was only a clumsy contract — which it is — how you showed all the objections to it — all the absurdities! If two and two made four when we were happy together, surely they make four now? I can’t understand it, I repeat!

*Jude the Obscure*

Part Sixth, Chapter 3, At Christminster Again (p. 359)

Harper & Brothers. New York, New York, USA. 1895

**Housman, A. E. (Alfred Edward)** 1859–1936

English poet, scholar, and satirist

To think that two and two are four

And neither five nor three

The heart of man has long been sore

And long ‘tis like to be.

*The Collected Poems of A.E. Housman*

Last Poems, XXXV (p. 142)

Henry Holt & Company. New York, New York, USA. 1940

**Ice-T** 1958–

American rapper, singer, and actor

I write rhymes with addition and algebra, mental geometry.

*Mind over Matter*

O.G.: Original Gangster CD

**Pope, Alexander** 1688–1744

English poet

Ah! why, ye Gods! Should two and two make four?

*The Complete Poetical Works* (Volume 4)

The Dunciad, Book 2, l. 285

Houghton Mifflin Company. New York, New York, USA. 1903

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Mrs. Bashom: At school I got as far as addition and subtraction; but I never could do multiplication or division.

Newton: Why, neither could I: I was too lazy. But they are quite unnecessary: addition and subtraction are quite sufficient. You ask the logarithms of the numbers; and the antilogarithm of the sum of the two is the answer. Let me see: three time seven?

*The Complete Plays of Bernard Shaw*

In Good King Charles’s Golden Days, Act I (p. 1335)

Odhams Press. London, England. 1950

**West, Mae** 1893–1980

American film actress

One figure can sometimes add up to a lot.

*The Wit and Wisdom of Mae West* (p. 35)

G.P. Putnam’s Sons. New York, New York, USA. 1967

I learned that two and two are four and five will get you ten if you know how to work it.

*The Wit and Wisdom of Mae West* (p. 52)  
G.P. Putnam's Sons. New York, New York, USA. 1967

## ADENOID

### Chapin, Charles V.

American physician

[It is] more important to remove adenoids from the child than it is to remove ashes from the back yard.

*How to Avoid Infection* (p. 61)  
Harvard University Press. Cambridge, Massachusetts, USA. 2001

## ADHESIVE

### Armour, Richard 1906–89

American poet

Removing adhesive is hazardous work:

Little by little?

Or one sudden jerk?

Whichever it is, you may doubt you will win —

Removing adhesive, but leaving the skin.

*The Medical Muse*  
Stuck with It  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1963

## ADRENAL GLAND

### Addison, Thomas 1793–1860

English physician

The functions of the supra-renal capsules...are almost or altogether unknown. The large supply of blood which they receive from three separate sources; their numerous nerves, derived immediately from the semilunar ganglia and solar plexus; their early development in the foetus; their unimpaired integrity to the latest period of life; and their peculiar gland-like structure; all point to the performance of some important office.

*On the Constitutional and Local Effects of Disease of the Supra-Renal Capsules* (p. 1)  
Samuel Highley. London, England. 1855

### Jeffers, Robinson 1887–1962

American poet

He saw clearly in his mind the little  
Adrenal glands perched on the red-brown kidneys,  
As if all his doomed tissues became transparent,  
Pouring in these passions their violent secretion  
Into his blood-stream, raising the tension unbearably.  
And the thyroids: tension, tension.

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 2)  
Margrave (p. 163)  
Stanford University Press. Stanford, California. USA. 1988

Howard felt a sudden increase of force and life in his mind, like a transfusion

Of strong red blood, he thought "The faithful adrenals  
Have just heard how near death I am..."

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 2)  
Such Counsels You Gave to Me (p. 575)  
Stanford University Press. Stanford, California. USA. 1988

...the leonine adrenal glands poured their blind fury  
Into his blood...

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 3)  
Hungerfield (p. 380)  
Stanford University Press. Stanford, California. USA. 1988

## ADSORPTION

### Matthews, Albert

No biographical data available

Adsorption...is a physico-chemical term meaning the concentration of substances at phase-boundaries in heterogeneous systems. Dressing can be called a process of adsorption. Every morning when we dress, clothing which has been distributed throughout our environment — dispersed in the surrounding phase — concentrates itself at the surface of our bodies. At night the process is reversed. We might go on to express these events by a curve or isotherm, showing how the quantity adsorbed is a function of the amount in the room, how it usually proceeds to an equilibrium, how it is greater at low than at high temperatures, that it is reversible and not accompanied by chemical change in the clothes, that it is specific in that certain clothes are adsorbed with greater avidity than others, that certain adsorbents (people) adsorb with greater avidity than others, or more so, and finally we could prove that the clothing moved into the surface film in virtue of the second law of thermodynamics and in consonance with the principle of Willard Gibbs.

In Joseph Needham  
*The Sceptical Biologist*  
The Sceptical Biologist, IV (p. 33)  
W.W. Norton & Company, Inc. New York, New York, USA. 1930

## AESTHETIC

### Bernstein, Jeremy 1929–

American physicist, educator, and writer

In science as in the arts, sound aesthetic judgments are usually arrived at only in retrospect. A really new art form or scientific idea is almost certain at first to appear ugly. The obviously beautiful, in both science and the arts, is more often than not an extension of the familiar. It is sometimes only with the passage of time that a really new idea begins to seem beautiful.

In Jeremy Bernstein  
*Experiencing Science*  
Part I, Two Faces of Physics, Chapter I, Kepler: Harmony of the



World (p. 3)  
Basic Books, Inc., Publishers. New York, New York, USA. 1978

**Bragg, Sir William Lawrence** 1890–1971  
Australian-born English physicist

When one has sought long for the clue to a secret of nature, and is rewarded by grasping some part of the answer, it comes as a blinding flash of revelation: it comes as something new, more simple and at the same time more aesthetically satisfying than anything one would have created in one's own mind. This conviction is of something revealed, and not something imagined.

In C.A. Coulson  
*Science and Christian Belief*  
Christian Belief (p. 99)  
The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1955

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

...aesthetics never do anything but what they are told.  
*Lunacy and Letters*  
The Love of Lead (p. 160)  
Sneed & Ward, Inc. New York, New York, USA. 1958

**Dewey, John** 1859–1952  
American philosopher and educator

For only when an organism shares in the ordered relations of its environment does it secure the stability essential to living. And when the participation comes after a phase of disruption and conflict, it bears within itself the germs of a consummation akin to the aesthetic.

*Art as Experience*  
Chapter I (p. 15)  
Milton, Balch & Company. New York, New York, USA. 1934

**du Noüy, Pierre Lecomte** 1883–1947  
French scientist

Whenever there is no objective confirmation, our attitude toward certain theories depends, in the last resort, on aesthetic considerations, disturbing as this may seem.

*The Road to Reason*  
Chapter I (fn 4, p. 30)  
Longmans, Green & Company. New York, New York, USA. 1949

**Flannery, Maura C.** 1947–  
Biologist

...although to the non-scientist the aesthetic of biology would mean simply the beauties of nature, to the biologist it means much more. For example, the surface beauty of a leaf is nothing compared to the beauty of its cellular structure and of the process of photosynthesis. Learning about these things just increases appreciation. This is contrary to the idea held by many non-scientists that analysis destroys beauty. This latter view is based on a lack of understanding and knowledge of the processes of science.

This is why many of the biologist's beauties are not appreciated by most non-scientists.

*Biology Is Beautiful*  
*Perspectives in Biology and Medicine*, Volume 35, Number 3, Spring 1992 (p. 430)

The aesthetic is intrinsic to biology. Biologists are drawn to the field by its aesthetic qualities and continually nurtured by them. This is true in all the sciences, but the aesthetics of biology is a little richer, or at least slightly different.

*Biology Is Beautiful*  
*Perspectives in Biology and Medicine* Volume 35, Number 3, Spring 1992 (p. 433)

**King, Jerry P.**  
American mathematician

...one's intellectual and aesthetic life cannot be complete unless it includes an appreciation of the power and the beauty of mathematics. Simply put, aesthetic and intellectual fulfillment requires that you know about mathematics.

*The Art of Mathematics*  
Introduction (p. 3)  
Plenum Press. New York, New York, USA. 1992

**Kline, Morris** 1908–92  
American mathematics professor and writer

Much research for new proofs of theorems already correctly established is undertaken simply because the existing proofs have no aesthetic appeal. There are mathematical demonstrations that are merely convincing; to use a phrase of the famous mathematical physicist, Lord Rayleigh, they "command assent." There are other proofs which woo and charm the intellect. They evoke delight and an overpowering desire to say, "Amen, Amen." An elegantly executed proof is a poem in all but the form in which it is written.

*Mathematics in Western Culture*  
Chapter XXVIII (p. 470)  
Oxford University Press, Inc. New York, New York, USA. 1953

**Kuhn, Thomas S.** 1922–96  
American historian of science

...the importance of aesthetic considerations can sometimes be decisive. Though they often attract only a few scientists to a new theory, it is upon those few that its ultimate triumph may depend. If they had not quickly taken it up for highly individual reasons, the new candidate for paradigm might never have been sufficiently developed to attract the allegiance of the scientific community as a whole.

*The Structure of Scientific Revolutions*  
Chapter XII (p. 156)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

**Penrose, Roger** 1931–  
English mathematical physicist

Aesthetic qualities are important in science, and necessary, I think, for great science.

In John Hogan  
Quantum Consciousness  
*Scientific American*, Volume 261, Number 5, November 1989 (p. 32)

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

And it is because simplicity, because grandeur, is beautiful, that we preferably seek simple facts, sublime facts, that we delight now to follow the majestic course of the stars, not to examine with the microscope that prodigious littleness which is also a grandeur, now to seek in geologic time the traces of a past which attracts because it is far away.

*The Foundations of Science*  
Science and Method, Book I  
Chapter I (p. 367)  
The Science Press. New York, New York, USA. 1913

**Steen, Lynn Arthur**  
American mathematician

...despite an objectivity about mathematical results that has no parallel in the world of art, the motivation and standards of creative mathematics are more like those of art than of science. Aesthetic judgments transcend both logic and applicability in the ranking of mathematical theorems: beauty and elegance have more to do with the value of a mathematical idea than does either strict truth or possible utility.

*Mathematics Today: Twelve Informal Essays*  
Mathematics Today (p. 10)  
Springer-Verlag. New York, New York, USA. 1978

**Sullivan, John William Navin** 1886–1937  
Irish mathematician

Since the primary object of the scientific theory is to express the harmonies which are found to exist in nature, we see at once that these theories must have an aesthetic value. The measure of the success of a scientific theory is, in fact, a measure of its aesthetic value, since it is a measure of the extent to which it has introduced harmony in what was before chaos.

*The Justification of the Scientific Method*  
*The Athenaeum*, Number 4644, 2 May 1919 (p. 275)

**Thomson, Sir George Paget** 1892–1975  
English physicist

One can always make a theory, many theories, to account for known facts, occasionally even to predict new ones. The test is aesthetic.

*The Inspiration of Science*  
Chapter II (p. 17)  
Oxford University Press, Inc. London, England. 1961

## AFFINITY

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

How great has been the progress of natural science since serious attention began to be given to affinities, and especially since their true underlying principles have been determined!

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter II (p. 29)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

We must then be guided everywhere by natural affinities in composing the groups which result by dividing each kingdom into classes, each class into orders, each order into sections or families, each family into genera, and each genus into different species if there is occasion for it.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter II (p. 33)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

**Whewell, William** 1794–1866  
English philosopher and historian

Attractions take place between bodies, Affinities between the particles of a body. The former may be compared to the alliances of states, the latter to the ties of family.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 2)  
Aphorisms  
Aphorisms Concerning Ideas, LXXV (p. 458)  
John W. Parker. London, England. 1847

## AGE OF EARTH

**Holmes, Arthur** 1890–1965  
English geologist

It is perhaps a little indelicate to ask of our Mother Earth her age, but Science acknowledges no shame and from time to time has boldly attempted to wrest from her a secret which is proverbially well guarded.

*The Age of the Earth: An Introduction to Geological Ideas*  
Preface (p. ix)  
T. Fisher Unwin. London, England. 1905

There are few problems more fascinating than those that are bound up with the bold question: How old is the Earth? With insatiable curiosity men have been trying for thousands of years to penetrate the carefully guarded secret.

*The Age of the Earth: An Introduction to Geological Ideas*  
Chapter I (p. 5)  
T. Fisher Unwin. London, England. 1905

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

The poor world is almost six thousand years old.  
In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)  
As You Like It  
Act IV, Scene i  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A great while ago the world began.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
The Twelfth Night  
Act V, Scene i, l. 413  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## AGEING

**Albutt, Thomas Clifford** 1836–1935  
English physician

The stealthy foot of time carries us from youth to age so imperceptibly that we are hardly aware of the change; insensibly we shorten our arms, husband our strength, and are willing to think our prowess undiminished.  
Sir William Osler  
*British Medical Journal*, Volume 1, 1920 (p. 64)

**Amiel, Henri-Frédéric** 1821–81  
Swiss philosopher, poet, and critic

To know how to grow old is the master-work of wisdom, and one of the most difficult chapters in the great art of living.  
Translated by Mrs. Humphrey Ward  
*Amiel's Journal*  
September 21, 1874 (p. 279)  
A.L. Burt Company, Publishers. New York, New York, USA. 1897

**Berthelot, Marcellin** 1827–1907  
French chemist

To my age first of all. Your sympathy makes it shine like the last burst of light from a lamp on the point of being extinguished in eternal night! The respect that humanity pays to the aged is the expression of the binding force that unites the present generations with those that have preceded us, and with those that are to follow.  
In Camille Matignon  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*  
Marcellin Berthelot (p. 684)  
Government Printing Office. Washington, D.C. 1908

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

About the best thing that extreme old age can do for us iz tew make death a relief.  
*Everybody's Friend: or Josh Billing's Encyclopædia and Proverbial Philosophy of Wit and Humor* (p. 242)  
American Publishing Company. Hartford, Connecticut, USA. 1874

**Brody, Elaine M.**  
Social worker, researcher and gerontologist

The aging person's functioning, impaired though it may be, can not be preserved or improved if he is assigned

the role of full-time professional patient. His person and dress, the room in which he lives, the opportunity for privacy, the rhythm of his daily life...should convey the fact that the institution is his home, and should permit expression of his personal life style.  
Long-term care for the Elderly: Optimums, Options, and Opportunities  
*Journal of the American Geriatric Society*, Volume 19, 1971

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

We all know the troubles of old age. The bones creak; the eyes get dim, one forgets names.... The spark does not ignite; adrenalin has lost its potency. But there is something to be said on the other side. It is pleasant to rise in the morning, look out at the snow, and remark "I'm not going to the office today..." The beauty of nature has lost none of its charm; the beauty of women none of its benediction. There is...a possibility of growing old gracefully, and with content in one's heart.  
Letter  
*Bulletin New York Academy of Medicine*, Volume 47, 1971 (pp. 1274–1275)

**Davy, Sir Humphry** 1778–1829  
English chemist

The advance in years bring indifference, and at the same time strength and steadiness. The young sapling is moved by every breeze; shoots forth its leaves vigorously when favoured by dew and sunshine; but is often severely injured, if not destroyed, by frost. In the mature tree, as the heartwood is covered by many coatings of sapwood, it becomes compressed and harder; but though it loses its vitality, it contributes to the strength of the vegetable.  
*The Collected Works of Sir Humphry Davy* (Volume 1)  
Memories of the Life of Sir Humphry Davy  
Chapter IV (p. 214)  
Smith, Elder & Company. London, England. 1839–1849

**Dirac, Paul Adrian Maurice** 1902–84  
English theoretical physicist

Age is, of course, a fever chill  
That every physicist must fear.  
He's better dead than living still  
When once he's past his thirtieth year.  
In Leon Lederman  
*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 5 (p. 168)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Einstein, Albert** 1879–1955  
German-born physicist

A person who has not made his great contribution to science before the age of thirty will never do so.  
In S. Brodetsky  
Newton: Scientist and Man  
*Nature*, Volume 150, Number 3816, December 19, 1942 (p. 699)

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

The young ones have always a claim to the old to help them forward.

*Middlemarch*

Book VI, Chapter LVI (p. 549)

Clarendon Press. Oxford, England. 1986

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Men born in the same year watch each other, especially as the sands of life begin to run low, as we imagine so many damaged hour-glasses to keep an eye on each other. Women, of course, never know who are their contemporaries.

*Our Hundred Days in Europe*

Chapter II (p. 44)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Habits are the crutches of old age; by the aid of these we manage to hobble along after the mental joints are stiff and the muscles rheumatic...when every act of self-determination costs an effort and a pang.

*Over the Teacups*

Chapter II (pp. 37–38)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

Women find it easier than men to grow old in a becoming way.... With old men it is too often different. They do not belong so much indoors as women do. They have no pretty little manual occupations.... [He] smokes his pipe, but does not know what to do with his fingers.

*Over the Teacups*

Chapter XII (p. 293)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Isaacs, Bernard**

English geriatric physician

The “Geriatric Giants” — immobility, incontinence, instability and intellectual deterioration.

*The Challenge of Geriatric Medicine* (p. 1)

Oxford University Press, Inc. New York, New York, USA. 1992

**Priestley, Joseph** 1733–1804

English theologian and scientist

It may be my fate to be a kind of comet, or flaming meteor in science, in the regions of which (like enough to a meteor) I made my appearance very lately, and very unexpectedly; and therefore, like a meteor, it may be my destiny to move very swiftly, burn away with great heat and violence and become as suddenly extinct.

*Philosophical Empiricism*

Section V (p. 67)

Printed for J. Johnson. London, England. 1775

**Ramsay, Sir William** 1852–1916

English chemist

The minds of most men, like their bodies, grow stiff with age and unreceptive of new impressions...

*Essays Biographical and Chemical*

The Great London Chemists

Lord Kelvin (p. 100)

Archibald Constable & Company Ltd. London, England. 1908

**Yudowitch, K. L.**

No biographical data available

The knowledge that so many important discoveries in physics have been made by young men comes as a surprise to most students — and a pleasant surprise. Students never fail to look with new interest upon work done by a man at very nearly their own age. Physics is revitalized in the minds of the students by the knowledge that it is a field for young men — men like themselves.

Young Men in Physics

*American Journal of Physics*, Volume 15, Number 2, March–April 1947 (p. 191)

## AILMENT

**Heller, Joseph** 1923–99

American writer

Yossarian had so many ailments to be afraid of that he was sometimes tempted to turn himself in to the hospital for good and spend the rest of his life stretched out there inside an oxygen tent with a battery of specialists and nurses seated at one side of his bed twenty-four hours a day waiting for something to go wrong....

*Catch-22*

Chapter Seventeen (pp. 177–178)

Dell Publishing Company, Inc. New York, New York, USA. 1985

## AIR

**Adams, George** 1750–95

English instrument maker

Air is a fluid into which you are plunged the moment you are born, and without which you would in a moment be deprived of life.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture I (p. 7)

Printed by R. Hindmarsh. London, England. 1794

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

The generality of men are so accustomed to judge of things by their senses that, because the air is invisible, they ascribe but little to it, and think it but one remove from nothing.

In Sir W. Ramsay

*The Gases of the Atmosphere*

Chapter I (p. 10)

Macmillan & Company Ltd. London, England. 1905

**Muir, John** 1838–1914  
American naturalist

The air was perfectly delicious, sweet enough for the breath of angels. Every draught of it gave a separate and distinct piece of pleasure. I do not believe that Adam and Eve tasted better in their balmiest nook.

*Letters to a Friend* (p. 38)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1915

**Ramsay, Sir William** 1852–1916  
English chemist

To tell the story of the development of men's ideas regarding the nature of atmospheric air is in great part to write a history of chemistry and physics.

*The Gases of the Atmosphere*

Chapter I (p. 1)

Macmillan & Company Ltd, London, England. 1905

## ALCHEMY

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

As long as the alchemist merely sought [the] philosopher's stone and aimed at finding the art of making gold, all [his] endeavors were fruitless; it was only when people restricted themselves to seemingly less valuable questions that they created chemistry. Thus natural science appears completely to lose from sight the large and general questions; but all the more splendid is the success when, gorgin in the thicket of special questions, we suddenly find a small opening that allows a hitherto undreamt of outlook on the whole.

In Brian McGuinness (ed.)

*Theoretical Physics and Philosophical Problems. Selected Writings*

The Second Law of Thermodynamics (p. 13–14)

Reidel Publishing Company, Boston, Massachusetts, USA. 1974

**Kircher, Athanasius** 1602–80  
German Jesuit archaeologist

...alchemy is a science, not yet known but which may become known.

In Bernard Jaffe

*Crucibles: The Story of Chemistry*

Chapter XVI (p. 331)

Dover Publications, New York, New York, USA. 1976

**Luciano, Giano**  
No biographical data available

[Alchemy]...the key to all good things, the Art of Arts, the science of sciences.

*The New Pearl of Great Price...*

The Third Distinction (pp. 138–139)

Arno Press, New York, New York, USA. 1974

**Mersenne, Marin** 1588–1648  
French theologian and mathematician

We can take pride in the fact that there is no science as certain as ours [alchemy] because it teaches by experience which is the mother, the source and the universal cause of all knowledge: and it is for the lack of this that Aristotle and the other philosophers have wondrously failed in their philosophy...

In Allen G. Debus

*The French Paracelsians*

Chapter 3 (p. 72)

Cambridge University Press, Cambridge, England. 1991

**Milton, John** 1608–74  
English poet

...if by fire

Of sooty coal th' empiric alchymist

Can turn, or holds it possible to turn,

Metals of drossiest ore to perfect gold.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book V, l. 439

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Norton, Thomas** 1532–84  
English alchemist

Maistryefull merveyulous and Archimastrye

Is the tincture of holy Alkimy;

A wonderful Science, secrete Philosophie,

A singular grace and gifte of th' Almightye;

Which never was found by labour of Mann,

But it by Teaching, or by Revalacion begann.

*The Ordinall of Alchemy*

Capitulum I, l. 181–186

Oxford University Press, Inc., London, England. 1975

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541  
Swiss alchemist and mystic

The great virtues that lie hidden in nature would never have been revealed if alchemy had not uncovered them and made them visible. Take a tree, for example; a man sees it in the winter, but he does not know what it is, he does not know what it conceals within itself, until summer comes and discloses the buds, the flowers, the fruit.... Similarly the virtues in things remain concealed to man, unless the alchemist disclose them, as the summer reveals the nature of the tree.

In Jolande Jacobi (ed.)

*Paracelsus: Selected Writings*

Chapter III (p. 218)

Pantheon Books, New York, New York, USA. 1951

**Pratchett, Terry** 1948–  
English author

The Explosion removed the windows, the door and most of the chimney.

It was the sort of thing you expected in the Street of Alchemists. The neighbors preferred explosions, which

were at least identifiable and soon over. They were better than the smells, which crept up upon you.

*Moving Pictures* (p. 15)  
Corgi Books. London, England. 1991

Most alchemists were nervous, in any case; it came from not knowing what the crucible of bubbling stuff they were experimenting with was going to do next.

*Moving Pictures* (p. 20)  
Corgi Books. London, England. 1991

### Proverb, Spanish

It is approved alchemy to have an income and spend nothing.

In Robert Christy  
*Proverbs, Maxims and Phrases of All Ages* (p. 21)  
G.P. Putnam's Sons. New York, New York, USA. 1888

**Sagan, Carl** 1934–96  
American astronomer and author

The ash of stellar alchemy was now emerging into consciousness. At an ever-accelerating pace, it invented writing, cities, art and science, and sent spaceships to the planets and the stars. These are some of the things that hydrogen atoms do, given fifteen billion years of cosmic evolution.

*Cosmos*  
Chapter XII (p. 338)  
Random House, Inc. New York, New York, USA. 1980

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

You are an alchemist; make gold of that.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume Two)  
Timon of Athens  
Act V, Scene i, l. 117  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ALGEBRA

**Arbuthnot, John** 1667–1735  
Scottish mathematician and physician

To understand the theory of chance thoroughly, requires a great knowledge of numbers, and a pretty competent one of Algebra.

*An Essay on the Usefulness of Mathematical Learning*  
25 November 1700

### Author undetermined

The human mind has never invented a labor-saving machine equal to algebra.

Two Works of Algebra *The Nation*, Volume 33, Number 847, September 22, 1881 (p. 237)

Does it lie 'mid Algebra's stern array,  
Where the Law of Symmetry points the way,

And the path leads up through ascending powers  
To the hill to won after weary hours.

The Happy Land  
*The Mathematical Gazette*, Volume VIII, Number 117, May 1915 (p. 99)

**Barrie, Sir James M.** 1860–1937  
Scottish journalist, writer, and dramatist

PHOEBE: Algebra! It — it is not a very ladylike study  
Isabella.

*The Plays of J.M. Barrie*  
Quality Street, Act II (p. 113)  
Charles Scribner's Sons. New York, New York, USA. 1948

MISS SUSAN: What is algebra exactly; is it those three-cornered things?

PHOEBE: It is x minus y equals z plus y and things like that. And all the time you are saying they are equal, you feel in your heart, why should they be?

*The Plays of J.M. Barrie*  
Quality Street, Act II (p. 115)  
Charles Scribner's Sons. New York, New York, USA. 1948

**Boole, Mary Everest** 1832–1916  
English mathematical psychologist

The method of solving problems by honest confession of one's ignorance is called Algebra.

*Philosophy & Fun of Algebra*  
Chapter 1 (p. 14)  
C.W. Daniel Ltd. London, England.

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

The operations of symbolic arithmetick seem to me to afford men one of the clearest exercises of reason that I ever yet met with, nothing being there to be performed without strict and watchful ratiocination, and the whole method and progress of that appearing at once upon the paper, when the operation is finished, and affording the analyst a lasting and, as it were, visible ratiocination.  
*The Works of the Honourable Robert Boyle* (Volume 3) (p. 426)  
Printed for J. & F. Rivington. London, England. 1772

**Brahmagupta** 598–670  
Indian mathematician

As the sun eclipses the stars by his brilliancy, so the man of knowledge will eclipse the fame of others in assemblies of the people if he proposes algebraic problems, and still more if he solves them.

In Florian Cajori  
*A History of Elementary Mathematics*  
The Hindus (p. 100)  
The Macmillan Company. New York, New York, USA. 1924

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

In mathematics he was greater  
Than Tycho Brahe or Erra Pater;

For he, by geometric scale,  
 Could take the size of pots of ale;  
 Resolve by sines and tangents straight  
 If bread or butter wanted weight;  
 And wisely tell you what hour o' th' day  
 The clock does strike, by algebra.

*The Poetical Works of Samuel Butler* (Volume 1)

Hudibras, Part I, Canto I, l. 125

Bell & Daldy. London, England. 1835

### **Clifford, William Kingdon** 1845–79

English philosopher and mathematician

We may always depend upon it that algebra, which cannot be translated into good English and sound common sense, is bad algebra.

*The Common Sense of the Exact Sciences*

Chapter 1, Section 7 (p. 20)

B.J. Holdsworth. London, England. 1823

### **Cochran, William G.** 1909–80

Scottish-born American statistician

### **Cox, Gertrude M.** 1900–78

American statistician

...polynomials are notoriously untrustworthy when extrapolated.

*Experimental Designs (Second Edition)*

Chapter 8A (p. 336)

John Wiley & Sons, Inc. New York, New York, USA. 1992

### **Comte, Auguste** 1798–1857

French philosopher

[Algebra] has for its object the resolution of equations; taking this expression in its full logical meaning, which signifies the transformation of implicit functions into equivalent explicit ones. In the same way arithmetic may be defined as destined to the determination of the values of functions.... We will briefly say that Algebra is the Calculus of functions, and Arithmetic is the Calculus of Values.

*Philosophy of Mathematics* (p. 55)

New York, New York, USA. 1851

### **Date, J. C. B.**

No biographical data available

To Algebra God is inclined —  
 The world is a thought in His Mind.  
 It seems so erratic,  
 Because it's quadratic,  
 And the roots are not easy to find.

In E.O. Parrott (ed.)

*The Penguin Book of Limericks*

Theory and Practice

Penguin Books, Ltd. London, England. 1983

### **de Fontenelle, Bernard le Bovier** 1657–1757

French author

Nothing proves more clearly that the mind seeks truth, and nothing reflects more glory upon it, than the delight it takes, sometimes in spite of itself, in the driest and thorniest researches of algebra.

*Histoire du renouvellement de l'Academie des Sciences*

Preface

Chez Pierre de Coup. Amsterdam. 1720

### **de Morgan, Augustus** 1806–71

English mathematician and logician

The first thing to be attended to in reading any algebraical treatise, is the gaining a perfect understanding of the different processes there exhibited, and of their connection with one another. This cannot be attained by a mere reading of the book, however great the attention which may be given. It is impossible, in a mathematical work, to fill up every process in the manner in which it must be filled up in the mind of the student before he can be said to have completely mastered it. Many results must be given of which the details are suppressed, such are the additions, multiplications, extractions of the square root, etc., with which the investigations abound. These must not be taken on trust by the student, but must be worked by his own pen, which must never be out of his hand, while engaged in any algebraical process.

*On the Study and Difficulties of Mathematics*

Chapter XII (pp. 175–176)

The Open Court Publishing Company. La Salle, Illinois, USA. 1943

The science of algebra, independently of any of its uses, has all the advantages which belong to mathematics in general as an object of study, and which it is not necessary to enumerate. Viewed either as a science of quantity, or as a language of symbols, it may be made of the greatest service to those who are sufficiently acquainted with arithmetic, and who have sufficient power of comprehension to enter fairly upon its difficulties.

*Elements of Algebra*

Preface

Taylor & Walton. London, England. 1837

Algebra, as an art, can be of no use to any one in the business of life; certainly not as taught in the schools. I appeal to every man who has been through the school routine whether this be not the case. Taught as an art it is of little use in the higher mathematics, as those are made to feel who attempt to study the differential calculus without knowing more of the principles than is contained in books of rules.

*Elements of Algebra*

Preface

Taylor & Walton. London, England. 1837

### **Einstein, Jacob**

German electrical engineer

Algebra is a merry science.

In Ronald W. Clark

*Einstein: The Life and Times*

Part One, Chapter 1 (p. 12)

The World Publishing Company. New York, New York, USA. 1971

**Hamilton, Sir William Rowan** 1805–65

Irish mathematician

...the subject matter of algebraic science is the abstract notion of time; divested of, or not yet clothed with, any actual knowledge which we may possess of the real Events of History, or any conception which we may frame of Cause and Effect in Nature; but involving, what indeed it cannot be divested of, the thought of possible Succession, or of pure, ideal Progression.

In Robert Percevel Graves

*Life of Sir William Rowan Hamilton* (Volume 3) (p. 633)

Hodges, Figgis & Company. Dublin, Ireland 1882–1889

...instead of seeking to attain consistency and uniformity of system, as some modern writers have attempted, by banishing this thought of time from the higher Algebra, I seek to attain the same object, by systematically introducing it into the lower or earlier parts of the science.

In Robert Percevel Graves

*Life of Sir William Rowan Hamilton* (Volume 3) (p. 634)

Hodges, Figgis & Company. Dublin, Ireland 1882–1889

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

...I would advise you Sir, to study algebra, if you are not an adept already in it...

*Johnsonian Miscellanies* (Volume 1)

Anecdotes (p. 301)

At the Clarendon Press. Oxford, England. 1847

**Khayyam, Omar** 1048–1122

Persian mathematician, astronomer, and poet

Whoever thinks algebra is a trick in obtaining unknowns has thought it in vain. No attention should be paid to the fact that algebra and geometry are different in appearance. Algebras are geometric facts which are proved.

Quoted by J.J. Winter and W. Arafat

The Algebra of "Umar Khayyam,"

*Journal of the Royal Asiatic Society of Bengal*, Volume 41, 1950

**Langer, Susanne Knauth** 1895–1985

American philosopher

Behind these symbols lie the boldest, purest, coolest abstractions mankind has ever made. No schoolman speculating on essences and attributes ever approached anything like the abstractness of algebra.

*Philosophy in a New Key*

Chapter I (p. 18)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Lebowitz, Fran** 1951–

American comedian

Stand firm in your refusal to remain conscious during algebra. In real life, I assure you, there is no such thing as algebra.

*Social Studies*

Tips for Teens (p. 36)

Random House, Inc. New York, New York, USA. 1981

**Locke, John** 1632–1704

English philosopher and political theorist

They that are ignorant of Algebra cannot imagine the wonders in [relations between abstract ideas] this kind are to be done by it: and what further improvements and helps advantageous to other parts of knowledge the sagacious mind of man may yet find out, it is not easy to determine. This at least I believe, that the *ideas of quantity* are not those alone that are capable of demonstration and knowledge; and that other, and perhaps more useful, parts of contemplation, would afford us certainty, if vices, passions, and domineering interest did not oppose and menace such endeavors.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book IV, Chapter III, Section 18 (p. 317)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The object of all arithmetical operations is to save direct enumeration, by utilizing the results of our old operations of counting. Our endeavor is, having done a sum once, to preserve the answer for future use.... Such, too, is the purpose of algebra, which, substituting relations for values, symbolizes and definitely fixes all numerical operations which follow the same rule.

*The Science of Mechanics* (5th Edition)

Chapter IV, Part IV, Section 5 (p. 585)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Morley, Christopher** 1890–1957

American writer

Marriage is the square of a plus b

In other words

$$a^2 + b^2 + 2ab$$

Where  $2ab$  (of course)

Are twins.

*Translations from the Chinese*

$$(a + b)^2$$

George H. Doran Company. New York, New York, USA. 1922

**Moser, Leo** 1921–1970

Austrian-born mathematician

A quadratic function, ambitious,

Said, "It's not only wrong, but it vicious.

It's surely no sin

To have max. and min.;

To limit me so is malicious."

In E.O. Parrott (ed.)

*The Penguin Book of Limericks*

Theory and Practice

Penguin Books, Ltd. London, England. 1983



**Pastan, Linda** 1932–  
American poet

I used to solve equations easily. If train A left Sioux Falls at nine o'clock, traveling at a fixed rate, I knew when it would meet train B. Now I wonder if the trains will crash; or else I picture naked limbs through Pullman windows, each a small vignette of longing.

In Ernest Robson and Jet Wimp

*Against Infinity*

Algebra (p. 50)

Primary Press, Parker Ford, Pennsylvania, USA. 1979

**Smullyan, Raymond** 1919–  
American mathematician and logician

I am a firm believer that in studying mathematics one should never forget one's common sense. Many years ago, I was teaching an elementary algebra course. On one exam, I had a standard-type question that involved finding the ages of the mother, father, and child. After the students read the question, I said, "On this problem, I'll give you one hint." All eyes eagerly turned to me. I continued, "If the child should turn out to be older than either of the parents, then you've done something wrong."

*5000 B.C. and Other Philosophical Fantasies*

Chapter 3 (p. 21)

St. Martin's Press. New York, New York, USA. 1983

**Trumbull, John** 1756–1843  
American painter

What though in algebra, his station

Was negative in each equation.

In Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter II (p. 62)

Government Printing Office. Washington, D.C. 1890

**Weil, Simone** 1909–43  
French philosopher and mystic

Money, mechanization, algebra. The three monsters of contemporary civilization.

*Gravity and Grace*

Algebra (p. 139)

Routledge & Kegan Paul. London, England. 1952

...algebra is the intellectual instrument which has been created for rendering clear the quantitative aspects of the world.

*The Organization of Thought*

Chapter I (pp. 14–15)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

## ALGORITHM

**Banks, Iain M.** 1954–  
Scottish writer

Elegance is an algorithm.

*The Algebraist*  
Orbit. London, England. 2004

**Joseph, George Gheverghese**  
Indian-born historian of mathematics

A "good" algorithm should have three properties:

- it should be clear and simple, laying out step by step the procedures to be followed,
- it should emphasize the general character of its applications by pointing out its appropriateness, not to a single problem but to a group of similar problems, and
- it should show clearly the answer obtained after the prescribed set of operations is completed.

*The Crest of the Peacock: Non-European Roots of Mathematics*

Chapter 5 (p. 127)

Penguin. London, England. 1991

**Kauffman, Stuart A.** 1939–  
American theoretical biologist

Algorithms are a set of procedures to generate the answer to a problem. An example is the algorithm to find the solution to a quadratic equation, which most of us were taught while learning algebra. Not only was I taught the algorithm, but our entire class was invited to tattoo it on our stomachs so that we could solve quadratic equations by rote.

*At Home in the Universe: The Search for Laws of Complexity*

Chapter 1 (p. 21)

Oxford University Press, Inc. New York, New York, USA. 1995

**Stoppard, Tom** 1937–  
Czech-born English playwright

Nature manipulates the  $x$  and turns it into  $y$ . Then  $y$  goldfish is your starting population for the following year... Your value for  $y$  becomes your next value for  $x$ . The question is what is being done to  $x$ ? What is the manipulation? Whatever it is, it can be written down as mathematics. It's called an algorithm.

*Arcadia*

Act I, Scene Four (p. 45)

Faber & Faber Ltd. London, England. 1993

## ALIENS

**Joyce, James** 1882–1941  
Expatriate Irish writer and poet

[Bloom] had conjectured as a working hypothesis which could not be proved impossible that a more adaptable and differently anatomically constructed race of beings might subsist otherwise under Martian, Mercurial, Veneral, Jovian, Saturnian, Neptunian or Uranian sufficient and equivalent conditions, though an apogean humanity of beings created in varying forms with finite differences resulting similar to the whole and to one another would probably there as here

remain inalterably and inalienably attached to vanities, to vanities of vanities and all that is vanity.

*Ulysses* (p. 684)

Random House, Inc. New York, New York, USA. 1946

**Koch, Howard** 1902–1995

American screen writer

Good heavens, something’s wriggling out of the shadow like a grey snake. Now it’s another one, and another. They look like tentacles to me. There, I can see the thing’s body. It’s large as a bear and glistens like wet leather. But that face. It — it’s indescribable. I can hardly force myself to keep looking at it. The eyes are black and gleam like a serpent’s. The mouth is V-shaped with saliva dripping from its rimless lips that seem to quiver and pulsate.

In Isabel S. Gordon and Sophie Sorokin (eds.)

*The Armchair Science Reader*

Part I, Man among the Stars, Invasion from Mars (p. 9)

Simon & Schuster. New York, New York, USA. 1959

**Scottie**

Fictional character

I bring you a warning...Tell the world ...tell this to everyone, wherever they are ...watch the skies ...watch everywhere ...keep looking ...watch the skies!

*The Thing*

Film (1951)

**Taylor, Rod** 1930–

Australian-born actor

You know, if this is Venus, or some other strange planet, we’re liable to run into some high-domed characters with green blood in their veins who’ll blast at us with their atomic death rayguns, and there we’ll be with these — these poor old-fashioned shootin’ irons.

*World Without End*

Film (1956)

**ALLERGY**

**Mather, Increase** 1639–1723

American Puritan clergyman

Some men also have strange antipathies in their natures against that sort of food which others love and live upon. I have read of one that could not endure to eat either bread or flesh; of another that fell into a swooning fit at the smell of a rose...

*Remarkable Providences*

Chapter IV (p. 71)

Reeves & Turner. London, England. 1890

**Pirquet von Cesenatico, C. P.** 1874–1929

Austrian pediatrician

For this general concept of the changed capacity for reaction, I propose the term “allergy”. “Allo” denotes the

deviation from the original state, from the behavior of the normal, as in “allorhythmia”, “allotropy”.

Allergie

*Muenchener medizinische wochenschrift*, Volume 53, July 24, 1906

**Welsh, Joan I.**

No biographical data available

Medical science has gone far;

On that we’ll all agree —

What used to be called an itch

Today’s an allergy.

*Quote, the Weekly Digest*, July 21, 1968 (p. 56)

**ALTERNATIVE LIFE**

**Jeffers, Robinson** 1887–1962

American poet

They are animals, as we are. There are many other chemistries of animal life

Besides the slow oxidation of carbohydrates and amino-acids.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

Animals (p. 364)

Stanford University Press. Stanford, California. USA. 1988

**AMBITION**

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

I have not chosen a career which will lead me to a great fortune, but that is not my principal ambition.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter I (p. 1)

Cambridge University Press. Cambridge, England. 1978

**AMINO ACID**

**Cloud, Preston Ercelle** 1912–91

American biogeologist, paleontologist, and humanist

One amino acid does not a protein make — let alone a being.

*Oasis in Space: Earth History from the Beginning*

Chapter Ten (p. 231)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

**AMNION**

**Cowen, Richard** 1940–

American paleontologist

...the most fundamental innovation is the evolution of another internal fluid-filled sac, the amnion, in which the embryo floats. Amniotic fluid has roughly the same

composition as seawater, so that in a very real sense, the amnion is the continuation of the original fish or amphibian eggs together with its microenvironment, just as a space suit contains an astronaut and a fluid that mimics the Earth's atmosphere. All of the rest of the amniote egg is add-on technology that is also required for life in an alien environment, and in that sense it corresponds to the rest of the space station with its food storage, fuel supply, gas exchangers, and sanitary disposal systems.

*History of Life*

Chapter Eight (p. 166)

Blackwell Scientific Publications. Boston, Massachusetts, USA. 1990

## AMPUTATION

**Middleton, Thomas** 1580–1627

English Jacobean playwright

I'll imitate the pities of old Surgeons  
To this lost limb, who, ere they show their art,  
Cast one asleep, then cut the disease'd part.

*Women Beware Women*

Act IV, Scene I (p. 128)

Manchester University Press. Manchester, England. 1975

**Webster, John** 1580?–1625?

English playwright

I had a limb corrupted to an ulcer,  
But I have cut it off; and now I'll go  
Weeping to heaven on crutches.

*The White Devil*

Act IV, Scene II, l. 117–119

A. & C. Black. London, England; 1996

## ANALOGY

**Banach, Stefan** 1892–1945

Polish mathematician

Good mathematicians see analogies between theorems or theories, the very best ones see analogies between analogies.

In S.M. Ulam

*Adventures of a Mathematician*

Chapter 10 (p. 203)

Charles Scribner's Sons. New York, New York, USA. 1976

**Bernstein, Jeremy** 1929–

American physicist, educator, and writer

It is probably no exaggeration to say that all of theoretical physics proceeds by analogy.

*Elementary Particles and Their Currents*

Philosophical Preface (p. vii)

W. H. Freeman. San Francisco, California, USA. 1968

**Binford, Lewis R.** 1930–

American archaeologist

Analogy serves to provoke certain types of questions which can, on investigation, lead to the recognition of

more comprehensive ranges of order in the archaeological data.

Smudge Pits and Hide Smoking: The Use of Analogy in Archaeological Reasoning

*American Antiquity*, Volume 32, Number 1, January 1967 (p. 10)

**Campbell, Norman R.** 1880–1949

English physicist and philosopher

...analogies are not "aids" to the establishment of theories; they are an utterly essential part of theories, without which theories would be completely valueless and unworthy of the name. It is often suggested that the analogy leads to the formulation of the theory, but that once the theory is formulated the analogy has served its purpose and may be removed or forgotten. Such a suggestion is absolutely false and perniciously misleading.

*Physics: The Elements*

Chapter VI (p. 129)

At the University Press. Cambridge, England. 1920

To regard analogy as an aid to the invention of theories is as absurd as to regard melody as an aid to the composition of sonatas.

*Physics: The Elements*

Chapter VI (p. 130)

At the University Press. Cambridge, England. 1920

**Chang, Kwang-Chih** 1931–2001

Chinese-born anthropologist and archaeologist

As to analogy, archaeology as a whole is analogy, for to claim any knowledge other than the objects themselves is to assume knowledge of patterns in culture and history and to apply these patterns to the facts.

*Rethinking Archaeology*

Chapter 6 (p. 109)

Random House, Inc. New York, New York, USA. 1967

**Chargaff, Erwin** 1905–2002

Austrian biochemist

When a science approaches the frontiers of its knowledge, it seeks refuge in allegory or in analogy.

*Essays on Nucleic Acids*

Chapter 8 (p. 119)

Elsevier Publishing Company. Amsterdam. 1963

**Cohen, Morris Raphael** 1880–1947

American philosopher

...the number of available analogies is a determining factor in the growth and progress of science.

*The Meaning of Human History*

Chapter 8 (p. 249)

The Open Court Publishing Company. LaSalle, Illinois, USA. 1947

**Cross, Hardy** 1885–1959

American professor of civil and structural engineering

An analogy is not a reason...

*Engineers and Ivory Towers*

For Man's Use of God's Gifts (p. 109)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Davy, Sir Humphry** 1778–1829  
English chemist

The substitution of analogy for fact is the bane of chemical philosophy; the legitimate use of analogy is to connect facts together and to guide to new experiments.

In Joseph William Mellor  
*Mellor's Modern Inorganic Chemistry*  
Chapter 14 (p. 200)  
Longmans. London, England. 1967

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

...science is nothing but the finding of analogy, identity, in the most remote parts.

*Ralph Waldo Emerson: Essays and Lectures*  
Nature: Addresses, and Lectures  
The American Scholar (p. 56)  
The Library of America. New York, New York, USA. 1983

**Hartley, David** 1705–57  
English physician and psychologist

Animals are also analogous to Vegetables in many things, and Vegetables to Minerals: So that there seems to be a perpetual Thread of Analogy continued from the most perfect Animal to the most imperfect Mineral, even till we come to elementary Bodies themselves.

*Observations on Man* (Volume 1)  
Chapter III, Section 1, Proposition 82 (p. 294)  
Woodstock Books. Poole, England. 1998

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Analogy is even slipperier than logic.

*Stranger in a Strange Land*  
Part III, Chapter XXIV (p. 318)  
G.P. Putnam's Sons. New York, New York, USA. 1961

**Hesse, Mary B.** 1924–  
English science historian

...one of the main functions of an analogy or model is to suggest extensions of the theory by considering extensions of the analogy, since more is known about the analogy than is known about the subject matter of the theory itself.... A collection of observable concepts in a purely formal hypothesis suggesting no analogy with anything would consequently not suggest either any directions for its own development.

Operational Definition and Analogy in Physical Theories  
*British Journal for the Philosophy of Science*, Volume II, Number 8,  
February 1952 (p. 291)

**Hodnett, Edward** 1901–84  
English illustration historian

Analogy suggests rather than proves.

*The Art of Problem Solving*  
Part III, Chapter 18 (p. 143)  
Harper & Brothers. New York, New York, USA. 1955

**Johnson-Laird, P. N.** 1936–  
English-born psychologist

A scientific problem can be illuminated by the discovery of a profound analogy, and a mundane problem can be solved in a similar way.

*The Computer and the Mind*  
Chapter 14 (p. 266)  
Harvard University Press. Cambridge, Massachusetts, USA. 1988

**Latham, Peter Mere** 1789–1875  
English physician

It is safest and best to fill up the gaps of our knowledge from analogy.

In William B. Bean  
*Aphorisms from Latham* (p. 37)  
Prairie Press. Iowa City, Iowa, USA. 1962

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

The way to determine the secret workings of Nature is from analogous cases where one has caught her in act.

In J.P. Stern  
*Lichtenberg: A Doctrine of Scattered Occasions*  
Further Excerpts from Lichtenberg's Notebooks (p. 293)  
Indiana University Press. Bloomington, Indiana, USA. 1959

**Melville, Herman** 1819–91  
American novelist, essayist, and poet

O Nature, and O soul of man! how far beyond all utterance are your linked analogies! not the smallest atom stirs or lives on matter, but has its cunning duplicate in mind.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 70 (p. 231)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Analogy is not identity.

*Geology Versus Astronomy: Or 'the Conditions and the Periods;' being a View of the Modifying Effects of Geologic Discovery on the Old Astronomic Inferences respecting the Plurality of Inhabited Worlds*  
Chapter I (p. 8)  
Glaegow. 1857

**Olson, Harry F.** 1901–82  
American acoustical engineer

Analogies are useful for analysis in unexplored fields. By means of analogies an unfamiliar system may be compared with one that is better known. The relations and actions are more easily visualized, the mathematics more readily applied, and the analytical solutions more readily

obtained in the familiar system.

In John N. Shive and Robert L. Weber

*Similarities in Physics*

Chapter 3 (p. 24)

John Wiley & Sons, Inc. New York, New York, USA. 1982

**Pasteur, Louis** 1822–95

French chemist

The arguments...by which you support my theories, are most ingenious, but not founded on demonstrated facts; analogy is no proof.

In R. Vallery-Radot

*Life of Pasteur*

Chapter VIII (p. 223)

Garden City Publishing Company. Garden City, New York, USA. 1926

**Pepper, Stephen** 1891–1972

American philosopher

A man desiring to understand the world looks about for a clue to its comprehension. He pitches upon some area of commonsense fact and tries to understand other areas in terms of this one. The original area becomes his basic analogy or root metaphor.

*World Hypotheses: A Study in Evidence*

Chapter V (p. 91)

University of California Press. Berkeley, California, USA. 1948

**Strindberg, August** 1849–1912

Swedish dramatist and novelist

Two times two — is two!, Yes! I shall prove it by means of analogy, the highest form of proof. Follow carefully. One times one is one, therefore two times two is two. What applies to one applies to the other.

Translated by Evert Sprinchorn

*Selected Plays*

A Dream Play (p. 696)

University of Minnesota Press. Minneapolis, Minnesota, USA. 1986

**Sylvester, James Joseph** 1814–97

English mathematician

Induction and analogy are the special characteristics of modern mathematics, in which theorems have given place to theories and no truth is regarded otherwise than as a link in an infinite chain. “*Omne exit in infinitum*” is their favorite motto and accepted axiom.

A Plea for the Mathematician

*Nature*, Volume 1, Thursday, January 6, 1870 (p. 261, fn)

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

All perception of truth is the detection of an analogy...

*The Journal of Henry D. Thoreau* (Volume 2)

September 5, 1851 (p. 463)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

**Westbroek, Peter** 1937–

Geologist

We have known since the days of Kant that scientific arguments must never be founded on analogies, but the authors are dead serious about these poetic digressions.

The Oceans Inside Us

*The London Times Higher Education Supplement*, November 3, 1995

## ANALYSIS

**Allen, Roy George Douglas** 1906–83

English economist and mathematician

Not even the most subtle and skilled analysis can overcome completely the unreliability of basic data.

*Statistics for Economists*

Chapter I (p. 14)

Hutchinson's University Library. London, England. 1951

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The technical analysis of any large collection of data is a task for a highly trained and expensive man who knows the mathematical theory of statistics inside and out. Otherwise the outcome is likely to be a collection of drawings — quartered pies, cute little battleships, and tapering rows of sturdy soldiers in diversified uniforms — interesting enough in the colored Sunday supplement, but hardly the sort of thing from which to draw reliable inferences.

*Mathematics: Queen and Servant of Science*

Choice and Chance (p. 383)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Boeham, George A. W.** 1922–93

American mathematician, editor, and writer

The backbone of mathematics, pure as well as applied, is a conglomeration of techniques known as “analysis.”

*Annual Report of the Board of Regents of the Smithsonian Institution, 1959*

New Uses of the Abstract (p. 317)

Government Printing Office. Washington, D.C. 1960

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

Our only way of avoiding the extremes of materialism and mysticism is the never ending endeavor to balance analysis and synthesis.

In Loyd S. Swenson, Jr.

*Genesis of Relativity: Einstein in Context*

Preface (p. xvi)

Burt Franklin & Company, Inc. New York, New York, USA. 1979

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

He was in Logick, a great Critick,

Profoundly skill'd in Analytick;

He could distinguish and divide

A hair 'twixt south and south-west side.

*The Poetical Works of Samuel Butler* (Volume 1)  
Hudibras, Part I, Canto I, l. 65  
Bell & Daldy. London, England. 1835

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

I have seen too much not to know that the impression of a woman may be more valuable than the conclusion of an analytical reasoner...

*The Complete Sherlock Holmes*  
The Man with the Twisted Lip  
Doubleday & Company, Inc. Garden City, New York, USA. 1930

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

The analysis of phenomena, philosophically speaking, is principally useful, as it enables us to recognize, and mark for special investigation, those which appear to us simple; to set methodically about determining their laws, and thus to facilitate the work of raising up general axioms, or forms of words, which shall include the whole of them, which shall, as it were, transplant them out of the eternal into the intellectual world, render them creatures of pure thought, and enable us to reason them out a priori.

*A Preliminary Discourse on the Study of Natural Philosophy*  
Part II, Chapter II, Section 88 (p. 97)  
Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Keynes, John Maynard** 1883–1946  
British economist

But to argue, without analysis of the instances, from the mere fact that a given event has a frequency of 10 percent in the thousand instances under observation, or even in a million instances, that...it is likely to have a frequency near to 1/10 in a further set of observations, is...hardly an argument at all.

*Treatise on Probability*  
Chapter XXXIII (p. 407)  
Macmillan & Company Ltd. London, England. 1921

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

An intelligence that, at a given instant, could comprehend all the forces by which nature is animated and the respective situation of the beings that make it up, if moreover it were vast enough to submit these data to analysis, would encompass in the same formula the movements of the greatest bodies of the universe and those of the lightest atoms. For such an intelligence nothing would be uncertain, and the future, like the past, would be open to its eyes.

*A Philosophical Essay on Probabilities* (p. 2)  
Dover Publications, Inc. New York, New York, USA. 1951

**Marlowe, Christopher** 1564–93  
English poet

Sweet Analytics, 'tis thou has ravish'd me...

*Christopher Marlowe's Doctor Faustus*  
Act I, Scene i  
Broadview Press. Peterborough, Ontario, Canada. 1991

**Mill, John Stuart** 1806–73  
English political philosopher and economist

...the habit of analysis has a tendency to wear away the feelings.

*Autobiography*  
V (p. 116)  
Oxford University Press, Inc. London, England. 1969

**Rudner, Richard** 1922–79  
American philosopher of science

The very excellence of analysis...tends to weaken and undermines whatever is the result of prejudice; that it enables us mentally to separate ideas which have only casually clung together...

In E.D. Klemke, Robert Hollinger, and A. David Kline  
*Introductory Reading in the Philosophy of Science*  
The Scientist Qua Scientist Makes Value Judgments (p. 234)  
Prometheus Books. Buffalo, New York, USA. 1980

**Silberling, N. J.**  
Geologist

The following discussion is based largely on speculation, preconception, supposition, and other subjective thinking processes fundamental to megathinking and therefore it must be considered as a preliminary statement or working hypothesis to be tested by further field work and other lines of objective endeavor.

*The Pick and Hammer Club*  
May 2, 1958 (p. 19)

**Stoppard, Tom** 1937–  
Czech-born English playwright

I can put two and two together, you know. Putting two and two together is my subject. I do not leap to hasty conclusions. I do not deal in suspicion and wild surmise. I examine the data; I look for logical inferences.

*Jumpers*  
Act One (p. 17)  
Grove Press, Inc. New York, New York, USA. 1972

**Tukey, John W.** 1915–2000  
American statistician

If data analysis is to be well done, much of it must be a matter of judgment, and "theory" whether statistical or non-statistical, will have to guide, not command.

*Annals of Mathematical Statistics*  
The Future of Data Analysis, Volume 33, Number 1, March 1962 (p. 10)

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

It requires a very unusual mind to undertake the analysis of the obvious.

*Science in the Modern World*

Chapter I (p. 4)  
The Macmillan Company. New York, New York, USA. 1925

## ANALYSIS OF VARIANCE

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

There is, then, in this analysis of variance no indication of any other than innate and heritable factors at work. The Causes of Human Variability (The coining of the phrase “analysis of variance.”) *Eugenics Review*, Volume 10, 1918

However, perhaps the main point is that you are under no obligation to analyse variance into its parts if it does not come apart easily, and its unwillingness to do so naturally indicates that one’s line of approach is not very fruitful. *Natural Selection, Heredity, and Eugenics* Letter to L. Hogben, 25 February 1933 (p. 218) Clarendon Press. Oxford, England. 1983

The analysis of variance is not a mathematical theorem, but rather a convenient method of arranging the arithmetic. Supplement, Discussion to “Statistics in Agricultural Research,” by J. Wishart, *Journal of the Royal Statistical Society*, Volume 1, 1934

## ANALYST

**Keeney, Ralph**  
Professor of systems management  
**Raiffa, Howard**  
Bayesian decision theorist

...be wary of analysts that try to quantify the unquantifiable. *Decisions with Multiple Objectives: Preferences with Value Trade-Offs* (p. 12) John Wiley & Sons, Inc. New York, New York, USA. 1976

## ANAPHYLAXIS

**Richet, Charles** 1850–1935  
French physiologist

Phylaxis, a word seldom used, stands in the Greek for protection. Anaphylaxis will thus stand for the opposite. Anaphylaxis, from its Greek etymological source, therefore means that state of an organism in which it is rendered hypersensitive, instead of being protected. *Nobel Lectures, Physiology or Medicine 1901–1921* Nobel lecture for award received in 1913 Anaphylaxis (p. 473) Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## ANATOMIST

**Richardson, Samuel** 1689–1761  
English novelist

And I believe that anatomists allow that women have more watery heads than men. *The Works of Samuel Richardson* Volume VII, The History of Clarissa Harlowe, Volume IV, Letter XXVII (p. 130) H. Sotheran. London, England. 1883–1884

## ANATOMY

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

In the inquiry which is made by anatomy, I find much deficiency: for they inquire of the parts, and their substances, figures, and collocations; but they inquire not of the diversities of the parts, the secrecies of the passages, and the seats or nestling of the humors, nor much of footsteps and impressions of diseases. In *Great Books of the Western World* (Volume 30) *Advancement of Learning* Second Book, Chapter X, Section 5 (p. 52) Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Burton, Robert** 1577–1640  
English clergyman and scholar

[Diseases] crucify the soul of man, attenuate our bodies, dry them, wither them, shrivel them up like old apples, make them as so many anatomies. *The Anatomy of Melancholy* (Volume 1) Part I, Sect. II, Memb. III, subsec. 10 (p. 323) AMS Press, Inc. New York, New York, USA. 1973

**Dagi, Teodoro Forcht**  
Physician

Ask any doctor off the street  
To speak of his most prized feat:  
No doubt he’d answer honestly,  
And say “to pass anatomy.” *Anatomy of the Brain and Spinal Medulla: A Manual for Students* *The New England Journal of Medicine*, Volume 286, Number 18, May 4, 1972 (p. 1010)

**de Vigevano, Guido** fl. 1330s  
High Medieval physician and engineer

Since it is prohibited by the Church to perform anatomies on the human body, and since it is impossible to know the medical art completely, unless one has knowledge of anatomy...I shall demonstrate patently and openly the anatomy of the human body, through properly executed illustrations. Quoted in E.L. Wickersheimer “Anatomie” de Guido de Vigevano, Médecin de la Reine Jeanne de Bourgogne *Archiv für geschichte de medizin*, Volume 7, 1914

**Dickinson, Emily** 1830–86  
American lyric poet

A science — so the Savants say,

“Comparative Anatomy” —  
 By which a single bone —  
 Is made a secret to unfold  
 Of some rare tenant of the mold,  
 Else perished in the stone —

*The Complete Poems of Emily Dickinson*  
 No. 100 (p. 49)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Fernel, Jean** 1497–1558

French physician

Anatomy is to physiology as geography is to history; it describes the theater of events.

*De naturali parte medicinae libri septem*

Chapter I

Apud Simonem Colinaeum. 1542

**Freeman, R. Austin** 1862–1943

British physician and mystery novelist

Anatomy has its uses, even in a midnight scuffle.

*The Uttermost Farthing*

Chapter III

C.A. Pearson. London, England. 1920

**Halle, John** 1529–1568

English physician

But chieflye the anatomye

Ye oughte to understande:

If ye will cure well anye thinge,

That ye doe take in hande.

In Mary Lou McDonough

*Poet Physician: An Anthology of Medical Poetry Written by Physicians*

Anatomy (p. 11)

C.C. Thomas. Springfield, Illinois, USA. 1945

**Harvey, William** 1578–1657

English physician

...I profess to learn and to teach anatomy, not from books but from dissections; not from the positions of philosophers but from the fabric of nature...

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Dedication (p. 268)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

What geology has done for our knowledge of the earth, has been done for our knowledge of the body by that method of study to which is given the name of General Anatomy.

*Medical Essays*

Border Lines in Medical Science (p. 222)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Maugham, W. Somerset** 1874–1965

English novelist and playwright

You will have to learn many tedious things...which you will forget the moment you have passed your final examination, but in anatomy it is better to have learned and lost than never to have learned at all.

*Of Human Bondage*

Chapter LIV (p. 239)

Doubleday & Company, Inc. Garden City, New York, USA. 1936

**Muller, Herbert J.** 1905–80

American historian and educator

To say...that a man is made up of certain chemical elements is a satisfactory description only for those who intend to use him as a fertilizer.

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*

Chapter V (p. 107)

G. Braziller. New York, New York, USA. 1943

**Nye, Bill** 1850–96

American journalist

The word anatomy is derived from two Greek spatters and three pollywogs, which, when translated, signify “up through” and “to cut,” so that anatomy actually, when translated from the original wappy-jawed Greek, means to cut up through. That is no doubt the reason why the medical student proceeds to cut up through the entire course.

*Remarks*

Anatomy (p. 27)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

Human anatomy is either general, specific, topographical or surgical. These terms do not imply the dissection and anatomy of generals, specialists, topographers and surgeons, as they might seem to imply, but really mean something else. I would explain here what they actually do mean if I had more room and knew enough to do it.

*Remarks*

Anatomy (p. 28)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Anatomy may be likened to a harvest-field. First come the reapers, who, entering upon untrodden ground, cut down great store of corn from all sides of them. These are the early anatomists of modern Europe, such as Vesalius, Fallopius, Malpighi, and Harvey. Then come the gleaners, who gather up ears enough from the bare ridges to make a few loaves of bread. Such were the anatomists of last century — Valsalva, Cotunnus, Haller, Winslow, Vicq d’Azyr, Camper, Hunter, and the two Monroes. Last of all come the geese, who still contrive to pick up a few grains scattered here and there among the stubble, and waddle home in the evening, poor things, cackling with joy because of their success. Gentlemen, we are the geese.



*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
The Leaven of Science (pp. 84–85)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Reid, Thomas** 1710–96  
Scottish philosopher

If a thousand of the greatest wits that ever the world produced were, without any previous knowledge in anatomy, to sit down and contrive how, and by what internal organs, the various functions of the human body are carried on, how the blood is made to circulate and the limbs to move, they would not, in a thousand years, hit upon anything like the truth.

*The Works of Thomas Reid*  
Essays on the Intellectual Powers of Man, Essay I, Chapter III (p. 235)  
Maclachlana & Stewart. Edinburgh, Scotland. 1863

**Stapp, Paul** 1910–99  
American Air Force colonel

The human body comes in only two shapes and three colors. I don't expect there will be any changes, so what we learn about it now will serve us for a long time to come.  
The Fastest Man on Earth  
*Time*, Volume LXVI, Number 11, September 12, 1955 (p. 88)

## ANEMIA

**Whipple, George H.** 1878–1976  
American pathologist

It is obvious to any student of anemia that a beginning has been made, but our knowledge of pigment metabolism and hemoglobin regeneration is inadequate in every respect. This is a stimulating outlook for the numerous investigators in this field and we may confidently expect much progress in the near future.

*Nobel Lectures, Physiology or Medicine 1922–1941*  
Nobel lecture for award received in 1934  
Hemoglobin Regeneration as Influenced by Diet and Other Factors (p. 353)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## ANESTHESIA

**Armour, Richard** 1906–89  
American poet

Behold the patient uncomplaining,  
Not asking whether losing, gaining,  
Not offering unsought advice,  
But really being very nice.

...

Behold the patient quite relaxed,  
With nerves, this once, not overtaxed,  
Serene, almost unrecognized,  
Not fighting back — anesthetized.

*The Medical Muse*

Behold the Patient  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1963

**du Bartas, Guillaume de Salluste** 1544–90  
French poet

Even as a Surgeon, minding off-to-cut  
Some cure-less Limb; before in cure he put  
His violent Engines on the vicious member,  
Bringeth his Patient in a sense-less slumber,  
And grief-less then (guided by Life and Art),  
To save the whole; saws off th' infested part...

*Du Bartas: His Divine Weekes and Workes*  
First Week, Sixth Day (p. 57)  
Printed by Robert Young. London, England. 1641

**Helmuth, William Tod** 1833–1902  
American physician

For thus we read (although the analgesia  
Of Richardson was then entirely unknown)  
Adam profoundly slept with anaesthesia,  
And from his thorax was removed a bone.  
This was the first recorded operation,  
(No doctor here dare tell me that I fib!)  
And surgery, thus early in creation,  
Can claim complete excision of a rib!

*Scratches of a Surgeon*  
Surgery vs. Medicine (p. 66)  
W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

...three natural anesthetics — sleep, fainting, death...

*Medical Essays*  
The Medical Profession in Massachusetts (p. 365)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Kraus, Karl** 1874–1936  
Austrian essayist and poet

Anesthesia: wounds without pain.  
In Harry Zohn (ed.)  
*Half-Truths & One-and-a-Half Truths*  
Lord, Forgive Them (p. 112)  
The University of Chicago Press. Chicago, Illinois, USA. 1990

**Massinger, Philip** 1583–1640  
English dramatic poet

1 October We have given her, sir,  
A sleepy potion, that will hold her long,  
That she may be less sensible of the torment  
The searching of the wound will put her to.

*The Plays of Philip Massinger* (Volume 1)  
The Duke of Milan, Act V, Scene II (p. 337)  
G. & W. Nicol. London, England. 1805

## The Bible

The Lord God then put the man into a deep sleep and, while he slept, he took one of the man's ribs and closed up the flesh over the place.

*The Revised English Bible*

Genesis 2:21

Oxford University Press, Inc. Oxford, England. 1989

## ANESTHETIST

### **Cvikota, Raymond J.**

No biographical data available

Anesthetist's cone: Ether bonnet.

*Quote, the Weekly Digest*, October 27, 1968 (p. 337)

### **Trotter, Wilfred** 1872–1939

Surgeon and sociologist

Mr. Anesthetist, if the patient can keep awake, surely you can.

Very Special Article

*The Lancet*, Volume 2, 1965 (p. 1340)

## ANIMAL

### **Abbey, Edward** 1927–89

American environmentalist and nature writer

We have never entered into an animal's mind and we cannot know what it is like, or even if it exists. The risk of attributing too much is no greater than the risk of attributing too little.

In Joseph Wood Krutch

*The Great Chain of Life*

Prologue (p. x)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1957

In all of nature, there is no sound more pleasing than that of a hungry animal at its feed. Unless you are the food.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 86)

St. Martin's Press. New York, New York, USA. 1989

### **Ackerman, Diane** 1948–

American writer

One of the things I like best about animals in the wild is that they're always off on some errand. They have appointments to keep. It's only we humans who wonder what we're here for.

*The Moon by Whale Light, and Other Adventures among Bats and Crocodilians, Penguins and Whales*

Chapter 1 (pp. 41–42)

Random House, Inc. New York, New York, USA. 1991

### **Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born U.S. naturalist, geologist, and teacher

Animals are worthy of our regard, not merely when considered as to the variety and elegance of their forms, or their adaptation to the supply of our wants; but the Animal Kingdom, as a whole, has a still higher significance. It is the exhibition of the divine thought, as carried

out in one department of that grand whole which we call Nature; and considered as such, it teaches us most important lessons.

*Principles of Zoology*

Chapter First (p. 25)

Gould, Kendall & Lincoln. Boston, Massachusetts, USA. 1848

### **Allee, Warder C.** 1885–1955

American zoologist

The subsocial and social life of animals shows two major tendencies: one toward aggressiveness, which is best developed in man and his fellow vertebrates; the other unconscious, and in higher animals, toward conscious cooperation. With various associates I have long experimented upon both tendencies. Of these, the drive toward cooperation...is the more elusive and the more important.

In James R. Newman (ed.)

*What Is Science? Twelve Eminent Scientists and Philosophers Explain*

*Their Various Fields to the Layman*

Biology (p. 243)

Simon & Schuster. New York, New York, USA. 1955

### **Beston, Henry** 1888–1968

American writer

We need another and a wiser and perhaps a more mystical concept of animals.... We patronize them for their incompleteness, for their tragic fate of having taken form so far below ourselves. And therein we err, and greatly err. For the animal shall not be measured by man. In a world older and more complete than ours they move finished and complete, gifted extensions of the senses we have lost or never attained, living by voices we shall never hear. They are not brethren, they are not underlings, they are other nations, caught with ourselves in the net of life and time, fellow prisoners of the splendor and travail of the Earth.

*The Outermost House*

Chapter II (p. 25)

Rinehart & Company. New York, New York, USA. 1928

### **Borges, Jorge Luis** 1899–1986

Argentine writer

...to a certain Chinese encyclopedia entitled Celestial Emporium of Benevolent Knowledge...it is written that animals are divided into (a) those that belong to the Emperor, (b) embalmed ones, (c) those that are trained, (d) suckling pigs, (e) mermaids, (f) fabulous ones, (g) stray dogs, (h) those that are included in this classification, (i) those that tremble as if they were mad, (j) innumerable ones, (k) those drawn with a very fine camel's hair brush, (l) others, (m) those that have just broken a flower vase, (n) those that resemble flies from a distance.

*Other Inquisitions*

The Analytical Language of John Wilkins (p. 103)

University of Texas Press. Austin, Texas, USA. 1964

**Bradbury, Ray** 1920–  
American writer

The animal does not question life. It lives. Its very reason for living is life; it enjoys and relishes life.

*The Martian Chronicles* (p. 91)  
HarperCollins Publishers, Inc. New York, New York, USA. 1997

**Brophy, Brigid** 1929–95  
English novelist and essayist

I don't hold animals superior or even equal to humans. The whole case for behaving decently to animals rests on the fact that we are the superior species. We are the species uniquely capable of imagination, rationality, and moral choice — and that is precisely why we are under an obligation to recognize and respect the rights of animals.

*Don't Never Forget: Collected Views and Reviews*  
The Rights of Animals (p. 21)  
Holt, Rinehart & Winston. New York, New York, USA. 1966

**Bruchac, Joseph**  
Native-American writer

Let my words  
be bright with animals,  
images the flash of a gull's wings.  
If we pretend  
that we are at the center,  
that moles and kingfishers,  
eels and coyotes  
are at the edge of grace,  
then we circle, dead moons  
almost a cold sun.  
This morning I ask only  
the blessing of the crayfish,  
the beatitude of the birds;  
to wear the skin of the bear  
in my songs;  
to work like a man with my hands.

*Near the Mountains*  
Prayer  
White Pine Press. Fredonia, New York, USA. 1987

**Canetti, Elias** 1905–94  
Bulgarian playwright and novelist

Whenever you observe an animal closely, you feel as if a human being sitting inside were making fun of you.

Translated by Joachim Neugroschel  
*The Human Province*  
1942 (p. 7)  
Seabury Press. New York, New York, USA. 1978

**Compton-Burnett, Ivy** 1884–1969  
English writer

A leopard does not change his spots, or change his feeling that spots are rather a credit.

*More Women than Men*

Chapter 4 (p. 54)  
Victor Gollancz LTD. London, England. 1974

**Dickens, Charles** 1812–70  
English novelist

...judiciously show a cat milk, if you wish her to thirst for it. Judiciously show a dog his natural prey, if you wish him to bring it down one day.

*A Tale of Two Cities*  
Book 2, Chapter XV (p. 160)  
Dodd, Mead & Company. New York, New York, USA. 1925

**Dillard, Annie** 1945–  
American poet, essayist, novelist, and writing teacher

There is a terrible innocence in the benumbed world of the lower animals, reducing life there to a universal chomp.

*Pilgrim at Tinker Creek*  
Chapter 10, I (p. 168)  
Harper's Magazine Press. New York, New York, USA. 1974

**Ehrlich, Gretel** 1946–  
American writer

Animals give us their constant, unjaded faces and we burden them with our bodies and civilized ordeals.

*The Solace of Open Spaces*  
Friends, Foes, and Working Animals (p. 62)  
Basic Books, Inc., Publishers. New York, New York, USA. 1982

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

Animals are molded by natural forces they do not comprehend. To their minds there is no past and no future. There is only the everlasting present of a single generation — its trails in the forest, its hidden pathways in the air and in the sea.

*The Star Thrower*  
The Long Loneliness (p. 37)  
Times Books. New York, New York, USA. 1978

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Animals are such agreeable friends — they ask no questions, they pass no criticism.

*Scenes of Clerical Life*  
Mr. Gilfil's Love Story, Chapter VII (p. 116)  
Oxford University Press, Inc. Oxford, England. 1985

**Gardner, John** 1933–82  
American writer and scholar

Always be kind to animals,  
Morning, noon, and night;  
For animals have feelings too,  
And furthermore, they bite.

*A Child's Bestiary*  
Introduction  
Alfred A. Knopf. New York, New York, USA. 1977

**Hornaday, William Temple** 1854–1937

American naturalist

To assume that every wild beast and bird is a sacred creature, peacefully dwelling in an earthly paradise, is a mistake. They have their wisdom and their folly, their joys and their sorrows, their trials and tribulations.

*The Minds and Manners of Wild Animals: A Book of Personal Observations*

Man and the Wild Animals (p. 1)

Charles Scribner's Sons. New York, New York, USA. 1922

On one side of the heights above the River of Life stand the men of this little world, the fully developed, the underdone, and the unbaked, in one struggling, seething mass. On the other side, and on a level but one step lower down, stands the vanguard of the long procession of "Lower" Animals, led by the chimpanzee, the orang and the gorilla. The natural bridge that almost spans the chasm lacks only the keystone of the arch.

*The Minds and Manners of Wild Animals: A Book of Personal Observations*

Part IV, Chapter XXV (p. 252)

Charles Scribner's Sons. New York, New York, USA. 1922

An Animal is a living creature belonging to the animal kingdom; but the word is commonly, though incorrectly, used to designate mammals alone.

In William H. Carr

*The Stir of Nature*

Chapter Fourteen (p. 181)

Oxford University Press, Inc. New York, New York, USA. 1930

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

In our conviction, if souls were viable we should distinctly see the strange fact that every individual of the human species corresponds to some one of the species of animal creation; and we might easily recognize the truth, which has as yet scarce occurred to the thinker, that from the oyster to the eagle, from the hog to the tiger, all animals are in man, and that each one of them is in a man. Sometimes even several of them at a time.

*Les Misérables*

Volume I, Book V, Chapter 5 (p. 167)

The Heritage Press. New York, New York, USA. 1938

**Huxley, Thomas Henry** 1825–95

English biologist

Not only does every animal live at the expense of some other animal or plant, but the very plants are at war.... The individuals of a species are like the crew of a foundered ship, and none but good swimmers have a chance of reaching the land.

*Collected Essays* (Volume 2)

*Darwiniana*

The Darwin Hypothesis (p. 18)

Macmillan & Company Ltd. London, England. 1904

...the animal world is on about the same level as a gladiator's show. The creatures are fairly well treated, and set to fight — whereby the strongest, the swiftest, and the cunningest live to fight another day. The spectator has no need to turn his thumbs down, as no quarter is given.

*Collected Essays* (Volume 9)

The Struggle for Existence in Human Society (pp. 199–200)

Macmillan & Company Ltd. London, England. 1904

**Jennings, Elizabeth** 1926–2001

English poet

I hate a word like "pets": it sounds so much

Like something with no living of its own.

*Collected Poems: 1953–1985*

My Animals

Carcanet Press. New York, New York, USA. 1986

**Jerome, Jerome K.** 1859–1927

English author

Let your boat of life be light, packed with only what you need — a homely home and simple pleasures, one or two friends, worth the name, someone to love and someone to love you, a cat, a dog, and a pipe or two, enough to eat and enough to wear, and a little more than enough to drink; for thirst is a dangerous thing.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter 3 (p. 25)

Time Incorporated. New York, New York, USA. 1964

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

...the most important reason why there are so many gaps in the available life histories of even the commoner animals is less the perversity of professors than the fact that there are an awful lot of these common creatures and that actually to follow their lives from day to day is a very difficult time-consuming task.

*The Desert Year*

The Contemplative Toad (p. 109)

W. Sloane Associates. New York, New York, USA. 1952

**Margulis, Lynn** 1938–

American cell biologist and evolutionist

**Sagan, Dorion** 1959–

American science writer

No animal has ever really completely left the watery microcosm. The blastula and embryo still develop in the primeval wetness and buoyancy of the womb.... No matter how high and dry the mountain top, no matter how secluded and modern the retreat, we sweat and cry what is basically seawater.

*Microcosmos*

Chapter 11 (pp. 183, 184)

Summit Books. New York, New York, USA. 1986

Human religion and mythology have always been full of fantastic combinations of creatures — the mermaids,

sphinxes, centaurs, devils, vampires, werewolves, and seraphs that combine animal parts to make imaginary beings. Truth being stranger than fiction, biology has refined the intuitively pleasing idea with its discovery of the overwhelming statistical probability of the reality of combined beings.

*Microcosmos*

Chapter 7 (p. 120)

Summit Books. New York, New York, USA. 1986

**Muir, John** 1838–1914

American naturalist

Of the many advantages of farm life for boys one of the greatest is the gaining a real knowledge of animals as fellow-mortals, learning to respect them and love them, and even to win some of their love. Thus godlike sympathy grows and thrives and spreads far beyond the teachings of churches and schools, where too often the mean, blinding, loveless doctrine is taught that animals have neither mind nor soul, have no rights that we are bound to respect, and were made only for man, to be petted, spoiled, slaughtered or enslaved.

*My Boyhood and Youth*

Chapter III (p. 89)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

Most wild animals get into the world and out of it without being noticed. Nevertheless we at last sadly learn that they are all subject to the vicissitudes of fortune like ourselves.

*My Boyhood and Youth*

Chapter III (p. 109)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

**Oken, Lorenz** 1779–1851

German naturalist

Animal is blossom without a stem.

In H.R. Hays

*Birds, Beasts, and Men: A Humanist History of Zoology*

Chapter 17 (p. 212)

G.P. Putnam's Sons. New York, New York, USA. 1972

**Pratchett, Terry** 1948–

English author

[For animals] the whole panoply of the universe has been neatly expressed to them as things to (a) mate with, (b) eat, (c) run away from, and (d) rocks.

*Equal Rites* (p. 78)

Gollancz. London, England. 1986

**Purcell, Rosamond**

American photographer

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Animals in nature, contrary to the suspicions of cynics or the hopes of idealists, are neither intrinsically vicious nor altruistic. Competition and cooperation are both nature's ways.

*Illuminations: A Bestiary*

Viper (p. 101)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Sanborn, Kate** 1839–1923

American writer

...if Darwin's theory should be true, it will not degrade man; it will simply raise the whole animal world into dignity, leaving man as far in advance as he is at present.

*Studies of Animal Nature*

*Atlantic Monthly*, February, 1877 (p. 135)

**Stoker, Bram** 1847–1912

English writer

Then a dog began to howl somewhere in a farmhouse far down the road, a long, agonized wailing, as if from fear. The sound was taken up by another dog, and then another and another, till, borne on the wind which now sighed softly through the Pass, a wild howling began, which seemed to come from all over the country, as far as the imagination could grasp it through the gloom of the night.

*Dracula*

Chapter I (p. 11)

Ameron House. Mattituck, New York, USA. No date

I have always thought that a wild animal never looks so well as when some obstacle of pronounced durability is between us. A personal experience has intensified rather than diminished that idea.

*Dracula*

Chapter XI (p. 148)

Ameron House. Mattituck, New York, USA. No date

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

Of all the animals, man is the only one that is cruel. He is the only one that inflicts pain for the pleasure of doing it.

*Collected Tales, Sketches, Speeches, and Essays 1891–1910*

Man's Place in the Animal World (p. 210)

The Library of America. New York, New York, USA. 1992

**Wheeler, William Morton** 1865–1937

American entomologist

Why animals and plants are as they are we shall never know; of how they came to be what they are, our knowledge will always be extremely fragmentary; but that organisms are as they are, that apart from members of our own species they are our only companions in an infinite and unsympathetic waste of electrons, planets, nebulae and stars, is a perennial joy and consolation.

In Joseph Wood Krutch

*The Thought of Turtles*

*The Nation*, Volume 166, Number 24, June 12, 1948

**Wordsworth, William** 1770–1850

English poet

The cattle are grazing,  
 Their heads never raising:  
 There are forty feeding like one!  
*The Complete Poetical Works of William Wordsworth*  
 The Cock Is Crowing  
 Crowell. New York, New York, USA. 1888

### ANIMAL: AMPHIBIAN

**Smith, Langdon** 1858–1908  
 American poet

We were amphibians, scaled and tailed  
 And drab as a dead man's hand;  
 We coiled at ease 'neath the dripping trees  
 Or trailed through the mud and sand.  
 Croaking and blind, with our three clawed feet  
 Writing a language dumb,  
 With never a spark in the empty dark  
 To hint at a life to come.  
 In David L. George (ed.)  
*The Family Book of Best Loved Poems*  
 Evolution  
 Hanover House. Garden City, New Jersey, USA. 1952

### ANIMAL: AMPHIBIAN: FROG

**Carr, Archie** 1909–87  
 American zoologist

I like the look of frogs, and their outlook, and especially  
 the way they get together in wet places on warm nights  
 and sing about sex.  
*The Windward Road: Adventures of a Naturalist on Remote Caribbean Shores*  
 The Paradox Frog (p. 90)  
 Alfred A. Knopf. New York, New York, USA. 1956

**Muir, John** 1838–1914  
 American naturalist

Frogs abound in all the bogs, marshes, pools, and lakes,  
 however cold and high and isolated. How did they man-  
 age to get up these high mountains? Surely not by  
 jumping. Long and dry excursions through weary miles  
 of boulders and brush would be trying to frogs. Most  
 likely their stringy spawn is carried on the feet of ducks,  
 cranes, and other water birds. Anyhow, they are most  
 thoroughly distributed, and flourish famously. What a  
 cheery, hearty set they are, and how bravely their krink  
 and tronk concerts enliven the rocky wilderness!  
*Our National Parks*  
 Chapter VI (p. 211)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### ANIMAL: AMPHIBIAN: TADPOLE

**Pallister, William Hales** 1877–1946  
 Canadian physician

Three large glass bowls,  
 In each some half grown tadpoles,  
 All hatched from the same spawn,  
 Breathing with gills like fishes  
 In their small transparent dishes,  
 Waving their long tails,  
 Important to themselves as whales,  
 Some of them to be experimented on...  
*Poems of Science*  
 The Nature of Things, Tadpoles (p. 6)  
 Playford Press. New York, New York, USA. 1931

### ANIMAL: AMPHIBIAN: TOAD

**Fawcett, Edgar** 1847–1904  
 American poet

Blue dusk, that brings the dewy hours,  
 Brings thee, of graceless form in smooth,  
 Dark stumbler at the roots of flowers,  
 Flaccid, inert, uncouth.  
 In John Burroughs (ed.)  
*Songs of Nature*  
 A Toad  
 Doubleday, Page & Company. Garden City, New York, USA. 1912

**McArthur, Peter** 1866–1924  
 Canadian poet

Probably no creature in all nature has been so villainously  
 libeled as the toad. The greatest of poets speak of “the toad,  
 ugly and venomous,” and in fairy lore they are regarded as  
 poisonous. So deeply rooted are these erroneous beliefs  
 that no amount of scientific education seems able to erad-  
 icate them. The children are taught in school that the toad  
 is not only harmless, but useful as an insect destroyer, and  
 yet little girls will shriek at a toad just like their mothers.  
*The Best of Peter McArthur*  
 Toads (p. 177)  
 Vancouver, Clarke, Irwin. Toronto, Ontario, Canada. 1967

**Milne, A. A. (Alan Alexander)** 1882–1956  
 English poet, children's writer, and playwright

(Weasels, Stoats, and Ferrets, together:) Toad! Toad!  
 Down with Toad!  
 Down with the popular, successful Toad!  
*Toad of Toad Hall*  
 Act I, Number 7 (p. 18)  
 Charles Scribner's Sons. New York, New York, USA. 1929

### ANIMAL: ANNELID

### ANIMAL: ANNELID: WORM

#### Author undetermined

In the eyes of most men...the earthworm is a mere  
 blind, dumb, senseless, and unpleasantly slimy annelid.

Mr. Darwin undertakes to rehabilitate his character, and the earthworm steps forth at once as an intelligent and beneficent personage, a worker of vast geological changes, a planer down of mountain sides...a friend of man...and an ally of the Society for the preservation of ancient monuments.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter IX (p. 395)

D. Appleton & Company. New York, New York, USA. 1896

**Beebe, William** 1877–1962

American ornithologist

There are many ways of considering a flatworm. A Creator might rightly be quoted, “He saw that it was good.” To an ant accidentally blundering into its slime, the worm would be a certain, evil death. A bird would give it no second glance for its flesh is worse than inedible.

*High Jungle*

Chapter X (p. 171)

Duell, Sloan & Pearce. New York, New York, USA. 1949

**Blake, William** 1757–1827

English poet, painter, and engraver

O rose, thou art sick!  
The invisible worm  
That flies in the night,  
In the howling storm,  
Has found out thy bed  
Of crimson joy,  
And his dark secret love  
Does thy life destroy.

*The Complete Poetry and Prose of William Blake*

Songs of Experience, The Sick Rose

University of California Press. Berkeley, California, USA. 1982

**Boone, John Allen** 1882–1965

Author

...if you should ever encounter me walking along a dirt road and should see me pause, lift my hat and bow to the direction of the ground, you will know that I am paying my respects to a passing earthworm.

*Adventures in Kinship with All Life*

Wormy Ways (p. 123)

Harper & Brothers. New York, New York, USA. 1954

**Darwin, Charles Robert** 1809–82

English naturalist

It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organised creatures.

*Darwin on Humus and the Earthworm: The Formation of Vegetable*

*Mould Through the Action of Worms with Observations on Their Habits*

Chapter VII (p. 148)

Faber & Faber Ltd. London, England. 1945

**Eaton, Burnham**

No biographical data available

The earthworm who, described as lowly,  
Grinds, like the gods, exceedingly slowly,  
Doth also grind exceedingly small.  
By diligent, continual  
And through subterranean toil,  
He doth homogenize the soil.

H—O—M—G—E—N—I—Z—A—T—I—O—N

*Nature Magazine*, Volume 50, Number 1, January 1957 (p. 41)

**Garstang, Walter** 1868–1949

English embryologist and amateur poet

The Onchosphere or Hexacanth was not designed for frolic,  
His part may be described perhaps as coldly diabolic:  
He’s born amid some gruesome things, but this should  
count for virtue,  
That steadily, ‘gainst fearful odds, he plies his task — to  
hurt you.

He’s now a Cysticerus in the muscles of a pig,  
With just a sporting chance of getting to grow up big.  
If you’ll consent to eat your pork half-raw or underdone,  
His troubles will be over, and a Tapeworm will have won:  
He’ll cast his anchors out, and on your best digested food  
Will thrive, and bud an endless chain to raise a countless  
brood.

*Larval Forms, and Other Zoological Verses*

The Onchosphere, Stanza 1, 4 (p. 37)

The University of Chicago Press. Chicago, Illinois, USA. 1985

**Gilman, Charlotte Perkins** 1860–1935

American writer and feminist

I don’t want to be a fly,

I want to be a worm!

In Burton Egbert Stevenson (ed.)

*The Home Book of Verse*

A Conservative

Henry Holt & Company. New York, New York, USA. 1915

**Martinson, Harry Edmund** 1904–78

Swedish novelist

Who really respects the earthworm,  
the farm worker far under the grass in the soil.

In Robert Bly

*Friends, You Drank Some Darkness: Three Swedish Poets*

The Earthworm (p. 139)

Beacon Press. Boston, Massachusetts, USA. 1975

**Pallister, William Hales** 1877–1946

Canadian physician

Then the WORMS seven thousand of species can show,  
All segmented, possessing a system of nerves:  
Life becoming more conscious, beginning to know;  
The small earthworm is soil’s great economy serves,  
Bringing earth to the surface, returning again,  
Even thus, he has buried old cities for men!

*Poems of Science*

Beginnings, Animal Life (p. 139)

Playford Press. New York, New York, USA. 1931

**Phillips, Adam**

British child psychotherapist and essayist

What would our lives be like if we took earthworms seriously, took the ground under our feet rather than the skies high above our heads, as the place to look, as well, eventually, as the place to be? It is as though we have been pointed in the wrong direction.

*Darwin's Worms*

Darwin Turns the Worm (pp. 60–61)

Faber &amp; Faber Ltd. London, England. 1999

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

Nature crying out and speaking to country people in these words: Clown, wherefore dost thou behold the heavens? Why dost thou seek after the stars? When thou art now weary with short sleep, the nights are troublesome to thee. So I scatter little stars in the grass, and I shew them in the evening when thy labour is ended, and thou art miraculously allured to look upon them when thou pass-est by: Dost thou not see how a light like fire is covered when she closeth her wings, and she carrieth both night and day with her.

In Thomas Moffett

*The Theater of Insects*

Glow-Worms

Printed by E. Cotes. London, England. 1658

**Sexton, Anne** 1928–74

American poet and writer

Slim inquirer, while the old fathers sleep you are reworking their soil, you have a grocery store there down under the earth and it is well stocked with broken wine bottles, old cigars, old door knobs and earth, that great brown flour that you kiss each day.

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Earthworm

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

Have you no beginning and end? Which heart is the real one? Which eye the seer? Why is it in the infinite plan that you would be severed and rise from the dead like a gargoyle with two heads?

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Earthworm

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**White, Gilbert** 1720–93

English naturalist and cleric

Earth-worms, though in appearance a small and despicable link in the chain of nature, yet, if lost, would make a lamentable chasm. For, to say nothing of half the birds, and some quadrupeds, which are almost entirely supported by them, worms seem to be the great promoters of vegetation,

which would proceed but lamely without them, by boring, perforating, and loosening the soil, and rendering it pervious to rains and the fibers of plants, by drawing straws and stalks of leaves and twigs into it; and, most of all, by throwing up such infinite numbers of lumps of earth...

*The Natural History of Selborne*

Letter XXXV

Robert M. McBride &amp; Company. New York, New York, USA. 1925

...the earth without worms would soon become cold, hard-bound, and void of fermentation; and consequently sterile...

*The Natural History of Selborne*

Letter XXXV

Robert M. McBride &amp; Company. New York, New York, USA. 1925

**ANIMAL: BIRD****Atkinson, Brooks** 1894–1984

American drama critic

Nothing wholly admirable ever happens in this country except the migration of birds.

*Once Around the Sun*

March 23 (p. 80)

Harcourt, Brace &amp; Company. New York, New York, USA. 1951

**Beston, Henry** 1888–1968

American writer

On flocks of birds flying up before him as he walks the beach: "Standing on the beach, I watch the lovely sight of the group instantly turned into a constellation of birds, into a fugitive Pleiades whose living stars keep their chance positions."

*The Outermost House*

Chapter II (p. 23)

Rinehart &amp; Company. New York, New York, USA. 1928

**Chapman, Frank M.** 1864–1945

American ornithologist

...birds will appeal most strongly to us through their songs. When your ears are attuned to the music of birds, your world will be transformed. Birds' songs are the most eloquent of Natures' voices....

*Bird-Life*

Chapter I (p. 11)

D. Appleton &amp; Company. New York, New York, USA. 1903

**Cornwall, Barry (Bryan Waller Procter)** 1787–1874

English author

Come, all ye feathery people of mid-air,  
Who sleep 'midst rocks, or on the mountain summits  
Lie down with the wild winds; and ye who build  
Your homes amidst green leaves by grottoes cool;  
And ye who on the flat sands hoard your eggs  
For suns to ripen, come!

*The Poetical Works of Milman, Bowles, Wilson, and Barry Cornwall*

An Invocation to Birds

A. &amp; W. Galignani. Paris, France. 1829



**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

A bird is an instrument working according to a mathematical law, which instrument it is within the capacity of man to reproduce, with all its movements.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Flying Machine (p. 493)

George Braziller. New York, New York, USA. 1958

**Darwin, Charles Robert** 1809–82

English naturalist

We behold the face of nature bright with gladness, we often see the superabundance of food; we do not see or we forget, that the birds which are idly singing round us mostly live on insects or seeds, and are thus constantly destroying life; or we forget how largely these songsters, or their eggs, or their nestlings, are destroyed by birds and beasts of prey; we do not always bear in mind, that, though food may be now superabundant, it is not so at all seasons of each recurring year.

In *Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection*

Chapter III (p. 32)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The bird is not in its ounces and inches, but in its relations to Nature; and the skin or skeleton you show me, is no more a heron, than a heap of ashes or a bottle of gases into which his body has been reduced, is Dante or Washington.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Beauty (p. 1099)

The Library of America. New York, New York, USA. 1983

Hast thou named all the birds without a gun?

*Collected Poems and Translations*

Forbearance

Library of America. New York, New York, USA. 1994

**Guinzelli, Guido** 1230–1276

Italian poet

Many strange birds are on the air abroad,  
Nor are all of one flights of one force,  
But each after his kind dissimilar.

In Robert Edwards (ed.)

*The Poetry of Guido Guinzelli*

Of Moderation and Tolerance

Garland Publications. New York, New York, USA. 1987

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Birds in general are stupid, in the sense of being little able to meet unforeseen emergencies; but their lives are

often emotional, and their emotions are richly and finely expressed.

*Essays of a Biologist*

An Essay on Bird-Mind (p. 111)

Alfred P. Knopf. New York, New York, USA. 1929

**Klee, Paul** 1879–1940

Swiss painter

The birds are to be envied:

They avoid

Thinking about the trees and the roots.

Agile, self contented, all day long they swing

And sing, perched on ultimate end.

*The Inward Vision: Watercolors, Drawings, Writings*

Cover Page

N.H. Abrams. New York, New York, USA. 1958

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

I never saw a wild thing

Sorry for itself.

A small bird will drop frozen dead

From a bough

Without ever having felt sorry for itself.

*The Complete Poems of D.H. Lawrence*

Self Pity

The Viking Press. New York, New York, USA. 1973

**Longfellow, Henry Wadsworth** 1807–82

American poet

You call them thieves and pillagers; but know,

They are the winged wardens of yours farms,

Who from the cornfields drive the insidious foe,

And from your harvests keep a hundred harms...

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 4)

The Poet's Tale

Birds of Killingworth, Stanza 19

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Lynd, Robert** 1879–1949

Anglo-Irish essayist

There is nothing in which the birds differ more from man than the way in which they can build and yet leave a landscape as it was before.

*The Blue Lion*

The Nuthatch (p. 29)

Books for Libraries Press. Freeport, New York, USA. 1968

**Mansfield, Katherine** 1888–1923

English author

It is astonishing how violently a big branch shakes when a silly little bird has left it. I expect the bird knows it and feels immensely arrogant.

In J. Middleton Murry (ed.)

*Journal of Katherine Mansfield*

1917, August 21, Alors, je pars (p. 70)

Alfred A. Knopf. New York, New York, USA. 1946

**McArthur, Peter** 1866–1924  
Canadian poet

The robins, killdeere, red-winged blackbirds and grackles come back with the warm wave. This means that the great university of nature is about to open for its spring and summer terms.

*The Best of Peter McArthur*  
Nature's University (pp. 169–170)  
Vancouver, Clarke, Irwin. Toronto, Ontario, Canada. 1967

**Pallister, William Hales** 1877–1946  
Canadian physician

Of the birds, thirteen thousands of species are named;  
This is the first life with warm blood! We could not  
know all

And quite truly one need not feel greatly ashamed  
If some few of the rare names are hard to recall,  
But the birds are so lovely, I wish that I knew  
All about all of them, and I'm sure so do you.

*Poems of Science*  
Beginnings, Animal Life (p. 141)  
Playford Press. New York, New York, USA. 1931

**White, Gilbert** 1720–93  
English naturalist and cleric

The language of birds is very ancient, and, like other ancient modes of speech, very elliptical: little is said, but much is meant and understood.

*The Natural History of Selborne*  
Letter XLIII (p. 198)  
Robert M. McBride & Company. New York, New York, USA. 1925

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

You must not know too much, or be too precise or scientific about birds and trees and flowers and watercraft; a certain free margin, and even vagueness — perhaps ignorance, credulity — helps your enjoyment of these things.

*Specimen Days*  
Birds — And a Caution (p. 112)  
D.R. Godine. Boston, Massachusetts, USA. 1971

## ANIMAL: BIRD: ADJUTANT

**Kipling, Lockwood** 1837–1911  
English illustrator, museum curator, and father of Rudyard Kipling

For grotesque devilry of dancing the Indian adjutant beats creation. Don Quixote or Malcollo was not half so solemn or dancing, and yet there is an abandonment and lightness of step, a wild lift in each solemn prance which are almost demoniacal. If it were possible for the most angular, tall, and demure of elderly maiden ladies to take a great deal too much champagne and then to give a lesson in ballet dancing, with occasional pauses of acute sobriety,

perhaps some faint idea might be conveyed of the peculiar quality of the adjutant's movements.

In Douglas Dewar  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*  
The Birds of India (p. 619)  
Government Printing Office. Washington, D.C. 1909

## ANIMAL: BIRD: ALBATROSS

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

And a good south wind sprung up behind,  
The Albatross did follow,  
And every day, for food or play,  
Came to the mariner's hollo!  
“God save thee, ancient Mariner!  
From the fiends that plague thus thee! —  
Why look'st thou so?” —

With my crossbow  
I shot the Albatross.  
*The Rime of the Ancient Mariner and Other Poems*  
Rime of the Ancient Mariner, Part I  
pt. I, Stanza 18, l. 71–74, 76–80  
Little Leather Library Corporation. New York, New York, USA. 1915

**Leland, Charles G.** 1824–1903  
American writer

Great albatross! — the meanest birds  
Spring up and flit away,  
While thou must toil to gain a flight,  
And spread those pinions grey...

*The Music-Lesson of Confucius*  
Perseverando, Stanza 3  
J.R. Sgoood & Company. Boston, Massachusetts, USA. 1872

## ANIMAL: BIRD: BALD EAGLE

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

I wish the Bald Eagle had not been chosen as the representative of our country. He is a bird of bad moral character; he does not get his living honestly...

*Ornithological Biography* (Volume 1)  
White-Headed Eagle (p. 168)  
Adam Black. Edinburgh, Scotland. 1831

## ANIMAL: BIRD: BIRD OF PARADISE

**Colum, Padraic** 1881–1972  
Irish poet and writer

With sapphire for her crown,  
And with the Libyan wine  
For lustre of her eyes;  
With azure for her feet  
(It is her henna stain);

Then iris for her vest,  
 Rose, ebony, and flame,  
 She lives a thing enthralled,  
 In forests that are old,  
 As old as is the Moon.

*Collected Poems*

Bird of Paradise

Devin-Adair. New York, New York, USA. 1953

**Moore, Thomas** 1779–1852

Irish poet

Those golden birds that, in the spice-time, drop  
 About the gardens, drunk with that sweet food  
 Whose scent hath lur'd them o'er the summer flood  
 And those that under Araby's soft sun  
 Build their high nests of budding cinnamon.

*The Poetical Works of Thomas Moore*

Lalla Rookh, The Veiled Prophet of Khorassan (p. 48)

Lee & Shepard. Boston, Massachusetts, USA. 1873

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

Nature seems to have taken every precaution that these, her choicest treasures, may not lose value by being too easily obtained. First we find an open, harbourless, inhospitable coast, exposed to the full swell of the Pacific Ocean; next, a rugged and mountainous country, covered with dense forests, offering in its swamps and precipices and serrated ridges an almost impassable barrier to the central regions; and lastly, a race of the most savage and ruthless character, in the very lowest stage of civilization. In such a country and among such a people are found these wonderful productions of nature. In those trackless wilds do they display that exquisite beauty and that marvelous development of plumage, calculated to excite admiration and astonishment among the most civilized and most intellectual races of man...

*Proceedings of the Zoological Society of London 1862* (p. 160)

## ANIMAL: BIRD: BLACKBIRD

**Moir, David Macbeth** 1798–1851

Scottish physician and writer

The birds have ceased their songs,  
 All save the blackbird, that from yon tall ash,  
 'Mid Pinkie's greenery, from his mellow throat,  
 In adoration of the setting sun,  
 Chants forth his evening hymn.

*The Poetical Works of David Macbeth Moir*

An Evening Sketch

W. Blackwood & Sons. Edinburgh, Scotland. 1860

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

The blackbird is a perfect gentleman, in deportment and attire, and is not noisy, I believe, except when holding religious services and political conventions in a tree...

*Following the Equator* (Volume 2)

Chapter II (p. 32)

Harper & Brothers Publishers. New York, New York, USA. 1899

## ANIMAL: BIRD: BLUE JAY

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

Reader, look at the plate in which are represented three individuals of this beautiful species — rogues though they be, and thieves, as I would call them, were it fit for me to pass judgment on their actions. See how each is enjoying the fruits of his knavery, sucking the egg which he has pilfered from the nest of some innocent dove or harmless partridge! Who could imagine that a form so graceful, arrayed by nature in a garb so resplendent, should harbour so much mischief...

*Ornithological Biography* (Volume 2)

The Blue Jay (p. 11)

Adam Black. Edinburgh, Scotland. 1834

**Twain, Mark (Samuel Langhorne Clem-**

**ens)** 1835–1910

American writer and humorist

Now there is more to a bluejay than any other animal. He has got more different kinds of feeling. Whatever a bluejay feels he can put into language, and not mere commonplace language, but straight out and out book talk, and there is such a command of language. You never saw a bluejay get stuck for a word. He is a vocabularized geyser. Now you must call a jay a bird, and so he is in a measure, because he wears feathers and don't belong to any church, but otherwise he is just as human nature made him. A bluejay hasn't any more principle than an ex-congressman, and he will steal, deceive and betray four times out of five; and as for the sacredness of an obligation, you cannot scare him in the detail of principle. He talks the best grammar of all the animals. You may say a cat talks good grammar. Well, a cat does; but you let a cat get excited, you let a cat get at pulling fur with another cat on a shed nights and you will hear grammar. A bluejay is human; he has got all a man's faculties and a man's weakness. He likes especially scandal; he knows when he is an ass as well as you do.

*A Tramp Abroad*

Chapter II

Penguin Books. New York, New York, USA. 1997

## ANIMAL: BIRD: BLUEBIRD

**Longfellow, Henry Wadsworth** 1807–82

American poet

In the thickets and the meadows

Piped the bluebird, the Owaissa...

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)

Hiawatha, Part XXI

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

A man's interest in a single bluebird is worth more than a complete but dry list of the fauna and flora of a town.

*The Writings of Henry David Thoreau* (Volume 6)

Letter to Daniel Ricketson, November 22, 1856 (p. 341)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

### ANIMAL: BIRD: BOBOLINK

**Cranch, Christopher Pearse** 1813–92

American Unitarian minister, poet, and author

One day in the bluest of summer weather,

Sketching under a whispering oak,

I heard five bobolinks laughing together,

Over some ornithological joke.

*Collected Poems of Christopher Pearse Cranch*

Bird Language, Stanza I

Scholars' Facsimiles & Reprints, Gainesville, Florida, USA. 1971

### ANIMAL: BIRD: CANARY

**Mulock, Dinah Maria (Mrs. Craik)** 1826–87

English author

Sing away, ay, sing away,

Merry little bird,

Always gayest of the gay,

Though a woodland roundelay

You ne'er sung nor heard;

Though your life from youth to age

Passes in a narrow cage.

*Miss Mulock's Poems*

The Canary in His Cage

Houghton, Osgood. Boston, Massachusetts, USA. 1880

**Nash, Ogden** 1902–71

American writer of humorous poetry

The song of canaries

Never varies,

And when they're molting

They're pretty revolting.

*Verses from 1929 On*

The Canary

Little, Brown & Company. Boston, Massachusetts, USA. 1959

### ANIMAL: BIRD: CONDOR

**Brower, David** 1912–2000

American environmentalist

A condor is about 5 percent feathers, blood, and bone, and about 95 percent place. Place designs the condor, as

it does the Arctic tern and the monarch butterfly.

*Let the Mountains Talk, Let the Rivers Run*

Chapter 18 (p. 146)

HarperCollins Publishers, Inc. New York, New York, USA. 1995

### ANIMAL: BIRD: CROW

**Baynes, Ernest Harold** 1868–1925

American naturalist and writer

Few birds are more intelligent than the Crow. That he has a language, by which he can readily communicate with his fellows, and which can be translated in English, is now well known to ornithologists.

In William H. Carr

*The Stir of Nature*

Chapter Eleven (p. 142)

Oxford University Press, Inc. New York, New York, USA. 1930

**Gay, John** 1685–1732

English poet and dramatist

To shoot at crows is powder flung away.

*The Poetical Works of John Gay* (Volume 1)

Epistle to the Right Honourable Paul Methuen, Esq., l. 96

Lawrence & Bullen. London, England. 1893

**Longfellow, Henry Wadsworth** 1807–82

American poet

Even the blackest of them all, the crow,

Renders good service as your man-at-arms,

Crushing the beetle in his coat of mail,

And crying havoc on the slug and snail.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 4)

The Poet's Tale

Birds of Killingworth, Stanza 19

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

In the course of his evolutionary promotion, his sublime march toward ultimate perfection, he has been a gambler, a low comedian, a dissolute priest, a fussy woman, a blackguard, a scoffer, a liar, a thief, a spy, an informer, a trading politician, a swindler, a professional hypocrite, a patriot for cash, a reformer, a lecturer, a lawyer, a conspirator, a rebel, a royalist, a democrat, a practicer and propagator of irreverence, a meddler, an intruder, a busybody, an infidel, and a wallower in sin for the mere love of it. The strange result, the incredible result, of this patient accumulation of all damnable traits is, that he does not know what care is, he does not know what sorrow is, he does not know what remorse is, his life is one long thundering ecstasy of happiness, and he will go to his death untroubled, knowing that he will soon turn up again as an author or something, and be even more intolerably capable and comfortable than ever he was before.

*Following the Equator* (Volume 2)

Chapter II (p. 31)

Harper & Brothers Publishers. New York, New York, USA. 1899

## ANIMAL: BIRD: CUCKOO

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...the cuckoo builds not for himself...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume Two)

Anthony and Cleopatra

Act II, Scene vi, l. 28

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ANIMAL: BIRD: DODO

**Cuppy, Will** 1884–1929

American humorist and critic

The Dodo never had a chance. He seems to have been invented for the sole purpose of becoming extinct and that was all he was good for.

*How to Become Extinct*

The Dodo (p. 102)

Dover Publications. New York, New York, USA. 1964

## ANIMAL: BIRD: DOVE

**Barrett-Browning, Elizabeth** 1806–61

English poet

And there my little doves did sit  
With feathers softly brown,  
And glittering eyes that showed their right  
To general Nature's deep delight.

*The Complete Poetical Works of Elizabeth Barrett Browning*

My Doves, Stanza 2

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The dove and very blessed spirit of peace...

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

Second Part of King Henry the Fourth

Act IV, Scene i, l. 46

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ANIMAL: BIRD: DUCK

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

...even the skeptical mind must be prepared to accept the unacceptable when there is no alternative. If it looks like a duck, and quacks like a duck, we have at least to consider the possibility that we have a small aquatic bird of the family *Anatidae* on our hands.

*Dirk Gently's Holistic Detective Agency*

Chapter 30 (p. 269)

Simon & Schuster. New York, New York, USA. 1988

**Nash, Ogden** 1902–71

American writer of humorous poetry

Behold the duck.

It does not cluck.

A cluck it lacks.

It quacks.

It is specially fond

Of a puddle or pond.

When it dines or sups,

It bottoms ups.

*Verses from 1929 On*

The Duck

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## ANIMAL: BIRD: EAGLE

**Tennyson, Alfred (Lord)** 1809–92

English poet

He clasps the crag with crooked hands,

Close to the sun in lonely lands;

Ring'd with the azure world, he stands.

The wrinkled sea beneath him crawls;

He watches from his mountain walls,

And like a thunderbolt he falls.

*Alfred Tennyson's Poetical Works*

The Eagle

Oxford University Press, Inc. London, England. 1953

## ANIMAL: BIRD: EMU

**Cuppy, Will** 1884–1929

American humorist and critic

His kick is less severe than that of the Ostrich, which easily breaks a man's leg. The Emu's kick seldom breaks more than the fibula, the smaller bone of the leg, leaving the tibia in first-class condition.

*How to Attract the Wombat*

The Emu (fn 4, p. 183)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Prelutsky, Jack** 1940–

American poet

Do not approach an emu,

the bird does not esteem you.

It wields a quick and wicked kick

That's guaranteed to cream you.

*A Pizza the Size of the Sun: Poems*

Do Not Approach an Emu

Greenwillow Books. New York, New York, USA. 1996

## ANIMAL: BIRD: FALCON

**Lowell, James Russell** 1819–91

American poet

I know a falcon swift and peerless  
As e'er was cradled in the pine:  
No bird had ever eye so fearless,  
Or wing so strong as this of mine.

*The Poetical Works of James Russell Lowell*

The Falcon

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

My falcon now is sharp and passing empty;  
And till she stoop, she must not be full-gorged,  
for then she never looks upon her lure.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Taming of the Shrew

Act IV, Scene i, l. 193–195

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ANIMAL: BIRD: FLAMINGO

**Thompson, Sir D'Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

[A] flock of flamingos, wearing on rosy breast and crimson wings a garment of invisibility, fades away into the sky at dawn or sunset like a cloud incarnadine.

*On Growth and Form* (Volume 2)

Chapter XVI (pp. 959–960)

At the University Press. Cambridge, England. 1951

## ANIMAL: BIRD: GOLDFINCH

**Cowper, William** 1731–1800

English poet

Two goldfinches, whose sprightly song  
Had been their mutual solace long,  
Lived happy prisoners there.

*The Poetical Works of William Cowper*

Faithful Bird

John W. Lovell Company. New York, New York, USA. No date

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

A goldfinch there I saw, with gawdy pride  
Of painted plumes, that hopped from side to side,  
Still pecking as she pass'd; and still she drew  
The sweets from every flower, and suck'd the dew:  
Sufficed at length, she warbled in her throat,  
And turned her voice to many a merry note...

*The Poetical Works of Dryden*

Tales from Chaucer: The Flower and the Leaf, l. 106–111

The Riverside Press. Cambridge, Massachusetts, USA. 1949

## ANIMAL: BIRD: GOOSE

**Nash, Ogden** 1902–71

American writer of humorous poetry

Be careful not to cross the gander,  
A bird composed of beak and dander,  
His heart is filled with prideful hate  
Of all the world except his mate.

And if the neighbors do not err

He's overfond of beating her.

Is she happy? What's the use

Of trying to psychoanalyze a goose?

*Verses from 1929 On*

The Gander

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

As wild geese that the creeping fowler eye,

Or russet-pated choughs, many in sort,

Rising and cawing at the gun's report,

Sever themselves, and madly sweep the sky.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

A Midsummer-Night's Dream

Act III, Scene ii, l. 20–23

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Young, Roland** 1887–1953

English actor

The plural of goose is geese,

But the plural of moose ain't meese,

And the plural of noose ain't neese,

But the plural of goose — is geese.

*Not for Children*

The Goose

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

## ANIMAL: BIRD: GRACKLE

**Nash, Ogden** 1902–71

American writer of humorous poetry

The grackle's voice is less than mellow,

His heart is black, his eye is yellow,

He bullies more attractive birds

With hoodlum deeds and vulgar words,

And should a human interfere,

Attacks that human in the rear.

I cannot help but deem the grackle

An ornithological debacle.

*Verses from 1929 On*

The Grackle

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## ANIMAL: BIRD: HAWK

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

When I bestride him, I soar, I am a hawk...

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Life of King Henry the Fifth  
Act III, Scene vii, l. 14  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tennyson, Alfred (Lord)** 1809–92

English poet

The wild hawk stood with the down on his beak,  
And stared with his foot on the prey.

*Alfred Tennyson's Poetical Works*

The Poet's Song, l. 11–12

Oxford University Press, Inc. London, England. 1953

**ANIMAL: BIRD: HORNBILL**

**Dewar, Douglas** 1875–1957

British civil servant and ornithologist

Hornbills are the clowns of the forest.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

The Birds of India (p. 619)

Government Printing Office. Washington, D.C. 1909

**ANIMAL: BIRD: HUMMING BIRD**

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

Where is the person who, on seeing this lovely little creature moving on humming winglets through the air, suspended as if by magic in it, flitting from one flower to another, with motions as graceful as they are light and airy, pursuing its course over our extensive continent, and yielding new delights wherever it is seen — where is the person, I ask of you, kind reader, who on observing this glittering fragment of the rainbow, would not pause, admire, and instantly turn his mind with reverence toward the Almighty Creator...

*Ornithological Biography* (Volume 1)

The Ruby-Throated Humming Bird (p. 248)

Adam Black. Edinburgh, Scotland. 1831

**Pallister, William Hales** 1877–1946

Canadian physician

A flashing, dashing, rainbow-streak,  
The whirl or wondrous wings;  
We hold our breath, we must not speak,  
Such shy, such splendid things!

*Poems of Science*

De Ipsa Natura, Humming-Birds (p. 222)

Playford Press. New York, New York, USA. 1931

**Riley, James Whitcomb** 1849–1916

American poet

And the humming-bird that hung  
Like a jewel up among  
The tilted honeysuckle-horns,  
They mesmerized and swung

In the palpitating air,  
Drownd with odors strange and rare,  
And, with whispered laughter, slipped away,  
And left him hanging there.

*The Complete Works of James Whitcomb Riley* (Volume 4)

The South Wind and the Sun, Stanza 8

P.F. Collier & Son, Company. New York, New York, USA. 1916

**Tabb, John Banister** 1845–1909

American poet

A flash of harmless lightning,  
A mist of rainbow dyes,  
The burnished sunbeams brightening,  
From flower to flower he flies...

*The Poetry of Father Tabb*

Birds, The Humming-Bird

Dodd, Mead. New York, New York, USA. 1928

**ANIMAL: BIRD: JAY**

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

What is the jay more precious than the lark,  
Because his feathers are more beautiful.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Taming of the Shrew

Act IV, Scene iii, l. 177–178

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**ANIMAL: BIRD: LARK**

**Barrett-Browning, Elizabeth** 1806–61

English poet

The music soars within the little lark,  
And the lark soars.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book III, l. 155–156

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Cather, Willa** 1873–1947

American novelist

...there are only two or three human stories, and they go on repeating themselves as fiercely as if they had never happened before; like the larks in this country, that have been singing the same five notes over for thousands of years.

*O Pioneers!*

Part II, Chapter IV (p. 119)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Muir, John** 1838–1914

American naturalist

The larks come in large flocks from the hills and mountains in the fall, and are slaughtered as ruthlessly as the robins. Fortunately, most of our song birds keep back in leafy hidings, and are comparatively inaccessible.

*Our National Parks*  
Chapter VII (p. 238)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

A balmy day. Sunshine and lark song in glorious measure. A petition is being circulated in favor of preservation of larks from the ruthless slaughter of gunners. Larks are as characteristic of California weather as sunbeams. As well shoot the sun out of the sky.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*  
Chapter VIII, Section 1, February 1 (p. 336)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

**Rossetti, Christina Georgina** 1830–94  
English poet

The sunrise wakes the lark to sing.  
*The Complete Poems of Christina Rossetti* (Volume 1)  
Poems Added in 1875, Bird Raptures (p. 210)  
Louisiana State University Press. Baton Rouge, Louisiana, USA. 1979

## ANIMAL: BIRD: LINNET

**Wordsworth, William** 1770–1850  
English poet

Hail to thee, far above the rest  
In joy of voice and pinion!  
Thou, linnet! in thy green array,  
Presiding spirit here to-day,  
Dost lead the revels of the May;  
And this is thy dominion.  
*The Complete Poetical Works of William Wordsworth*  
The Green Linnet, Stanza II,  
Crowell. New York, New York, USA. 1888

## ANIMAL: BIRD: LOON

**Lawrence, Jerome** 1915–2004  
American writer and lyricist

**Lee, Robert Edwin** 1918–94  
American writer and lyricist

Henry: Anytime you hear a man called “loony,” just remember that’s a great compliment to the man and a great disrespect to the loon. A loon doesn’t wage war, his government is perfect, being nonexistent. He is the world’s best fisherman and completely in control of his senses, thank you.

*The Night Thoreau Spent in Jail*  
Act One (p. 18–19)  
Samuel French, Inc. London, England. 2000

## ANIMAL: BIRD: LOUISIANA WATER THRUSH

**Audubon, John James** 1785–1851  
West Indian-born American ornithologist and artist

Much and justly as the song of the Nightingale is admired, I am inclined, after having often listened to it, to pronounce it in no degree superior to that of the Louisiana Water Thrush. The notes of the latter bird are as powerful and mellow, and at times as varied.

*Ornithological Biography* (Volume 1)  
The Louisiana Water Thrush (p. 99)  
Adam Black. Edinburgh, Scotland. 1831

## ANIMAL: BIRD: MARTLET

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...the martlet  
Builds in the weather on the outward wall,  
Even in the force and road of causality.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The Merchant of Venice  
Act II, Scene ix, l. 28–30  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ANIMAL: BIRD: MOCKING BIRD

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Then from the neighboring thicket the mocking-bird,  
wildest of singers,  
Swinging aloft on a willow spray that hung o’er the water,  
Shook from his little throat such floods of delirious music,  
That the whole air and the woods and the waves seemed silent to listen.  
*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)  
Evangeline  
Part II, Stanza II (pp. 75–76)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

## ANIMAL: BIRD: MOUNTAIN QUAIL

**Muir, John** 1838–1914  
American naturalist

...like every true mountaineer, he is quick to follow the spring back into the highest mountains.

*Our National Parks*  
Chapter VII (p. 220)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## ANIMAL: BIRD: NIGHTINGALE

**Sappho** 630 BCE–570 BCE  
Greek lyric poet

The nightingale is the harbinger of Spring and her voice is desire.



*Poems and Fragments*

Fragment 114

University of Michigan Press. Ann Arbor, Michigan, USA. 1965

## ANIMAL: BIRD: OSTRICH

**Nash, Ogden** 1902–71

American writer of humorous poetry

The ostrich roams the great Sahara.

Its mouth is wide, its neck is narra.

It has such long and lofty legs,

I'm glad it sits to lay its eggs.

*Verses from 1929 On*

The Ostrich

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## ANIMAL: BIRD: OWL

**Borland, Hal** 1900–78

American writer

The owl, that bird of onomatopoeic name, is a repetitious question wrapped in feathery insulation especially for Winter delivery.

*Sundial of the Seasons: A Selection of Outdoor Editorials from the New York Times*

Questions, December 27 (p. 271)

Lippencott. Philadelphia, Pennsylvania, USA. 1964

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The clamorous owl that nightly hoots and wonders

At our quaint spirits.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

A Midsummer-Night's Dream

Act II, Scene ii, l. 6–7

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ANIMAL: BIRD: PARROT

**Prelutsky, Jack** 1940–

American poet

The parrots, garbed in gaudy dress,

with almost nothing to express,

delight in spouting empty words...

they are extremely verbal birds.

*A Pizza the Size of the Sun: Poems*

The Parrots

Greenwillow Books. New York, New York, USA. 1996

## ANIMAL: BIRD: PARTRIDGE

**Spenser, Edmund** 1552–99

English poet

Like as a fearful partridge, that is fled

From the sharpe hauke which her attacked neare,

And falls to ground to seeke for succor theare,

Whereas the hungry spaniells she does spye,

With greedy jaws her ready for to teare.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book III, Canto VIII, Stanza 33

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

## ANIMAL: BIRD: PASSENGER PIGEON

**Abbott, Roy L.** 1886–1968

American professor of biology

We human beings are seemingly so indifferent to the death of one of our own kind that for us to give thought to the death of a bird appears strange indeed. Yet thousands of people took serious and melancholy notice of the death of a certain bird back in 1914.... Its death marked the close of what was perhaps Nature's greatest dynasty of birds. Its history is one of thoughtless destruction and ruthless persecution without parallel.

*Natural History*

The Passing of the Passenger Pigeon, Volume 53, Number 2, February

1944 (p. 86)

## Wisconsin Society of Ornithology

We have erected a monument to commemorate the funeral of a species. It symbolizes our sorrow. We grieve because no living man will see again the onrushing phalanx of victorious birds, sweeping a path for spring across the March skies, chasing defeated winter from all the woods and prairies of Wisconsin.

In Aldo Leopold

*A Sand County Almanac, with Essays on Conservation from Round River*

Part II, Wisconsin (p. 116)

Sierra Club. San Francisco, California, USA. 1970

## ANIMAL: BIRD: PEACOCK

**Leland, Charles G.** 1824–1903

American author

To Paradise, the Arabs say,

Satan could never find the way

Until the peacock led him in.

*The Music-Lesson of Confucius*

The Peacock, Stanza 2

J.R. Osgood & Company. Boston, Massachusetts, USA. 1872

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Why, he stalks up and down like a peacock — a stride and a stand...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Troilus and Cressida

Act III, Scene iii, l. 251–252

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**ANIMAL: BIRD: PELICAN**

**Merritt, Dixon Lanier** 1879–1954  
American poet and humorist

A wonderful bird is the pelican!  
His bill will hold more than his belican.  
He can take in his beak  
Food enough for a week  
But I'm darned if I see how the helican.

*The Pelican*  
Apocryphal—No source found

**Montgomery, James** 1771–1854  
Scottish poet and journalist

Bird of the wilderness, what is thy name? —  
The pelican! — go, take the trump of fame,  
And if thou give the honour due to me,  
The world may talk a little more of thee.

*Poetical Works of James Montgomery* (Volume 2)  
Birds  
Printed for Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**ANIMAL: BIRD: PENGUIN**

**Herford, Oliver** 1863–1935  
American writer and illustrator

The Pen-guin sits up-on the shore  
And loves the lit-tle fish to bore;  
He has one en-er-vat-ing joke  
That would a very Saint provoke:  
“The Pen-guin’s might-i-er than the Sword-fish”  
He tell this dai-ly to the bored fish,  
Un-til they are so weak, they float  
With-out re-sis-tance down his throat.

*A Child's Primer of Natural History*  
A Penguin  
Charles Scribner's Sons. New York, New York, USA. 1899

**Young, Roland** 1887–1953  
English actor

The little penguins look alike  
Even as Ike resembles Mike.  
They are so gentle and so nice  
God keeps these little birds on ice.

*Not for Children*  
The Penguin  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

**ANIMAL: BIRD: PHEASANT**

**Pope, Alexander** 1688–1744  
English poet

See! from the brake the whirring pheasant springs,  
And mounts exalting on triumphant wings:  
Short is his joy; he feels the fiery wound,

Flutters in blood, and panting beats the ground.

*The Complete Poetical Works*  
Windsor Forest, l. 111–114  
Houghton Mifflin Company. New York, New York, USA. 1903

**ANIMAL: BIRD: PHOENIX**

**Kirchmayer, George Caspard** b. 1635  
German writer

I have to enquire, with the help of God, what real truth  
there is in the Phoenix.

*Hexas Disputationum Zoologicarum*  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1939

**ANIMAL: BIRD: PIGEON**

**Willis, Nathaniel Parker** 1806–67  
American author

On the cross-beam under the Old South bell  
The nest of a pigeon is builded well.  
In summer and winter that bird is there,  
Out and in with the morning air.

*Poems of Nathaniel Parker Willis*  
The Belfry Pigeon  
Hurst & Company. New York, New York, USA. 1882

**ANIMAL: BIRD: PURPLE FINCH**

**Peterson, Roger Tory** 1908–96  
American naturalist

...a Sparrow dipped in raspberry juice.

*Field Guide to the Birds*  
(Eastern) Purple Finch (p.224)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1947

**ANIMAL: BIRD: QUAIL**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

The song-birds leave us at the summer's close,  
Only the empty nests are left behind,  
And pipings of the quail among the sheaves.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 3)  
The Harvest Moon  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**ANIMAL: BIRD: RAVEN**

**Poe, Edgar Allan** 1809–49  
American short story writer and poet

And the raven, never flitting, still is sitting, still is sitting  
On the pallid bust of Pallas just above my chamber door;  
And his eyes have all the seeming of a demon's that is  
dreaming,

And the lamplight o'er him streaming throws his  
shadow on the floor;  
And my soul from out that shadow that lies floating on  
the floor  
Shall be lifted — nevermore!  
*The Raven and Other Poems*  
The Raven, Stanza 18  
Columbia University Press. New York, New York, USA. 1942

**ANIMAL: BIRD: ROBIN**

**Blake, William** 1757–1827  
English poet, painter, and engraver  
A Robin Red breast in a Cage  
Puts all Heaven in a Rage.  
*The Complete Poetry and Prose of William Blake*  
Auguries of Innocence, l. 5–6  
University of California Press. Berkeley, California, USA. 1982

**ANIMAL: BIRD: ROOK**

**Tennyson, Alfred (Lord)** 1809–92  
English poet  
The building rook'll caw from the windy tall elm-tree...  
*Alfred Tennyson's Poetical Works*  
The May Queen, New Year's Eve, Stanza 5  
Oxford University Press, Inc. London, England. 1953

**ANIMAL: BIRD: RUKH****The Arabian Nights**

And... behold the sun became concealed from us, and the  
day grew dark, and there came over us a cloud by which  
the sky was obscured. So we raised our heads to see what  
had intervened between us and the sun, and saw that the  
wings of the rukh were what veiled from us the sun's  
light, so that the sky was darkened.  
Translated by Edward William Lane  
*The Arabian Nights*  
The Story of Sinbad the Sailor and Sinbad the Porter  
The Fifth Voyage (p. 484)  
Oxford University Press. Oxford, England. 1915

**ANIMAL: BIRD: SANDPIPER**

**Thaxter, Celia** 1835–94  
American poet  
Across the narrow beach we flit,  
One little sandpiper and I;  
And fast I gather, bit by bit,  
The scattered driftwood, bleached and dry.  
The wild waves reach their hands for it,  
The wild wind raves, the tide runs high,  
As up and down the beach we flit,  
One little sandpiper and I.

*The Poems of Celia Thaxter*  
The Sandpiper  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**ANIMAL: BIRD: SEA GULL**

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor  
And being fed by us you used us so  
As that ungentle gull, the cuckoo's bird,  
Useth the sparrow.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The First Part of King Henry the Fourth  
Act V, Scene i, l. 59–61  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**ANIMAL: BIRD: SEA-MEW**

**Barrett-Browning, Elizabeth** 1806–81  
English poet  
How joyously the young sea-mew  
Lay dreaming on the waters blue,  
Whereon our little bark had thrown  
A little shade, the only one,  
But shadows ever man pursue.  
*The Complete Poetical Works of Elizabeth Barrett Browning*  
The Sea-Mew, Stanza I  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Garstang, Walter** 1868–1949  
English embryologist and amateur poet  
Bold Sea-mew — you whose soaring flight  
Inspires my envious Muse —  
Pray, with this compliment polite  
My liberty excuse.  
*Larval Forms, and Other Zoological Verses*  
To a Herring Gull, Stanza 1 (p. 72)  
The University of Chicago Press. Chicago, Illinois, USA. 1985

**ANIMAL: BIRD: SEDGE-BIRD**

**Clare, John** 1793–1864  
English poet  
Fixed in a white-thorn bush, its summer guest,  
So low, e'en grass o'er-topped its tallest twig,  
A sedge-bird built its little benty nest,  
Close by the meadow pool and wooden brig.  
*The Rural Muse*  
Poems, The Sedge-Bird's Nest  
Whittaker & Company. London, England. 1835

**ANIMAL: BIRD: SPARROW**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

The sparrows chirped as if they still were proud  
Their race in Holy Writ should mentioned be.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 4)  
The Poet's Tale  
The Birds of Killingworth, Stanza 12  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The hedge-sparrow fed the cuckoo so long,  
That it had its head bit off by its young.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
King Lear  
Act I, Scene iv, l. 235–236  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ANIMAL: BIRD: SWALLOW

**Barrie, Sir James M.** 1860–1937

Scottish journalist, writer, and dramatist

“Do you know,” Peter asked “why swallows build in the eaves of houses? It is to listen to the stories.”

*Peter Pan*  
Chapter 3 (pp. 40, 42)  
Charles Scribner's Sons. New York, New York, USA. 1954

**Tennyson, Alfred (Lord)** 1809–92

English poet

...nature's licensed vagabond, the swallow...

*Alfred Tennyson's Poetical Works*  
Queen Mary  
Act V, Scene I  
Oxford University Press, Inc. London, England. 1953

**Thomson, James** 1700–48

Scottish poet

The swallow is come!  
The swallow is come!  
O, fair are the seasons, and light  
Are the days that she brings,  
With her dusky wings,  
And her bosom snowy white.

*The Seasons*  
Spring, l. 651  
Printed by W.W. Woodward. Philadelphia, Pennsylvania, USA. 1797

## ANIMAL: BIRD: SWAN

**Boston, Henry** 1888–1968

American writer

...I chanced to look up a moment at the southern sky,  
and there for the first and still the only time in my life, I  
saw a flight of swans. The birds were passing along the  
coast well out to sea; they were flying almost cloud high

and traveling very fast, and their course was as direct as  
an arrow's from a bow. Glorious white birds in the blue  
October Heights over the solemn unrest of ocean — their  
passing was more than music, and from their wings  
descended the old loveliness of earth which both affirms  
and heals.

*The Outermost House*  
Chapter II (p. 37)  
Rinehart & Company. New York, New York, USA. 1928

**Thomson, James** 1700–48

Scottish poet

The stately-sailing swan  
Gives out his snowy plumage to the gale;  
And, arching proud his neck, with oary feet  
Bears forward fierce, and guards his osier isle,  
Protective of his young.

*The Seasons*  
Spring, l. 775  
Printed by W.W. Woodward. Philadelphia, Pennsylvania, USA. 1797

## ANIMAL: BIRD: THROSTLE

**Wordsworth, William** 1770–1850

English poet

And hark! how blithe the throstle sings!  
He, too, is not mean preacher:  
Come forth into the light of things,  
Let Nature be your teacher.

*The Complete Poetical Works of William Wordsworth*  
The Tables Turned, Stanza IV  
Crowell. New York, New York, USA. 1888

## ANIMAL: BIRD: THRUSH

**Hardy, Thomas** 1840–1928

English poet and regional novelist

At once a voice arose among  
The bleak twigs overhead  
In a full-hearted evensong  
Of joy illimited;  
An aged thrush, frail, gaunt, and small,  
In blast-beruffled plume,  
Had chosen thus to fling his soul  
Upon the growing gloom.

*Collected Poems of Thomas Hardy*  
The Darkling Thrush, Verse 3 (p. 137)  
The Macmillan Company. New York, New York, USA. 1964

**Tennyson, Alfred (Lord)** 1809–92

English poet

When rosy plumelets tuft the larch,  
And rarely pipes the mounted thrush...

*Alfred Tennyson's Poetical Works*  
In Memoriam, Verse XCI  
Oxford University Press, Inc. London, England. 1953

**ANIMAL: BIRD: TOUCAN**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The toucan's profile is prognathous,  
Its person is a thing of bathos.  
If even I can tell a toucan  
I'm reasonably sure that you can.

*Verses from 1929 On*

The Toucan

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Wood, Robert William** 1868–1955  
American physicist

Very few can  
Tell the Toucan  
From the Pecan —  
Here's a new plan:  
To take the Toucan from the Tree,  
Requires im-mense a-gil-i-tee,  
While anyone can pick with ease  
The Pecans from the Pecan trees.  
It's such an easy thing to do,  
That even the Toucan he can too.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*

The Pecan. The Toucan (p. 11)

Dover Publications, Inc. New York, New York, USA. 1959

**ANIMAL: BIRD: TURKEY**

**Audubon, John James** 1785–1851  
West Indian-born American ornithologist and artist

The great size and beauty of the Wild Turkey, its value as a delicate and highly prized article of food, and the circumstance of its being the origin of the domestic race now generally dispersed over both continents, render it one of the most interesting of the birds indigenous to the United States of America.

*Ornithological Biography* (Volume 1)

The Wild Turkey (p. 1)

Adam Black. Edinburgh, Scotland. 1831

**Breathed, Guy Berkeley** 1957–  
American cartoonist

Dear Lord, I've been asked, nay commanded, to thank Thee for the Christmas turkey before us...a turkey which was no doubt a lively, intelligent bird...a social being...capable of actual affection...nuzzling its young with almost human-like compassion. Anyway, it's dead and we're gonna eat it. Please give our respects to its family....

*Bloom Country Babylon*

Washington Post Company. 1996

**Nash, Ogden** 1902–71  
American writer of humorous poetry

There is nothing more perky  
Than a masculine turkey.  
When he struts he struts  
With no ifs or buts.

When his face is apoplectic  
His harem grows hectic,  
And when he gobbles  
Their universe wobbles.

*Verses from 1929 On*

The Turkey

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**ANIMAL: BIRD: VULTURE**

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

The Vulture eats between his meals,  
And that's the reason why  
He very, very rarely feels  
As well as you and I.

*Complete Verse*

The Vulture (p. 244)

Gerald Duckworth. London, England. 1970

**Montgomery, James** 1771–1854  
Scottish poet and journalist

Abdominal harpies, spare the dead.

— We only clear the field which man has spread;  
On which should Heaven its hottest vengeance rain?  
You slay the living, we but strip the dead.

*Poetical Works of James Montgomery* (Volume 2)

Birds

Printed for Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

A vulture on board; bald, red, queer-shaped head, featherless red places here and there on his body, intense great black eyes set in featherless rims of inflamed flesh; dissipated look; a business-like style, a selfish, conscienceless, murderous aspect — the very look of a professional assassin, and yet a bird which does no murder. What was the use of getting him up in that tragic style for so innocent a trade as his? For this one isn't the sort that wars upon the living, his diet is offal — and the more out of date it is the better he likes it. Nature should give him a suit of rusty black; then he would be all right, for he would look like an undertaker and would harmonize with his business; whereas the way he is now he is horribly out of true.

*Following the Equator* (Volume 2)

Chapter I (p. 15)

Harper & Brothers Publishers. New York, New York, USA. 1899

**ANIMAL: BIRD: WARBLER**

**Halle, Louis J.** 1910–98  
American diplomat and writer

When I see men able to pass by such a shining and miraculous thing as this Cape May warbler, the very distillate of life, and then marvel at the internal-combustion engine, I think we had better make ourselves ready for another Flood.

*Spring in Washington*  
Chapter II (p. 74)

William Sloane Associates, Inc.. New York, New York, USA. 1947

**ANIMAL: BIRD: WHITE-THROAT**

**Clare, John** 1793–1864  
English poet

The happy white-throat on the swinging bough,  
Rocked by the impulse of the gadding wind  
That ushers in the showers of April, now  
Carols right joyously; and now reclined  
Crouching, she clings close to her moving seat,  
To keep her hold.

*The Rural Muse*

Poems, The Happy Bird

Whittaker & Company. London, England. 1835

**ANIMAL: BIRD: WHOOPING CRANE**

**Allen, Robert Porter** 1905–63  
American author and conservationist

When you sit crouched in a blind and watch an adult (whooping crane) stride close by you, his head high and proud, his bearing arrogant and imposing, you feel the presence of a strength and of a stubborn will to survive...

*The Whooping Crane*

Preface (p. iv)

National Audubon Society. New York, New York, USA. 1952

For the whooping crane there is no freedom but that of unbounded wilderness, no life except its own. Without meekness, without a sign of humility, it has refused to accept our idea of what the world should be like.

*The Whooping Crane*

Part I, Distribution (p. 14)

National Audubon Society. New York, New York, USA. 1952

**ANIMAL: BIRD: WOODPECKER**

**Audubon, John James** 1785–1851  
West Indian-born American ornithologist and artist

I have always imagined, that in the plumage of the beautiful Ivory-Billed Woodpecker, there is something very closely allied to the style of colouring of the great Vandyke. The

broad extent of its dark glossy body and tail, the large and well-defined white markings of its wings, neck, and bill, relieved by the rich carmine of the pendent crest of the male, and the brilliant yellow of its eye, have never failed to remind me of some of the boldest and noblest productions of that inimitable artist's pencil.

*Ornithological Biography* (Volume 1)

The Ivory-Billed Woodpecker (p. 341)

Adam Black. Edinburgh, Scotland. 1831

It would be difficult for me to say where I have not met with that hardy inhabitant of the forest, the Pileated Woodpecker. Even now, when several species of our birds are becoming rare, either to gratify the palate of the epicure or to adorn the cabinet of the naturalist; it is to be found everywhere in the wild woods, although scarce and shy in the peopled districts.

*Ornithological Biography* (Volume 2)

The Pileated Woodpecker (p. 74)

Adam Black. Edinburgh, Scotland. 1834

**ANIMAL: BIRD: WREN**

**Wordsworth, William** 1770–1850  
English poet

Among the dwellings framed by birds  
In fields or forests with nice care,  
Is none that with the little wren's  
In snugness may compare.

*The Complete Poetical Works of William Wordsworth*

A Wren's Nest, Stanza I

Crowell. New York, New York, USA. 1888

**ANIMAL: CHILERATA****ANIMAL: CHILERATA: MITE****Author undetermined**

The cheese-mites asked how the cheese got there,  
And warmly debated the matter;  
The orthodox said it came from the air,  
And the heretics said from the platter.

In Arnold Silcock

*Verse and Worse*

Four More Brief Beliefs (p. 60)

Faber & Faber Ltd. London, England. 1952

**Duck, Stephen** 1705–56  
English poet

Dear Madam, did you never gaze  
Thro' optic glass on rotten cheese?  
There, Madam, did you ne'er perceive  
A crowd of dwarfish creatures live?  
The little things, elate with Pride,  
Strut to and fro, from side to side:  
In tiny pomp and partly vein,

Lords of their pleasing orb they reign;  
And fill'd with harden'd Curds and Cream,  
Think the Whole Dairy made for *them*.

In T.E. Hughes

*Mites, or the Acari* (p. vii)

University of London. London, England. 1959

**Frost, Robert** 1874–1963

American poet

A speck that would have been beneath my sight  
On any but a paper sheet so white  
Set off across what I had written there.  
And I had idly poised my pen in air  
To stop it with a period of ink  
When something strange about it made me think.  
This was no dust speck by my breathing blown,  
But unmistakably a living mite  
With inclinations it could call its own.

*Complete Poems of Robert Frost*

A Considerable Speck

Henry Holt & Company. New York, New York, USA. 1949

**Hooke, Robert** 1635–1703

English physicist

The least of Reptiles I have hitherto met with, is a Mite.

*Micrographia*

Observation, LV (p. 213)

Printed by Jo. Martyn & Ja. Allestry. London, England. 1665

## ANIMAL: CHILERATA: SCORPION

**Belloc, Hilaire** 1870–1953

French-born poet and historian

The Scorpion is as black as soot,  
He dearly loves to bite;  
He is a most unpleasant brute  
To find in bed, at night.

*Complete Verse*

The Scorpion (p. 243)

Gerald Duckworth. London, England. 1970

## ANIMAL: CHILERATA: SPIDER

**Dickinson, Emily** 1830–86

American lyric poet

The spider as an artist  
Has never been employed  
Though his surpassing merit  
Is freely certified.

By every broom and Bridget  
Throughout a Christian land.

Neglected son of genius,  
I take thee by the hand.

*The Complete Poems of Emily Dickinson*

No. 1275 (p. 557)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Fabre, Jean-Henri** 1823–1915

French entomologist and author

The Spider has a bad name: to most of us, she represents an odious, noxious animal, which every one hastens to crush under foot. Against this summary verdict the observer sets the beast's industry, its talent as a weaver, its wiliness in the chase, its tragic nuptials and other characteristics of great interest.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Chapter I (p. 39)

Dodd, Mead & Company. New York, New York, USA. 1913

**Florian, Douglas** 1950–

American author and illustrator

O Daddy

Daddy O

How'd you get

Those legs to grow

So very long

And lean in size?

From spiderobic

Exercise?

*Insectlopedia: Poems and Paintings*

The Daddy Longlegs

Harcourt Brace. San Diego, California, USA. 1998

**Martin, Charles-Noël** 1923–

French physicist

Spiders act as if they had the brains of first-class mathematicians. For them, space has properties which makes its structure quite unique.

Translated by A.J. Pomerans

*The Role of Perception in Science*

Chapter 5 (p. 114)

Hutchinson of London. London, England. 1963

**Pallister, William Hales** 1877–1946

Canadian physician

Of the SPIDERS and SCORPIONS, five thousand kinds:

These are scattered abroad, on the sea and the shore,  
Quite unpleasant to think of, but still it reminds

To be glad there are not many thousand kinds more.

These are eight-legged beauties, with schemes of their own,

And the safest precaution is: Leave them alone!

*Poems of Science*

Beginnings, Animal Life (p. 140)

Playford Press. New York, New York, USA. 1931

**Smith, Bertha Wilcox**

No biographical data available

Throughout the night he spun a thread  
With which he wove medallioned lace  
That stretched between two milkweed pods  
Beside a dusty, traveled place;

The pattern was a scalloped round —  
 Each radius exactly drawn  
 With trellised filaments between,  
 And over all bright diamonds shone;  
 In meshed and tenuous design  
 It was a fragile, wayside sonnet —  
 The maker, heedless of acclaim,  
 Had left no signature upon it.  
*Nature Magazine*, Volume 50, Number 5, May 1957 (p. 234)

**Taylor, Ann** 1782–1866  
 English poet and children’s author

“O look at that great ugly Spider,” said Ann,  
 And screaming, she knocked it away with her fan;  
 “‘Tis a great ugly creature, as ever can be,  
 I wish that it would not come crawling on me.”  
*Original Poems for Infant Minds*  
 The Spider, Stanza I  
 Robert Carter. New York, New York, USA. 1856

**Topsell, Edward** 1572–1625?  
 English divine and writer

To begin therefore to make an enumeration of their pray-  
 ses, I will declare unto yo, the rich vertues and external  
 goods of the body, fortune and minde. And first to begin  
 with the good gifts of their bodies. If you will weigh and  
 consider the matter and substance of a Spiders body, you  
 shall finde it to be light, partaking much of fire and ayr,  
 (being two of the most noble and effectual elements in  
 operation) and having but little earthy dragginesse and  
 drossy refuse.

*The History of Four-Footed Beasts*  
 The History of Serpents  
 Of the Spider (p. 778)  
 G. Sawbridge. London, England. 1658

**White, Terence Hanbury** 1906–64  
 English author

A spider is an air worm, as it is provided with nourish-  
 ment from the air, which a long thread catches down to  
 its small body.

*The Book of Beasts: Being a Translation From a Latin Bestiary of the*  
*Twelfth Century* (p. 191)  
 G.P. Putnam’s Sons. New York, New York, USA. 1954

## ANIMAL: CHILERATA: TARANTULA

**Twain, Mark (Samuel Langhorne**  
**Clemens)** 1835–1910  
 American writer and humorist

Some of these spiders could straddle over a common  
 saucer with their hairy, muscular legs, and when their  
 feelings were hurt, or their dignity offended, they were  
 the wickedest-looking desperadoes the animal world  
 can furnish. If their glass prison-houses were touched

ever so lightly they were up and spoiling for a fight  
 in a minute. Starchy? — proud? Indeed, they would  
 take up a straw and pick their teeth like a member of  
 Congress.

*Roughing It* (Volume 1)  
 Chapter XXI (p. 176)  
 Harper & Brothers Publishers. New York, New York, USA. 1899

## ANIMAL: CHILERATA: TICK

**Florian, Douglas** 1950–  
 American author and illustrator

Not gigan-tic.  
 Not roman-tic.  
 Not artis-tic.  
 Not majes-tic.  
 Not magne-tic.  
 Nor aesthe-tic.  
 Ticks are strictly parasi-tic.  
*Insectlopedia: Poems and Paintings*  
 The Ticks  
 Harcourt Brace. San Diego, California, USA. 1998

## ANIMAL: CHORDATA

### ANIMAL: CHORDATA: OIKOPLEURA

**Garstang, Walter** 1868–1949  
 English embryologist and amateur poet

Now although Oikopleura sits by himself  
 In the midst of his house on a jelly-built shelf,  
 He’s firmly attached in front by his snout, and never lets  
 go till his house wears out.

*Larval Forms, and Other Zoological Verses*  
 Oikopleura, Jelly-Builder  
 The University of Chicago Press. Chicago, Illinois, USA. 1985

## ANIMAL: CNIDARIA

### ANIMAL: CNIDARIA: CORAL

**Agassiz, Jean Louis Rodolphe** 1807–73  
 Swiss-born American naturalist, geologist, and teacher

Hence the extraordinary assemblage of all classes of ani-  
 mals upon the reef, where, besides those particular kinds  
 of corals which contribute largely to its formation, we  
 find upon it, or on the foundation from which it rises,  
 a great variety of other corals, which, though too insig-  
 nificant in size to take a conspicuous part in building up  
 these extensive accumulations of organic lime-rock, add  
 none the less their small share in the work, contributing  
 especially to fill up the vacant spaces left by the more  
 rapid and durable growth of the larger kinds. They are to  
 the giants of the reef what the more slender parts are to  
 the lords of the forest, adding the elegance and delicacy



of slighter forms to the strength, power, and durability of their loftier companions.

*Annual Report of the Superintendent of the Coast Survey, Showing the Progress of that Work During the Year Ending November, 1851*

Extracts from the report of Professor Agassiz to the Superintendent of the Coast Survey, on the examination of the Florida reefs, keys, and coast (p. 151)

Printed by Robert Armstrong, Washington. 1852

**Crabbe, George** 1754–1832

English poet

Involved in sea-wrack, here you find a race,  
Which science, doubting, knows not where to place;  
On shell or stone is dropp'd the embryo-seed,  
And quickly vegetates a vital breed.

*Poems* (Volume 1)

The Borough, Letter IX, l. 90–94

AMS Press. New York, New York, USA. 1979

## ANIMAL: CNIDARIA: JELLYFISH

**Allen, Grant** 1848–99

American naturalist

A jellyfish swam in a tropical sea,  
And he said, “This world it consists of me:  
There’s nothing above and nothing below  
That a jellyfish ever can possibly know  
(Since we’ve got no sight, or hearing, or smell),  
Beyond what our single sense can tell.”

*Poems of Evolution*

The First Idealist

Haldeman-Julius, Girard, Kansas, USA. 1924

**Kendall, May (Emma Goldworth)** 1861–1931

English writer

Her beauty, passive in despair,  
Through sand and seaweed shone,  
The fairest jelly-fish I e'er  
Had set mine eyes upon.  
It would have made a stone abuse  
The callousness of fate,  
This creature of prismatic hues,  
Stranded and desolate!

*Dreams to Sell*

The Philanthropist and the Jelly-Fish

Longmans, Green Publishers. New York, New York, USA. 1887

**Schweitzer, Albert** 1875–1965

Alsatian-German theologian and philosopher

Every evening the glimmer of the sea, as the ship ploughs her way through it, is wonderful: the foam is phosphorescent, and little jelly-fishes spring up through it like glowing balls of metal.

Translated by C.T. Campion

*On the Edge of the Primeval Forest*

Chapter II (p. 21)

The Macmillan Company. New York, New York, USA. 1931

## ANIMAL: CRUSTACEAN

**Brusca, Gary** –2000

American fisheries biologist

The range of morphological diversity among crustaceans far exceeds that of even the insects. In fact, because of their diversity of form and number, it is often said that crustaceans are the “insects of the sea.” We prefer to think of insects as the “crustaceans of the land.”

*Invertebrates Evolution*

Chapter Sixteen (p. 514)

Sinauer Associates, Inc. Sunderland, Maine, USA. 2003

**Pallister, William Hales** 1877–1946

Canadian physician

With eight thousand CRUSTACEAN species, we list  
All the lobsters and crabs, many others beside;  
On the beaches and tide-strips their races subsist  
On the wreck of the sea and the wrack of the tide;  
In his jointed shell, hungry and seeking each goes,  
If one loses a claw, soon another one grows.

*Poems of Science*

Beginnings

Playford Press. New York, New York, USA. 1931

## ANIMAL: CRUSTACEAN: CRAB

**James, William** 1842–1910

American philosopher and psychologist

Probably a crab would be filled with a sense of personal outrage if it could hear us class it without ado or apology as a crustacean, and thus dispose of it. “I’m no such thing,” it would say, “I am MYSELF, MYSELF.”

*The Varieties of Religious Experience*

Lecture I (p. 10)

The Modern Library. New York, New York, USA. 196?

## ANIMAL: CRUSTACEAN: CRAWFISH

**Flaubert, Gustave** 1821–90

French novelist

Crayfish. Female of the lobster. Walks backward. Always call reactionaries “crayfish.”

*Dictionary of Accepted Ideas*

Animal Life (pp. 139–140)

M. Reinhardt. London, England. 1954

## ANIMAL: CRUSTACEAN: LOBSTER

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“Tis the voice of the Lobster: I heard him declare  
“You have baked me too brown, I must sugar my hair.”

*The Complete Works of Lewis Carroll*

Through the Looking-Glass  
Chapter X (p. 111)  
The Modern Library. New York, New York, USA. 1936

## ANIMAL: CRUSTACEAN: WOODLOUSE

**Garstang, Walter** 1868–1949  
English embryologist and amateur poet

MacBride was in his garden settling pedigrees,  
When came a baby Woodlouse and climbed upon his knees,  
And said: “Sir, if our six legs have such an ancient air,  
Shall we be less ancestral when we’ve grown our mother’s pair?”

*Larval Forms, and Other Zoological Verses*  
Isopod Phylogeny, Stanza 3 (p. 50)  
The University of Chicago Press. Chicago, Illinois, USA. 1985

## ANIMAL: DUCK-BILLED PLATYPUS

**Flanders, Michael** 1922–75  
English actor and singer

We call him “Duck-billed Platypus”  
And mock him for his name:  
He does not seem to mind it.  
He feels no sense of shame  
Because he does not know himself  
By such a title,  
He’s a “Golden, Shining Love-Bird”  
In Duck-billed Platypese.

*Creatures Great and Small*  
The Duck-Billed Platypus  
Holt, Rinehart & Winston. New York, New York, USA. 1965

## ANIMAL: FISH

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

No one knows whence nor how the first fish came. The earth is silent on the matter.

*Parade of the Living*  
Part I, Chapter V (p. 52)  
Coward-McCann, Inc. New York, New York, USA. 1930

**Cuppy, Will** 1884–1929  
American humorist and critic

As a rule fish in their native element do not remain stationary for any length of time, especially when something is chasing them.

*How to Attract the Wombat*  
The Squid (fn 5, p. 122)  
Rinehart & Company, Inc. New York, New York, USA. 1949

**Hemingway, Ernest** 1899–1961  
American novelist, short-story writer and journalist

He is a great fish and I must convince him, he thought. I must never let him learn his strength nor what he could do if he made his run...but thank God, they are not as intelligent as we who kill them; although they are more noble and more able.

*The Old Man and the Sea* (p. 61)  
Charles Scribner’s Sons. New York, New York, USA. 1952

**Hunt, Leigh** 1784–1859  
English author, poet, and editor

You strange, astonish’d-looking, angle-faced,  
Dreary-mouth’d, gaping wretches of the sea,  
Gulping salt-water everlastingly,  
Cold-blooded, though with red your blood be graced,  
And mute, through dwellers in the roaring waste;  
And you, all shapes beside, that fishy be —  
Some round, some flat, some long, all devilry,  
Legless, unloving, infamously chaste:

*The Poetical Works of Leigh Hunt*  
The Fish, the Man, and the Spirit (p. 250)  
Oxford University Press, Inc. London, England. 1923

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

This is beyond me, this fish,  
His God stands outside my God.

*The Collected Poems of D.H. Lawrence*  
Fish  
Martin Secker. London, England. 1928

**MacLeish, Archibald** 1892–1982  
American poet and Librarian of Congress

Plunge beneath the ledge of coral  
Where the silt of sunlight drifts  
Like dust that settles toward a floor —  
As slow as that: feel the lifting  
Surge that rustles white above  
But here is only movement deep  
As breathing: watch the reef fish hover  
Dancing in their silver sleep  
Around their stone, enchanted tree...

*The Collected Poems of Archibald MacLeish*  
The Reef Fisher  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1952

**Maisey, John**  
American paleontologist

The term “fish” is of value on restaurant menus, to anglers and aquarists, to stratigraphers and in theological discussions of biblical symbolism. Many systematists use it advisedly and with caution. Fishes are gnathostomes that lack tetrapod characters; they have no unique derived characteristics. We can conceptualize fishes with relative ease because of the great evolutionary gaps between them and their closest living relatives, but that does not mean they comprise a natural group. The only way to make the

fishes monophyletic would be to include tetrapods, and to regard the latter merely as a kind of fish. Even then, the term “fish” would be a redundant colloquial equivalent of “gnathostome” (or “craniate,” depending upon how far down the phylogenetic ladder one wished to go).

In D.R. Prothero and R.M. Shoch (eds.)

*Major Features of Vertebrate Evolution*

Short Courses in Paleontology 7

University of Tennessee Press. Knoxville, Tennessee, USA. 1994

**Pallister, William Hales** 1877–1946

Canadian physician

Fifteen thousands of species of FISHES are known,  
And some kinds are enormous and others minute;  
They are widespread, wherever their tribes can be  
grown

And all seeking the foods which their habits will suit;  
Some migrating in millions that their spawn may be  
sown,

Some in depths of the ocean, but rarely alone.

*Poems of Science*

Beginnings, Animal Life (p. 140)

Playford Press. New York, New York, USA. 1931

**Peacock, Thomas Love** 1785–1866

English writer

Premising that this is a remarkably fine slice of salmon, there is much to be said about fish: but not in the way of misnomers. Their names are single and simple. Perch, sole, cod, eel, carp, char, skate, trench, trout, brills, bream, pike, and many others, plain monosyllables: salmon, dory, turbot, gudgeon, lobster, whitebait, grayling, haddock, mullet, herring, oyster, sturgeon, flounder, turtle, plain disyllables: only two trisyllables worth naming: anchovy and mackerel; unless any one should be disposed to stand up for halibut, which, for my part, I have excommunicated.

*Gryll Grange*

Chapter 1 (p. 12)

Penguin Books. Harmondsworth, England. 1949

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

3<sup>rd</sup> FISHERMAN: Master, I marvel how the fishes live in the sea.

1<sup>st</sup> FISHERMAN: Why, as men do a-land: the great ones eat up the little ones.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Pericles, Prince of Tyre

Act II, Scene i, l. 30–32

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Who hears the fish when they cry?

*The Writings of Henry David Thoreau* (Volume 1)

A Week on the Concord and Merrimack Rivers

Saturday (p. 45)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Walton, Izaak** 1593–1683

English writer

If I should begin but to name the several sorts of strange fish...that run into the sea, I might beget wonder in you, or unbelief, or both; and yet I will venture to tell you....

*The Complete Angler*

Chapter XIX

T.N. Foulis. London, England. 1913

**ANIMAL: FISH: BARRACUDA**

**Gardner, John** 1933–82

American writer and scholar

Slowly, slowly, he cruises,

And slowly, slowly, he chooses

Which kind of fish he prefers to take this morning;

Then without warning

The Barracuda opens his jaws, teeth flashing,

And with a horrible, horrible grinding and gnashing,

Devours a hundred poor creatures and feels no remorse.

“But,” (as he says with an evil grin) “it’s actually not my fault, you see: I’ve nothing to do with the tragedy; I open my mouth for a yawn and — ah me — They all swim in.”

*A Child’s Bestiary*

The Barracuda

Alfred A. Knopf. New York, New York, USA. 1977

**ANIMAL: FISH: CODFISH**

**Author undetermined**

The codfish lays a thousand eggs

The homely hen lays one. The codfish never cackles

To tell you what she’s done.

And so we scorn the codfish

While the humble hen we prize

Which only goes to show you

That it pays to advertise.

In Mark Kurlansky

*Cod: A Biography of the Fish that Changed the World* (p. 29)

Walker & Company. New York, New York, USA. 1997

**ANIMAL: FISH: COELACANTH**

**Smith, J. B. L.**

South African ichthyologist

Coelacanth — yes, God! Although I had come prepared, that first sight hit me like a white-hot blast and made me feel shaky and queer, my body tingled. I stood as if

stricken to stone. Yes, there was not a shadow of doubt, scale by scale, bone by bone, fin by fin, it was a true Coelacanth. It could have been one of those creatures of 200 million years ago come alive again. I forgot everything else and just looked and looked, and then almost fearfully went close up and touched and stroked.

*Old Fourlegs: The Story of the Coelacanth*

Longman, Green Publishers. London, England. 1956

### ANIMAL: FISH: GUPPY

**Nash, Ogden** 1902–71

American writer of humorous poetry

Whales have calves,

Cats have kittens,

Bears have cubs,

Bats have bittens.

Swans have cygnets,

Seals have puppies,

But guppies just have little guppies.

*Verses from 1929 On*

The Guppy

Little, Brown & Company. Boston, Massachusetts, USA. 1959

### ANIMAL: FISH: HERRING

**Cuppy, Will** 1884–1929

American humorist and critic

Some fishes become extinct, but Herrings go on forever. Herrings spawn at all times and places and nothing will induce them to change their ways. They have no fish control. Herrings congregate in schools, where they learn nothing at all. They move in vast numbers in May and October. Herrings subsist upon Copepods and Copepods subsist upon Diatoms and Diatoms just float around and reproduce. Young Herrings or Sperling or Whitebait are rather cute. They have serrated abdomens. The skull of the Common or Coney Island Herring is triangular, but he would be just the same anyway. (The nervous system of the Herring is fairly simple. When the Herring runs into something the stimulus is flashed to the forebrain, with or without results.)

*How to Become Extinct*

The Herring (p. 13)

Dover Publications. New York, New York, USA. 1964

### ANIMAL: FISH: KIPPER

**Nash, Ogden** 1902–71

American writer of humorous poetry

For half a century, man and nipper,

I've doted on a tasty kipper,

But since I am no Jack the Ripper

I wish the kipper had a zipper.

*Everyone but Thee and Me*

The Kipper (p. 63)

Little, Brown & Company. Boston, Massachusetts, USA. 1962

### ANIMAL: FISH: PICKEREL

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The pickerel...the swiftest, wariest, and most ravenous of fishes.

*The Writings of Henry David Thoreau* (Volume 1)

A Week on the Concord and Merrimack Rivers

Saturday (p. 36)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### ANIMAL: FISH: SALMON

**McGregor, James**

No biographical data available

Oh! For the thrill of a Highland stream,  
With the bending rod of a fisherman's dream,  
The screaming reel and flying line,  
Where the far-flung pearl-drops wetly shine —  
The sudden leap, then the silent strife,  
While the salmon grimly fights for life;  
As a worthy foe, or a regal dish,  
We respect this gallant fighting fish.

In Arnold Silcock

*Verses and Worse*

Ode to a Salmon (p. 21)

Faber & Faber Ltd. London, England. 1952

### ANIMAL: FISH: SCULPIN

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Now the Sculpin (*Cottus virginianus*) is a little water beast which pretends to consider itself a fish, and, under that pretext, hangs about the piles on which West Boston Bridge is built, swallowing the bait and hook intended for flounders. On being drawn from the water, it exposes an immense head, a diminutive bony carcass, and a surface so full of spines, ridges, ruffles and frills that the naturalist have not been able to count them without quarreling about their number.

*The Professor at the Breakfast Table*

Chapter I (p. 2)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

### ANIMAL: FISH: SEA HORSE

**Kraus, Jack**

No biographical data available

SEA HORSE: Philly of flounder.

*Quote, the Weekly Digest*, October 23, 1966 (p. 17)

**ANIMAL: FISH: SEA SQUIRT**

**Dennett, Daniel Clement** 1942–  
American philosopher

The juvenile sea squirt wanders through the sea searching for a suitable rock or hunk of coral to cling to and make its home for life. For this task, it has a rudimentary nervous system. When it finds its spot and takes root, it doesn't need its brain anymore so it eats it! (It's rather like getting tenure.)

*Consciousness Explained*

Chapter 7 (p. 177)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

**ANIMAL: FISH: SHARK**

**Benchley, Peter** 1940–2006  
American writer

Sharks have everything a scientist dreams of. They're beautiful — God, how beautiful they are! They're like an impossibly perfect set of machinery. They're as graceful as any bird. They're as mysterious as any animal on earth.... The more I learned about them, the more I knew I didn't know...

*Jaws*

Part II, Chapter 6 (p. 121)

Doubleday & Company, Inc. Garden City New York, USA. 1974

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

"You see," he went on after a pause, "it's as well to be provided for *everything*. That's the reason the horse has anklets around his feet."

"But what are they for?" Alice asked in a tone of great curiosity.

"To guard against the bite of sharks," the Knight replied.

*Alice's Adventures in Wonderland & Through the Looking-Glass*

Chapter 8 (p. 105)

The Macmillan Company. New York, New York, USA. 1966

**Cromie, William J.** 1930–  
American journalist and writer

Sharks are infamous for their ravenous appetites and catholic diet.

*The Living World of the Sea*

Chapter 8 (p. 138)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1966

**Melville, Herman** 1819–91  
American novelist, essayist, and poet

Though amid all the smoking horror and diabolism of a sea-fight, sharks will be seen longingly gazing up to the ship's decks, like hungry dogs round a table where red

meat is being carved, ready to bolt down every killed man that is tossed to them...

*In Great Books of the Western World (Volume 48)*

*Moby Dick*

Chapter 64 (p. 217)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nash, Ogden** 1902–71  
American writer of humorous poetry

How many Scientists have written

The shark is gentle as a kitten!

Yet this I know about the shark:

His bite is worse than his bark.

*Verses from 1929 On*

The Shark

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Schweitzer, Albert** 1875–1965  
Alsatian-German theologian and philosopher

"A shark! A shark!" I rushed out of the writing room and was shown a black triangle sticking out of the water some fifty meters from the ship, and moving in our direction. It was the fin of the dread monster.

Translated by C.T. Campion

*On the Edge of the Primeval Forest*

Chapter II (pp. 17–18)

The Macmillan Company. New York, New York, USA. 1931

**ANIMAL: FISH: SMELT**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Oh, why does man pursue the smelt?

It has no valuable pelt,

It boasts of no escutcheon royal,

It yields not ivory or oil,

Its life is dull, its death is tame,

A fish as humble as its name.

Yet — take this salmon somewhere else,

And bring me half a dozen smelts.

*Verses from 1929 On*

The Smelt

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**ANIMAL: FISH: STURGEON**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

On the white sand of the bottom

Lay the monster Mishe-Nahma,

Lay the sturgeon, King of Fishes;

Through his gills he breathed the water,

With his fins he fanned and winnowed,

With his tail he swept the sand-floor.

There he lay in all his armor;

On each side a shield to guard him,

Plates of bone upon his forehead,  
Down his sides and back and shoulders  
Plates of bone with spines projecting!

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)  
Hiawatha, Part VIII  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

## ANIMAL: FISH: WHITING

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“Will you walk a little faster?” said a whiting to a snail,  
“There’s a porpoise close behind us, and he’s treading  
on my tail.”

*The Complete Works of Lewis Carroll*  
Through the Looking-Glass  
Chapter X (p. 107)  
The Modern Library. New York, New York, USA. 1936

## ANIMAL: EUGLENA VIRIDIS

**Pallister, William Hales** 1877–1946  
Canadian physician

A plant when there is sunshine; an animal at night.  
The living proof of theories, biologists’ delight,  
Created by environment and matching it so well,  
You are both plant and animal. Which one the time can  
tell.

*Poems of Science*  
Euglena Viridis  
Playford Press. New York, New York, USA. 1931

## ANIMAL: INSECT

**Ackerman, Diane** 1948–  
American writer

Although it may be a little odd to think of it as a form of  
armor, smell plays many crucial roles in an insect’s life.  
It’s similar to a telephone wire over which different kinds  
of messages can flow: threat, invitation, courtship; the  
whereabouts of food; a call to arms; a password; a death  
knell; the trail home.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*  
Insect Love (p. 150)  
Vintage Books. New York, New York, USA. 1997

**Allee, Warder C.** 1885–1955  
American zoologist

The mortal enemies of man are not his fellows of  
another continent or race; they are the aspects of the  
physical world which limit or challenge his control,  
the disease germs that attack him and his domesticated  
plants and animals, and the insects that carry many of  
these germs as well as working notable direct injury.

This is not...the age of man, however great his supe-  
riority in size and intelligence; it is literally the age  
of insects.

*The Social Life of Insects*  
Chapter 7  
W.W. Norton & Company, Inc. New York, New York, USA. 1938

**Čapek, Josef** 1887–1945  
Czech artist

**Čapek, Karel** 1890–1938  
Czech author

Chrysalis: The whole earth is quivering,  
Something mighty it is delivering,  
I am being born.  
Moth: Unravel life. What are we else, We, woven from  
daintiest fabrics,  
But thought and soul of creation?

*The Life of the Insects*  
Oxford University Press, Inc. London, England. 1923

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“What sort of insects do you rejoice in, where *you* come  
from?” the Gnat inquired.

“I don’t *rejoice* in insects at all,” Alice explained...  
*Alice’s Adventures in Wonderland & Through the Looking-Glass*  
Chapter 3 (p. 34)  
The Macmillan Company. New York, New York, USA. 1966

**Clare, John** 1793–1864  
English poet

Those tiny loiterers on the barleys beard & happy units  
of a numerous herd

Of playfellows the laughing summer brings

Mocking the sunshine on their glittering wings.  
*The Rural Muse*  
Insects  
Whittaker & Company. London, England. 1835

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

The sky was of the deepest blue, with a few white, fleecy  
clouds drifting lazily across it, and the air was filled with  
the low drone of insects or with a sudden sharper note as  
bee or bluefly shot past with its quivering, long-drawn  
hum, like an insect tuning-fork.

*Beyond the City*  
A Naval Conquest (p. 46)  
University of Virginia. Charlottesville, Virginia, USA. 1996

**Eisner, T.** 1929–  
American entomologist

**Wilson, Edward O.** 1929–  
American biologist and author

Whether fully aware of it or not, we human beings are immersed in a world of insects.

*The Insects: Readings from Scientific American*

General Introduction: The Conquerors of the Land (p. 2)

W.H. Freeman & Company. San Francisco, California, USA. 1977

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Of what use, however, is a general certainty that an insect will not walk with his head hindmost, when what you need to know is the play of inward stimulus that sends him hither and thither in a network of possible paths?

*The Writings of George Eliot*

Volume 16, Daniel Deronda, Volume II, Book 3, Chapter 25 (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1907–1908

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Whoever looks at the insect world, at flies, aphides, gnats, and innumerable parasites, and even at the infant mammals, must have remarked the extreme content they take in suction, which constitutes the main business of their life. If we go into a library or news-room, we see the same function on a higher plane, performed with like ardor, with equal impatience of interruption, indicating the sweetness of the act.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

The Comic

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903–1904

**Evans, Howard Ensign** 1919–2002  
American entomologist

The sense that insects belong to a different world than ours is shared by many people, and it is a perfectly valid feeling. After all, the search for a common ancestor of insects and ourselves would take us back more than half a billion years.... In a sense insects are very much of this world, and *Homo sapiens* is a strange and aberrant creature of recent origin who has sought to create his own world, apart from that of nature.

*The Pleasures of Entomology: Portraits of Insects and the People Who Study Them*

Chapter 18 (p. 215)

Smithsonian Institution Press. Washington, D.C. 1985

**Gray, Thomas** 1716–71  
English poet

Yet hark, how through the peopled air  
The busy murmur glows!  
The insect-youth are on the wing,  
Eager to taste the honied spring  
And float amid the liquid noon:  
Some lightly o'er the current skim,  
Some show their gayly-gilded trim  
Quick-glancing to the sun.

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson,*

*and Kirke White*

Ode on the Spring

J. Blackwood. London, England. 1800

**Heinlein, Robert A.** 1907–88  
American science fiction writer

In handling a stinging insect, move very slowly.

*Time Enough for Love*

Second Intermission (p. 365)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Kellogg, Vernon L.** 1867–1937  
American entomologist

Perhaps no more uninteresting matter, for the general reader or entomological amateur, can be written about insects than a descriptive catalogue of the parts and pieces of the insect body.

*American Insects*

Chapter 1 (p. 1)

Henry Holt & Company. New York, New York, USA. 1908

**Kirby, William F.** 1759–1850  
English clergyman and entomologist

Insects, indeed, appear to have been nature's favorite productions, in which to manifest her power and skill, she has combined and concentrated almost all that is either beautiful and graceful, interesting and alluring, or curious and singular, in every other class and order of her children.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Introductory Letter (p. 4)

Longman, Green, Longman & Roberts. London, England. 1860

In variegation, insects certainly exceed every other class of animated beings. Nature, in her sportive mood, when painting them, sometimes imitates the clouds of heaven; at others, the meandering course of the rivers of the earth, or the undulations of their waters: many are veined like beautiful marbles; others have the semblance of a robe of the finest net-work thrown over them; some she blazons with heraldic insignia, giving them to bear in fields sable — azure — vert — gules — argent and or fesses — bars — bends — crosses — crescents — stars, and even animals. On many, taking her rule and compasses, she draws with precision mathematical figures; points, lines, angles, triangles, squares, and circles. On others she portrays, with mystic hand, what seem like hieroglyphic symbols, or inscribes them with the characters and letters of various languages, often very correctly formed; and what is more extraordinary, she has registered in others figures which correspond with several dates of the Christian era.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Introductory Letter (pp. 5–6)

Longman, Green, Longman & Roberts. London, England. 1860

...insects, unfortunate insects, are so far from attracting us, that we are accustomed to abhor them from our childhood. The first knowledge that we get of them is as tormentors; they are usually pointed out to us by those about us, as ugly, filthy, and noxious creatures; and the whole insect world, butterflies perhaps and some few other expected, are devoted by one universal to proscription and execration, as fit only to trodden under our feet and crushed...

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Introductory Letter (p. 2)

Longman, Green, Longman & Roberts. London, England. 1860

...other insects seem emblematical of a different class of unearthly beings; when we behold some tremendous for the numerous horns and spines projecting in horrid array from their head or shoulders — others for their threatening jaws of fearful length, and armed with cruel fangs: when we survey the dismal hue and demoniac air that distinguish others, the dens of darkness in which they live, the impurity of their food, their predatory habits and cruelty, the nets which they spread, and the pits which they sink to entrap the unwary, we can scarcely help regarding them as aptly symbolising evil demons, the enemy of man...

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Letter I (p. 6)

Longman, Green, Longman & Roberts. London, England. 1860

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

Two-legged creatures we are supposed to love as well as we love ourselves. The four-legged, also, can come to seem pretty important. But six legs are too many from the human standpoint.

*The Twelve Seasons*

August (p. 74)

W. Sloane Associates. New York, New York, USA. 1949

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

one thing that  
shows that  
insects are  
superior to men  
is the fact that  
insects run their  
affairs without  
political campaigns  
elections and so forth

*the lives and times of archy & mehitabel*

random thoughts by archy (p. 223)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

as a representative of the insect world

i have often wondered

on what man bases his claims  
to superiority  
everything he knows he has had  
to learn whereas we insects are born  
knowing everything we need to know

*the lives and times of archy and mehitabel*

quote and only man is vile quote (p. 206)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

i do not see why men  
should be so proud insects have the more  
ancient lineage

according to the scientists

insects were insects

when man was only

a burbling whatisit

*the lives and times of archy & mehitabel*

certain maxims of archy (p. 54)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Muir, John** 1838–1914

American naturalist

Baby grubs, happy fellows, find themselves in a sweet world of plenty, feeding their way through the heart of the cone from one nut-chamber to another, secure from rain and wind and heat, until their wings are grown and they are ready to launch out into the free ocean of air and light.

*Steep Trails*

Chapter XIII (pp. 172–173)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

Insect swarms are dancing in the sunbeams, burrowing in the ground, diving, swimming, a cloud of witnesses telling Nature's joy.

*Our National Parks*

Chapter II (p. 70)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...every leaf and flower seems to have its winged representative in the swarms of happy flower-like insects that enliven the air above them.

*Our National Parks*

Chapter V (p. 163)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Pallister, William Hales** 1877–1946

Canadian physician

Of the INSECTS, such numbers of species exist  
That their species have filled up whole volumes of  
books.

Over four hundred thousand are named in their list!

Every one has six legs, though they differ in looks.

The long warfare with insects gives men little ease,

For four-fifths of the whole earth's species are these!

*Poems of Science* (p. 140)

Playford Press. New York, New York, USA. 1931

**Teale, Edwin Way** 1899–1980

American naturalist



If insects had the gift of speech, as we understand it, I am sure a main topic of conversation would begin: "Let me tell you about my molt."

*Near Horizons: The Story of an Insect Garden*

Chapter 10 (p. 97)

Dodd, Mead & Company. New York, New York, USA. 1943

**Webb, Mary** 1881–1927

English novelist

Insects are the artists of fragrance; they have a genius for it; there seems to be some affinity between the tenuity of their being and this most refined of the sense-impressions.

*Poems and the Spring of Joy*

Joy of Fragrance (p. 164)

Jonathan Cape. London, England. 1937

**Wood, John George** 1827–1889

English writer on natural history

The habits of insects are very mines of interesting knowledge, and it is impossible carefully to watch the proceedings of any insect, however insignificant, without feeling that no writer of fiction ever invented a drama of such absorbing interest as is acted daily before our eyes, though to indifferent spectators.

In W.J. Holland

*The Moth Book: A Popular Guide to a Knowledge of the Moths of North America*

Family Psychidae (p. 360)

Doubleday, Page & Company. New York, New York, USA. 1904

## ANIMAL: INSECT: ANT

**Darwin, Charles Robert** 1809–82

English naturalist

...the brain of an ant is one of the most marvelous atoms of matter in the world, perhaps more so than the brain of man.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Part I, Chapter II (p. 281)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The instincts of the ant are very unimportant, considered as the ant's; but the moment a ray of relation is seen to extend from it to man, and the little drudge is seen to be a monitor, a little body with a mighty heart, then all its habits, even that said to be recently observed, that it never sleeps, become sublime.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses and Lectures

Language (p. 22)

The Library of America. New York, New York, USA. 1983

**Hölldobler, Bert** 1936–

German myrmecologist

**Wilson, Edward O.** 1929–

American biologist and writer

The foreign policy aim of ants can be summed up as follows: restless aggression, territorial conquest, and genocidal annihilation of neighboring colonies whenever possible. If ants had nuclear weapons, they would probably end the world in a week.

*Journey to the Ants: A Story of Scientific Exploration*

War and Foreign Policy (p. 59)

Harvard University Press. Cambridge, Massachusetts, USA. 1994

**Lubbock, Sir John** 1834–1913

English banker, author, and scientist

The Anthropoid apes no doubt approach nearer to man in bodily structure than do any other animals; but when we consider the habits of ants, their social organization, their large communities and elaborate habitations, their roadways, their possession of domestic animals, and even, in some cases, of slaves, it must be admitted that they have a fair claim to rank next to man in the scale of intelligence.

*Ants, Bees and Wasps*

Introduction (p. 1)

D. Appleton & Company. New York, New York, USA. 1884

**Muir, John** 1838–1914

American naturalist

Ants...whose tiny sparks of life only burn the brighter with the heat...

*My First Summer in the Sierra*

June 3 (pp. 10–11)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

## The Bible

Go to the ant, you sluggard, observe her ways and gain wisdom.

*The Revised English Bible*

Proverbs 6:6

Oxford University Press, Inc. Oxford, England. 1989

**Thomas, Lewis** 1913–93

American physician and biologist

Ants are so much like human beings as to be an embarrassment. They farm fungi, raise aphids as livestock, launch armies into wars, use chemical sprays to alarm and confuse enemies, capture slaves. The families of weaver ants engage in child labor, holding their larvae like shuttles to spin out the thread that sews the leaves together for their fungus gardens. They exchange information ceaselessly. They do everything but watch television.

*The Lives of a Cell: Notes of a Biology Watcher*

On Societies as Organisms (pp. 11–12)

The Viking Press. New York, New York, USA. 1974

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

It seems to me that in the matter of intellect the ant must be a strangely overrated bird. During the many summers, now, I have watched him, when I ought to have been in better business, and I have not yet come across a living ant that seemed to have any more sense than a dead one.

*A Tramp Abroad*

Chapter XXII (p. 139)

Penguin Books. New York, New York, USA. 1997

## ANIMAL: INSECT: BEDBUG

### Author undetermined

The June bug hath a gaudy wing  
The lightning bug a flame  
The bedbug hath no wings at all  
But he gets there just the same.

In Arnold Mallis

*American Entomologist*

Chapter 8 (p. 205)

Rutgers University Press. New Brunswick, New Jersey, USA. 1971

## ANIMAL: INSECT: BEE

### Burroughs, John 1837–1921

American naturalist and writer

There is no creature with which man has surrounded himself that seems so much like a product of civilization, so much like the result of development on special lines and in special fields, as the honey-bee.

*Birds and Bees Essays*

Bees (p. 45)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1914

The honey-bee goes forth from the hive in spring like the dove from Noah's ark, and it is not till after many days that she brings back the olive leaf, which in this case is a pellet of golden pollen upon each hip...

*Locusts and Wild Honey*

The Pastoral Bees (p. 13)

Edinburgh University Press. Edinburgh, Scotland. 1884

### Cleveland, John 1613–58

English poet

Nature's confectioner, the bee.

*The Poems of John Cleveland*

Fuscara, or the Bee Errant

The Grafton Press. New York, New York, USA. 1903

### Dickinson, Emily 1830–86

American lyric poet

To make a prairie it takes a clover and one bee,  
One clover and a bee,  
And revery.

The revery alone will do,

If bees are few.

*The Complete Poems of Emily Dickinson*

No. 1755 (p. 710)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

### Gay, John 1685–1732

English poet and dramatist

The careful insect 'midst his works I view,  
Now from the flow'rs exhaust the fragrant Dew;  
With golden Treasures load his little Thighs,  
And steer his airy Journey through the Skies;  
With liquid Sweets the waxen Cells distend,  
While some 'gainst Hostile Drones their Cave defend;  
Each in Toil a proper Station bears,  
And in the little Bulk a might Soul appears...

*Rural Sports: A Poem*

Canto I, l. 83–90

Printed for J. Tonson. London, England. 1713

### Purchas, Samuel (the Younger) 1577–1626

English travel writer

Bees are political creatures, and destinate all their actions to one common end; they have one common habitation, one common work, all work for all, and one common care and love towards all their young, and that under one Commander...

*A Theatre of Political Flying-Insects* (p. 16)

Printed for T. Parkhurst. London, England. 1657

### Shakespeare, William 1564–1616

English poet, playwright, and actor

...so work the honey-bees,

Creatures, that by a rule in nature, teach

The act of order to a peopled kingdom.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Life of King Henry the Fifth

Act I, Scene ii, l. 187–189

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Smythe, Daniel 1908–81

American poet

The bees, those intergarden missiles,

Now make their thin propellers hum

To landing fields of flowers and thistles

More certain of their goal than some.

Small Flyers

*Nature Magazine*, Volume 50, Number 6, June–July 1957 (p. 292)

### Topsell, Edward 1572–1625?

English divine and writer

Of all Insects, Bees are the principal and are chiefly to be admired, being the only creature of that kinde framed for the nourishment of Man; but the rest are procreated either to be useful in physic, or for delight of the eyes, the pleasure of the ears, or the completing and ornament of the body...

*The History of Four-Footed Beasts and Serpents*

The Theater of Insects

Chapter I (p. 889)  
G. Sawbridge. London, England. 1658

## ANIMAL: INSECT: BEETLE

**Crowson, Roy Albert** 1914–99  
English biologist

The beetles are at once absolutely typical of, and unique among, the Insecta, a paradox of a kind which, though familiar to any practising systematist, is a constant stumbling block to laboratory experimentalists of the modern school.

*The Biology of the Coleoptera*

Chapter I (p. 1)

Academic Press. London, England. 1981

**Darwin, Charles Robert** 1809–82  
English naturalist

But no pursuit at Cambridge was followed with nearly so much eagerness or gave so much pleasure as collecting beetles. It was the mere passion for collecting, for I did not dissect them, and rarely compared their external characters with published descriptions, but got them named anyhow. I will give proof of my zeal: one day, on tearing off some old bark, I saw two rare beetles, and seized one in each hand; then I saw a third and new kind, which I could not bear to lose, so I popped the one which I held in my right hand into my mouth. Alas! It ejected some intensely acrid fluid, which burnt my tongue so that I was forced to spit the beetle out, which was lost, as was the third one.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 43)

D. Appleton & Company. New York, New York, USA. 1896

It seems therefore that a taste for collecting beetles is some indication of future success in life!

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 44)

D. Appleton & Company. New York, New York, USA. 1896

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

When asked by a group of theologians what one could conclude as to the nature of the Creator from a study of His creation, Haldane is said to have answered, “An inordinate fondness for beetles.”

In G. E. Hutchinson

Homage to Santa Rosalia, or Why Are There So Many Kinds of Animals

*American Naturalist*, Volume 93, 1959 (p. 146)

**Levi, Primo** 1919–87  
Italian writer and chemist

After the planet becomes theirs, many millions of years will have to pass before a beetle particularly loved by

God, at the end of its calculations will find written on a sheet of paper in letters of fire that energy is equal to the mass multiplied by the square of the velocity of light. The new kings of the world will live tranquilly for a long time, confining themselves to devouring each other and being parasites among each other on a cottage industry scale.

*Other People's Trades*

Beetles

Summit Books. New York, New York, USA. 1989

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The sense of death is most in apprehension;  
And the poor beetle that we tread upon,  
In corporal sufferance finds a pang as great  
As when a giant dies.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Measure for Measure

Act III, Scene i, l. 78–81

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wordsworth, William** 1770–1850

English poet

The beetle, panoplied in gems and gold

A mailed angel on a battle day.

*The Complete Poetical Works of William Wordsworth*

Stanzas Written in My Pocket-Copy of Thomson's Castle of Indolence

Crowell. New York, New York, USA. 1888

## ANIMAL: INSECT: BUTTERFLY

**Ackerman, Diane** 1948–  
American writer

A hundred million monarchs migrate each year. Gliding, flapping, hitching rides on thermals like any hawk or eagle, they fly as far as four thousand miles and as high as two thousand feet, rivaling the great animal migrations of Africa, the flocking of birds across North America.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

The Winter Palace of Monarchs (p. 132)

Vintage Books. New York, New York, USA. 1997

**Bates, Henry Walter** 1825–92  
English naturalist and explorer

...the study of butterflies — creatures selected as the types of airiness and frivolity — instead of being despised, will some day be valued as one of the most important branches of biological science.

*The Naturalist on the River Amazons* (Volume 2)

Chapter V (p. 346)

John Murray. London, England. 1863

**Borland, Hal** 1900–78  
American writer

...the emergence of a chick from an egg, in itself a marvelous thing, is simplicity itself, for the chick is a miniature of

the creature that laid the egg. Here we have a totally different event. A butterfly laid an egg. That egg hatched into a caterpillar with no hint of flight or winged beauty. That caterpillar retired into a cocoon or a chrysalis, and out of that house of change now comes a fragile-winged creature of the air, a living bit of sheer beauty and imagination.

*The Enduring Pattern*

Life — The Pygmy Hordes: Butterflies and Moths (p. 159)  
Simon & Schuster. New York, New York, USA. 1959

**Brower, David** 1912–2000

American environmentalist

“Butterfly is a stupid word,” the Spaniard said; “mariposa is so much more beautiful.”

“I much prefer farfalla,” the Italian countered. The woman from Paris said, “papillon, of course.” The Japanese suggested, “I like the softness of chocho-san.” The German bristled and demanded, “What’s the matter with schmetterling?”

*For Earth’s Sake: The Life and Times of David Brower*

Chapter I, Butterflies (p. 13)

Peregrine Smith Books, Salt Lake City, Utah, USA. 1990

**Dyson, Freeman J.** 1923–

American physicist and educator

To me the most astounding fact in the universe, even more astounding than the flight of the Monarch butterfly, is the power of mind that drives my fingers as I write these words. Somehow, by natural processes still totally mysterious, a million butterfly brains working together in a human skull have the power to dream, to calculate, to see and to hear, to speak and to listen, to translate thoughts and feelings into marks on paper which other brains can interpret. Mind, through the long course of biological evolution, has established itself as a moving force in our little corner of the universe. Here on this small planet, mind has infiltrated matter and has taken control.

*Infinite in All Directions*

Part One, Chapter Six (p. 118)

HarperCollins Publishers, Inc. New York, New York, USA. 1988

**Gay, John** 1685–1732

English poet and dramatist

And what’s a Butterfly? At best,  
He’s but a caterpillar, drest...

*The Poetical Works of John Gay* (Volume 2)

Fable XXIV, Volume the First, The Butterfly and the Snail, l. 41–42

Lawrence & Bullen. London, England. 1893

**Heinlein, Robert A.** 1907–88

American science fiction writer

Butterflies are not insects... they are self-propelled flowers.

*The Cat Who Walks Through Walls*

Book Three (p. 369)

The Berkley Publishing Group. New York, New York, USA. 1988

**Kirby, William F.** 1759–1850

English clergyman and entomologist

The butterfly, adorned with every beauty and every grace, borne by radiant wings through the fields of ether, and extracting nectar from every flower, gives us some idea of the blessed inhabitants of happier worlds, of angels, and of the spirits of the just arrived at their state of perfection.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Letter I (p. 6)

Longman, Green, Longman & Roberts. London, England. 1860

**Levi, Primo** 1919–87

Italian writer and chemist

The butterfly’s attractiveness derives not only from colors and symmetry: deeper motives contribute to it. We would not think them so beautiful if they did not fly, or if they flew straight and briskly like bees, or if they stung, or above all if they did not enact the perturbing mystery of metamorphosis: the latter assumes in our eyes the value of a badly decoded message, a symbol, a sign.

*Other People’s Trades*

Butterflies

Summit Books. New York, New York, USA. 1989

**Shelley, Percy Bysshe** 1792–1822

English poet

What hand would crush the silken-winged fly,  
The youngest of inconstant April’s minions,  
Because it cannot climb the purest sky,  
Where the swan sings, amid the sun’s dominions?  
Not thine.

*The Complete Poetical Works*

To Mary (On Her Objecting to the Following Poem, Upon the Score of its Containing No Human Interest)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Wilcox, Ella Wheeler** 1850–1919

American poet and journalist

I happened one night in my travels  
To stray into Butterfly Vale,  
Where my wondering eyes beheld butterflies  
With wings that were wide as a sail  
They lived in such houses of grandeur,  
Their days were successions of joys  
And the very last fad these butterflies had  
Was making collections of boys.

The Butterflies’ Fad

*The New York Times*, 16 June, 1895 (p. 27)

## ANIMAL: INSECT: CATERPILLAR

**Walton, Izaak** 1593–1683

English writer

And, yet, I will exercise your promised patience by saying a little of the caterpillar, or the palmer-fly or worm; that by them you may guess what a work it were, in a discourse, but to run over those very many flies, worms, and little living creatures with which the sun and summer adorn and beautify the river-banks and meadows, both for the recreation and contemplation of us anglers; pleasures which, I think, I myself enjoy more than any other man that is not of my profession.

*The Complete Angler*  
The Fourth Day (p. 92)  
T.N. Foulis. London, England. 1913

## ANIMAL: INSECT: CENTIPEDE

**Blanshard, Brand** 1892–1987

American philosopher

The centipede was happy quite  
Until the toad for fun  
Said: “Pray which leg comes after which?”  
This wrought his mind to such a pitch,  
He lay distracted in the ditch  
Considering how to run.

*The Nature of Thought* (Volume 1)  
Chapter VI, fn 1 (p. 232)  
George Allen & Unwin Ltd. London, England. 1939

## ANIMAL: INSECT: CHIGGER

**Hungerford, H. B.**

American entomologist

The thing called a chigger  
Is really no bigger  
Than the smaller end of a pin.  
But the bump that it raises  
Just itches like blazes  
And that’s where the rub set in.

In Tyler A. Woolley  
*Acarology: Mites and Human Welfare*  
Chapter 4 (p. 41)  
John Wiley & Sons, Inc. New York, New York, USA. 1988

## ANIMAL: INSECT: COCKROACH

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

She thinks that the cockroaches just need employment  
To prevent them from idle and wanton destruction.  
So she’s formed from that lot of disorderly louts,  
A troop of well-disciplined helpful boy scouts,  
With a purpose in life and a good to do —  
And she’s even created a Beetle Tattoo.

*The Collected Poems and Plays 1909–1950*  
The Old Gumbie Cat (p. 151)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

The cockroach and the birds were both here long before we were. Both could get along very well without us, although it is perhaps significant that of the two the cockroach would miss us more.

*The Twelve Seasons*  
November (pp. 118–119)  
W. Sloane Associates. New York, New York, USA. 1949

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

a good many  
failures are happy because they don’t realize it many a  
cockroach believes  
himself as beautiful  
as a butterfly  
have a heart o have a heart and let them dream on  
*the lives and times of archy & mehitabel*  
archygrams (p. 259)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

## ANIMAL: INSECT: CRICKET

**Riley, James Whitcomb** 1849–1916

American poet

But thou, O cricket, with thy roundelay,  
Shalt laugh them all to scorn! So wilt thou, pray  
Trill me thy glad song o’er and o’er again:  
In thy sweet prattle, since it sings the lone  
Heart home again.

*The Complete Works of James Whitcomb Riley* (Volume 3)  
To the Cricket  
P.F. Collier & Son, Company. New York, New York, USA. 1916

## ANIMAL: INSECT: DAMSEL FLY

**Barbault, Anna Laetitia** 1743–1825

English poet

Lo! the bright train their radiant wings unfold,  
With silver fring’d and freckl’d o’er with gold.  
On the gay bosom of some fragrant flower  
They idly fluttering live their little hour;  
Their life all pleasure, and their task all play,  
All spring their age, and sunshine all their day.

*Poems*  
To Mrs. Priestley, with some Drawings of Birds and Insects (p. 46)  
Printed for Joseph Johnson. London, England. 1773

**Moore, Thomas** 1779–1852

Irish poet

The beautiful blue-damsel flies  
That flutter’d round the jasmine stems,  
Like winged flowers or flying gems...

*The Poetical Works of Thomas Moore*  
Paradise and the Pearl, l. 409–11  
Lee & Shepard. Boston, Massachusetts, USA. 1873

**ANIMAL: INSECT: DRAGON FLY**

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

Clouds of insects danced and buzzed in the golden autumn light, and the air was full of the piping of the song-birds. Long, glinting dragonflies shot across the path, or hung tremulous with gauzy wings and gleaming bodies.

*The White Company*  
Chapter XI (p. 90)  
William Morrow & Company. New York, New York, USA. 1988

**Florian, Douglas** 1950–  
American writer and illustrator

I am the dragon,  
The demon of skies.  
Behold my bold  
Enormous eyes.  
I sweep  
I swoop  
I terrorize.  
For lunch I munch  
On flies and bees.  
Mosquitoes with  
My feet I seize.  
I am the dragon:  
Down on your knees!

*Insectlopedia: Poems and Paintings*  
The Dragonfly  
Harcourt Brace. San Diego, California, USA. 1998

**ANIMAL: INSECT: FIREFLY**

**Beebe, William** 1877–1962  
American ornithologist

A male firefly blazes his trail through the woods. At last he perceives a dim inconspicuous gleam, a mere spark, but it is his LANDING BEACON and he levels off and steers straight for the wingless mate, who has laboriously climbed to the top of a fern and there hung out her signal...

*High Jungle*  
Chapter XXI (p. 335)  
Duell, Sloan & Pearce. New York, New York, USA. 1949

**Frost, Robert** 1874–1963  
American poet

Here come real stars to fill the upper skies,  
And here on earth come emulating flies,  
That though they never equal stars in size,  
(And they were never really stars at heart)  
Achieve at times a very star-like start.

*Complete Poems of Robert Frost*  
Fireflies in the Garden  
Henry Holt & Company. New York, New York, USA. 1949

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The firefly's flame  
Is something for which science has no name.  
I can think of nothing eerier  
Than flying around with an unidentified  
red glow on a person's posterior.

*Verses from 1929 On*  
The Firefly  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**ANIMAL: INSECT: FLEA**

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American writer and humorist

Nelson would have been afraid of ten thousand fleas, but a flea wouldn't be afraid of ten thousand Nelsons.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*  
More Maxims of Mark (p. 945)  
The Library of America. New York, New York, USA. 1992

Consider the flea! Incomparably the bravest of all the creatures of God, if ignorance of fear were courage.

*Pudd'nhead Wilson*  
Chapter XII (p. 115)  
Harper & Brothers Publishers. New York, New York, USA. 1904

**Young, Roland** 1887–1953  
English actor

And here's the happy bounding flea —  
You cannot tell the he from she.  
The sexes look alike you see;  
But she can tell, and so can he.

*Not for Children*  
The Flea  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

**ANIMAL: INSECT: FLY**

**Doane, R. W.**  
No biographical data available

A few of them [flies] were nice things to have around, to make things seem homelike.... Those that were knocked into the coffee or the cream could be fished out; those that went into the soup or the hash were never missed.

*Insects and Disease*  
Chapter V (p. 57)  
Henry Holt & Company. New York, New York, USA. 1910

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

i scurry around  
gutters and sewers  
and garbage cans  
*the lives and times of archy and mehitabel*  
a spider and a fly (p. 40)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Nash, Ogden** 1902–71

American writer of humorous poetry

Aunt Betsy was fixing to change her will,  
And would have left us out in the chill.

A *Glossina morsitans* bit Aunt Betsy

Tsk, tsk, tsetse.

*Verses from 1929 On*

*Glossina Morsitans*, or, the Tsetse

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Shapiro, Paul** 1913–2000

No biographical data available

O hideous little bat, the size of snot,  
With polyhedral eye and shabby clothes,  
To populate the stinking cat you walk  
The promontory of the dead man's nose,  
Climb with the fine leg of a Duncan-Phyfe  
The smoking mountains of my food  
And in a comic mood

In mid-air take to bed a wife.

*The Wild Card: Selected Poems, Early & Late*

The Fly

University of Illinois Press. Urbana, Illinois, USA. 1998

**Walton, Izaak** 1593–1683

English writer

You are to know, that there are so many sorts of flies as there be of fruits: I will name you but some of them; as the dun-fly, the stone-fly, the red-fly, the moor-fly, the tawny-fly, the shell-fly, the cloudy or blackish-fly, the flag-fly, the vine-fly; there be of flies, caterpillars, and canker-flies, and bear-flies; and indeed too many either for me to name, or for you to remember. And their breeding is so various and wonderful, that I might easily amaze myself, and tire you in a relation of them.

*The Complete Angler*

The Fourth Day (p. 92)

T.N. Foulis. London, England. 1913

**ANIMAL: INSECT: GNAT****Rudzewicz, Eugene**

American educator and poet

Gnats are gnumerious

But small.

We hardly gnotice them

At all.

In John Gardner

*A Child's Bestiary*

The Gnat

Alfred A. Knopf. New York, New York, USA. 1977

**ANIMAL: INSECT: GRASSHOPPER****Lindsay, Vachel** 1879–1931

American poet

The Grasshopper, the grasshopper,  
I will explain to you: He is the Brownies' racehorse,  
The fairies' Kangaroo.

*Collected Poems*

The Grasshopper

The Macmillan Company. New York, New York, USA. 1925

**Lovelace, Richard** 1618–58

English cavalier and poet

O thou that swing'st upon the waving haire  
Of some well-filled Oaten Beard,  
Drunke ev'ry night with a Delicious teare,  
Dropt thee from Heav'n, where now th'art!  
The joys of Earth and Ayre are thine intire,  
That with thy feet and wings dost hop and flye;  
And when thy Poppy workes, thou dost retire  
To thy carv'd Acorn-bed to lye.

*The Poems of Richard Lovelace*

Grasse-Hopper (p. 38)

The Clarendon Press. Oxford, England. 1930

**ANIMAL: INSECT: KATYDID****Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Thou are a female, Katydid!

I know it by the trill

That quivers through thy piercing notes

So petulant and shrill.

I think there is a knot of you

Beneath the hollow tree,

A knot of spinster Katydids —

Do Katydids drink tea?

*The Complete Poetical Works of Oliver Wendell Holmes*

To an Insect

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Riley, James Whitcomb** 1849–1916

American poet

Sometimes I keep

From going to sleep,

To hear the katydids "cheep-cheep!"

And think they say

Their prayer that way;

But katydids don't have to pray!

*The Complete Works of James Whitcomb Riley*

Volume 8, The Katydids

P.F. Collier & Son, Company. New York, New York, USA. 1916

**ANIMAL: INSECT: LADY BIRD****Hurdis, James** 1763–1801

British poet

SIR JOHN: What ye look at?

CECILIA: A little animal, that round my glove,

And up and down to ev'ry finger's tip,

Has travell'd merrily, and travels still,  
Tho' it has wings to fly. What its name is  
With learned men I know not. Simple folks  
Call it the Lady-bird.

*Sir Thomas More: A Tragedy*

Act 1, Scene Sir Thomas More's Garden (p. 19)

Printed for J. Johnson. London, England. 1792

## ANIMAL: INSECT: LIGHTNING BUG

### Author undetermined

The lightning bug seems brilliant  
But he has not any mind  
For he stumbles through existence  
With his head light on behind.

*Entomological News*, Volume 16, Number 3, 1905 (p. 88)

## ANIMAL: INSECT: LOUSE

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

a louse i  
used to know  
told me that  
millionaires and  
bums tasted  
about alike  
to him.

*the lives and times of archy and mehitabel*

random thoughts by archie (p. 224)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

## ANIMAL: INSECT: MAGGOT

**Ammons, Archie Randolph** 1926–2001

American poet

Honor the maggot, supreme catalyst: he spurs the rate of  
change....

*Collected Poems: 1951–1971*

Catalyst, I. 1–3

W.W. Norton & Company, Inc. New York, New York, USA. 1972

## ANIMAL: INSECT: MILLIPEDE

**Garstang, Walter** 1868–1949

English embryologist and amateur poet

The hatching of a Millipede brings curious things to  
light:

The embryo within its shell is curled up snug and tight  
Enclosed inside an inner skin with a thorn upon its neck,  
Whose task it is to pierce the shell, as chicks their  
prisons peck.

What is this extra covering that thus comes into view?

An heirloom from antiquity here blended with the new?

Another “Nauplius-coat” around another embryo,  
The same that Peracarids on their cradled babes bestow?

*Larval Forms, and Other Zoological Verses*

The Millipede's Egg-Tooth, Stanza 1 (p. 51)

The University of Chicago Press. Chicago, Illinois, USA. 1985

## ANIMAL: INSECT: MOSQUITO

**Beaver, Wilfred**

No biographical data available

Mosquitoes are like little children — the moment they  
stop making noises you know they're getting into some-  
thing.

*Quote, the Weekly Digest*, November 10, 1968 (p. 378)

**Cuppy, Will** 1884–1929

American humorist and critic

I am often asked why Mosquitoes hum loudest when  
close to one's ear. I don't know.

*How to Attract the Wombat*

The Mosquito (fn 2, p. 146)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Pallister, William Hales** 1877–1946

Canadian physician

The whole of Africa is our domain,  
Millions of men have fought us, few remain.  
We rule the lowlands of the entire earth,  
The fertile lands, of far the greatest worth;  
Our swarms produce their billions as we wish,  
The world belongs to us, and to the fish.

*Poems of Science*

De Ipsa Natura, Moss Beginnings, Animal Lifequitoes (p. 219)

Playford Press. New York, New York, USA. 1931

## ANIMAL: INSECT: MOTH

**Carlyle, Thomas** 1795–1881

English historian and essayist

But see! a wandering Night-moth enters,  
Allured by taper gleaming bright.  
What passions in her small heart whirling,  
Hopes boundless, adoration, dread;  
At length her tiny pinions twirling,  
She darts, and — puff! — the moth is dead.

In Rodger L. Tarr and Flemming McClelland (eds.)

*The Collected Poems of Thomas and Jane Welsh Carlyle*

Tragedy of the Night-Moth, Stanza 2, (p. 1)

The Penkevill Publishing Company. Greenwood, Florida, USA. 1986

**Hooper, Judith**

American biology writer

Some might say that butterflies are Lepidoptera that people  
like while moths are ones they don't like...

*Of Moths and Men: The Untold Story of Science and the Peppered Moth*

Chapter 1 (p. 3)



W.W. Norton & Company, Inc. New York, New York, USA. 2002

**Nabokov, Vladimir** 1899–1977  
Russian-American writer

He told me about the odors of butterflies — musk and vanilla; about the voices of butterflies; about the piercing sound given out by the monstrous caterpillar of a Malayan hawkmoth, an improvement on the mouselike squeak of our Death's Head moth; about the small resonant tympanum of certain tiger moths; about the cunning butterfly in the Brazilian forest which imitates the whir of a local bird. He told me about the incredible artistic wit of mimetic disguise...

*Nabokov's Butterflies: Unpublished and Uncollected Writings The Gift* (p. 178)  
Bacon Press. Boston, Massachusetts, USA. 2000

**Sharp, David** 1840–1922  
English entomologist

The only definition that can be given of Heterocera is the practical one that all Lepidoptera that are not butterflies are Heterocera.

*Cambridge Natural History* (Volume 6)  
Chapter VI, Section II (p. 366)  
Macmillan & Company Ltd. London, England. 1901

**Wilson, Edward O.** 1929–  
American biologist and writer

The three-toed sloth feeds on leaves high in the canopy of the lowland forests through large portions of South and Central America. Within its fur live tiny moths, the species *Cryptoses choloepi*, found nowhere else on Earth. When a sloth descends to the forest to defecate (once a week), female moths leave the fur briefly to deposit their eggs on the fresh dung. The emerging caterpillars build nests of silk and start to feed. Three weeks later they complete their development by turning into adult moths, and then fly up into the canopy in search of sloths. By living directly on the bodies of the sloths, the adult *Cryptoses* assure their offspring first crack at the nutrient-rich excrement and a competitive advantage over the myriad of other coprophages.

*Biophilia*  
Bernhardsdorp (p. 9)  
Harvard University Press. Cambridge, Massachusetts. 1984

## ANIMAL: INSECT: PRAYING MANTIS

**Florian, Douglas** 1950–  
American writer and illustrator

Upon a twig  
I sit and pray  
For something big  
To wend my way:  
A caterpillar,

Moth,  
Or bee —  
I swallow them  
Religiously.  
*Insectlopedia: Poems and Paintings*  
The Praying Mantis  
Harcourt Brace. San Diego, California, USA. 1998

## ANIMAL: INSECT: TERMITE

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Some primal termite knocked on wood  
And tasted it, and found it good,  
And that is why your Cousin May  
Fell through the parlor floor today.  
*Verses from 1929 On*  
The Termite  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Thomas, Lewis** 1913–93  
American physician and biologist

When you consider the size of an individual termite, photographed standing alongside his nest, he ranks with the New Yorker and shows a better sense of organization than a resident of Los Angeles.  
*The Lives of a Cell: Notes of a Biology Watcher*  
Living Language (p. 133)  
The Viking Press. New York, New York, USA. 1974

## ANIMAL: INSECT: WALKING STICK

**Florian, Douglas** 1950–  
American writer and illustrator

The walkingstick is thin, not thick,  
And has a disappearing trick:  
By looking like a twig or stalk,  
It lives another day to walk.  
*Insectlopedia: Poems and Paintings*  
The Walkingstick  
Harcourt Brace. San Diego, California, USA. 1998

## ANIMAL: INSECT: WASP

**Field, Eugene** 1850–95  
American poet and journalist

See the wasp. He has pretty yellow stripes around his body, and a darning needle in his tail. If you will pat the wasp upon the tail we will give you a nice picture book.  
*The Complete Tribune Primer* (p. 47)  
The Mutual Book Company. Boston, Massachusetts, USA. 1901

**Gay, John** 1685–1732  
English poet and dramatist

Of all the plagues that heav'n hath sent,

A wasp is most impertinent!

*The Poetical Works of John Gay* (Volume 2)

Fable VIII, Volume the First, The Lady and the Wasp, l. 29–30

Lawrence & Bullen. London, England. 1893

**Sexton, Anne** 1928–74

American poet and writer

A red-hot needle  
hangs out of him, he steers by it  
as if it were a rudder, he  
would get in the house any way he could  
and then he would bounce from window  
to ceiling, buzzing and looking for you.

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Wasp

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**Topsell, Edward** 1572–1625?

English divine and writer

If you will have the endowments of his minde described,  
he is a political and flocking or regal creature, subject to  
Monarchy, laborious, a lover of his young, and a lover of  
his neighbor, of a very quarrelsome disposition, and very  
prone to choler.

*The History of Four-Footed Beasts and Serpents*

The Theater of Insects

Chapter I (p. 921)

G. Sawbridge. London, England. 1658

## ANIMAL: INSECT: WEEVIL

**Florian, Douglas** 1950–

American writer and illustrator

We are weevils.

We are evil.

We've aggrieved

Since time Primeval.

*Insectlopedia: Poems and Paintings*

The Weevils

Harcourt Brace. San Diego, California, USA. 1998

## ANIMAL: MAMMAL

### ANIMAL: MAMMAL: AARDVARK

#### Author undetermined

...it's aardvark, but it pays well.

In John S. Crosbie

*Crosbie's Dictionary of Puns* (p. 5)

### ANIMAL: MAMMAL: APE

**Broca, Paul** 1824–80

French surgeon and anthropologist

I would rather be a transformed ape than a degenerate  
son of Adam.

In Carl Sagan

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 1 (p. 6)

Random House, Inc. New York, New York, USA. 1979

**Young, Roland** 1887–1953

English actor

The sacred ape, now, children, see.

He's searching for the modest flea.

If he should turn around we'd find

He has no hair on his behind.

*Not for Children*

The Ape

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

## ANIMAL: MAMMAL: ARMADILLO

**Nash, Ogden** 1902–71

American writer of humorous poetry

The armadillo lives inside

A corrugated plated hide.

Below the border this useful creature

Of tidy kitchens use a feature,

For housewives use an armadillo

To scour their pots, instead of Brillo.

*Everyone but Thee and Me*

The Armadillo

Little, Brown & Company. Boston, Massachusetts, USA. 1962

## ANIMAL: MAMMAL: BAT

**Ackerman, Diane** 1948–

American writer

Suddenly, smoke billowed from underneath the bridge.

No, not smoke but a column of bats.

*The Moon by Whale Light, and Other Adventures Among Bats and*

*Crocodilians, Penguins and Whales*

Chapter 1 (p. 59)

Random House, Inc. New York, New York, USA. 1991

Bats eat so much food each evening that they have  
weighed in at as much as 50 percent heavier after one  
night's dining.

*The Moon by Whale Light, and Other Adventures Among Bats and*

*Crocodilians, Penguins and Whales*

Chapter 1 (p. 14)

Random House, Inc. New York, New York, USA. 1991

Bats kept surging out, and soon four columns stretched  
miles across the sky. A few strays looped and fed near  
us, passing like shuttles through the weave of the trees.  
The night was noticeably free of insects, but that was no  
surprise. These bats would eat five thousand pounds of  
insects that one night alone.

*The Moon by Whale Light, and Other Adventures Among Bats and*

*Crocodilians, Penguins and Whales*

Chapter 1 (p. 59)

Random House, Inc. New York, New York, USA. 1991

**Berryman, John** 1914–72  
American poet and critic

Bats have no bankers and they do not drink and cannot be arrested and pay no tax and, in general, bats have it made.

*77 Dream Songs*

No. 63 (p. 70)

Farrar, Straus & Giroux. New York, New York, USA. 1964

**Dawkins, Richard** 1941–  
English biologist

A bat is a machine, whose internal electronics are so wired up that its wing muscles cause it to home in on insects, as an unconscious guided missile homes in on an aeroplane.

*The Blind Watchmaker*

Chapter 2 (p. 37)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Montgomery, James** 1771–1854  
Scottish poet and journalist

What shall I call thee — bird, or beast, or neither?  
— Just what you will; I'm rather both than neither;  
Much like the season when I whirl my flight,  
The dusk of evening — neither day nor night.

*Poetical Works of James Montgomery* (Volume 2)

The Bat

Printed for Longman, Rees, Orme, Brown, Green & Longman. London, England. 1836

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Myself, I rather like the bat,  
It's not a mouse, it's not a rat.  
It has no feathers, yet has wings,  
It's quite inaudible when it sings.  
It zigzags through the evening air  
And never lands on ladies' hair,  
A fact of which men spend their lives  
Attempting to convince their wives.

*Verses from 1929 On*

The Bat

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Sexton, Anne** 1928–74  
American poet and writer

His awful skin  
Stretched out by some tradesman  
is like my skin, here between my fingers,  
a kind of webbing, a kind of frog.

In Linda Gray Sexton (ed.)

*45 Mercy Street*

Bat

Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**Tabb, John Banister** 1845–1909  
American poet

To his cousin the Bat  
Squeaked the envious Rat,  
“How fine to be able to fly!”  
Tittered she, “Leather wings  
Are convenient things;  
But nothing to sit on have I.”

*The Poetry of Father Tabb*

Humorous Verse, An Inconvenience

Dodd, Mead & Company. New York, New York, USA. 1928

**Tennyson, Alfred (Lord)** 1809–92  
English poet

And bats went round in fragrant skies,  
And wheel'd or lit the filmy shapes  
That haunt the dusk, with ermine capes  
And woolly breasts and beaded eyes...

*Alfred Tennyson's Poetical Works*

In Memoriam, Verse XCIII

Oxford University Press, Inc. London, England. 1953

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American writer and humorist

A bat is beautifully soft and silky; I do not know any creature that is pleasanter to the touch or is more grateful for caressings, if offered in the right spirit.

*Mark Twain's Autobiography* (Volume 1)

Chapters Begun in Vienna (p. 104)

Harper & Brothers Publishers. New York, New York, USA. 1924

## ANIMAL: MAMMAL: BEAR

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

If people persist in trespassing upon the grizzlies' territory, we must accept the fact that the grizzlies, from time to time, will harvest a few trespassers.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 86)

St. Martin's Press. New York, New York, USA. 1989

**Lear, Edward** 1812–88  
English humorist and artist

There was an old person of Ware,  
Who rode on the back of a bear;  
When they ask'd, “Does it trot?” he said, “Certainly not!  
He's a Moppsikon Floppsikon bear!”

*Of Pelicans and Pussycats*

Dial Books for Young Readers. New York, New York, USA. 1990

**Muir, John** 1838–1914  
American naturalist

Bears are peaceable people and mind their own business, instead of going about like the devil seeking whom they may devour.

*Our National Parks*

Chapter I (p. 28)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Pope, Alexander** 1688–1744  
English poet

The fur that warms a monarch, warm'd a bear.  
*The Complete Poetical Works* (Volume 2)  
An Essay on Man, Epistle III, l. 44  
Houghton Mifflin Company. New York, New York, USA. 1903

## ANIMAL: MAMMAL: BEAVER

**Outwater, Alice** American environmental engineer and writer

The beaver is utterly familiar. Forty inches long and over a foot upright, a beaver seems like a little person with a fondness for engineering.  
*Water: A Natural History*  
Chapter Two (p. 19)  
Basic Books, Inc. New York, New York, USA. 1996

## ANIMAL: MAMMAL: BIGHORN SHEEP

**Muir, John** 1838–1914  
American naturalist

The largest of the canon animals one is likely to see is the wild sheep, or Rocky Mountain bighorn, a most admirable beast, with limbs that never fail, at home on the most nerve-trying precipices, acquainted with all the springs and passes and broken-down jumpable places in the sheer ribbon cliffs, bounding from crag to crag in easy grace and confidence of strength, his great horns held high above his shoulders, wild red blood beating and hissing through every fiber of him like the wind through a quivering mountain pine.  
*Steep Trails*  
Chapter XXIV (p. 375)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## ANIMAL: MAMMAL: BUFFALO

### Author undetermined

The buffalo is the death  
that makes a child climb a thorn tree....  
He is the butterfly of the savannah:  
He flies along without touching the grass.  
When you hear thunder without rain —  
it is the buffalo approaching.  
In Ulli Beier  
*Yoruba Poetry*  
Buffalo  
General Publications Section, Ministry of Education. Ibadan, Nigeria. 1959

**Muir, John** 1838–1914  
American naturalist

I suppose we need not go mourning the buffaloes. In the nature of things they had to give place to better cattle, though the change might have been made without barbarous wickedness.

*Our National Parks*  
Chapter X (p. 335)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## ANIMAL: MAMMAL: CAT

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

...cats seem to go on the principle that it never does any harm to ask for what you want.  
*The Twelve Seasons*  
February (p. 160)  
W. Sloane Associates. New York, New York, USA. 1949

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

If a dog jumps in your lap, it is because he is fond of you; but if a cat does the same thing, it is because your lap is warmer.  
In Lucien Price  
*Dialogues of Alfred North Whitehead*  
Chapter XXV, December 10, 1941 (p. 187)  
Little Brown. Boston, Massachusetts, USA. 1954

## ANIMAL: MAMMAL: COW

**Young, Roland** 1887–1953  
English poet and actor

The cow's a gentle, patient soul,  
With milk she fills the flowing bowl.  
She's kind to babies, mean to flies,  
She has the most coquettish eyes.  
*Not for Children*  
The Cow  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

## ANIMAL: MAMMAL: COYOTE

**Austin, Mary Hunter** 1868–1934  
American novelist and essayist

When the five coyotes that range the Tejon from Pasteria to Tunawai planned a relay race to bring down an antelope strayed from the band, beside myself to watch, an eagle swung down from Mt. Pinos, buzzards materialized out of invisible ether, and hawks came trooping like small boys to a street fight.  
*The Land of Little Rain*  
The Scavengers (p. 55)  
Houghton Mifflin & Company. Boston, Massachusetts, USA. 1903

**James, William** 1842–1910  
American philosopher and psychologist

I saw a moving sight the other morning before breakfast.... The young man of the house had shot a little wolf called a coyote in the early morning. The heroic little animal lay on the ground, with his big furry ears, and his clean white teeth, and his jolly cheerful little body, but his brave little life was gone. It made me think how brave all these living things are. Here little coyote was, without any clothes or house or books or anything, with nothing but his own naked self to pay his way with, and risking his life so cheerfully — and losing it — just to see if he could pick up a meal near the hotel. He was doing his coyote-business like a hero...

In Henry James (ed.)

*The Letters of William James* (Volume 2)

Letter to his Son Alexander, August 28, 1898 (pp. 81–82)

The Atlantic Monthly Press. Boston, Massachusetts, USA. 1920

### Twain, Mark (Samuel Langhorne Clemens) 1835–1910

American writer and humorist

The coyote is a living, breathing allegory of Want. He is always hungry. He is always poor, out of luck and friendless. The meanest creatures despise him and even the flea would desert him for a velocipede.

*Roughing It* (Volume 1)

Chapter V (p. 48)

Harper & Brothers Publishers. New York, New York, USA. 1899

## ANIMAL: MAMMAL: DEER

### Muir, John 1838–1914

American naturalist

Deer give beautiful animation to the forests, harmonizing finely in their color and movements with the gray and brown shafts of the trees as they stand in groups at rest...

*Steep Trails*

Chapter XXII (p. 320)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## ANIMAL: MAMMAL: DOG

### Butler, Samuel 1612–80

English novelist, essayist, and critic

The greatest pleasure of a dog is that you may make a fool of yourself with him and not only will he not scold you, but he will make a fool of himself.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Dog (p. 314)

Jonathan Cape. London, England. 1951

### Doyle, Sir Arthur Conan 1859–1930

Scottish writer

A hound it was, an enormous coal-black hound, but not such a hound as mortal eyes have ever seen. Fire burst

from its open mouth, its eyes glowed with a smoldering glare, its muzzle and hackles and dewlap were outlined in flickering flame. Never in the delirious dream of a disordered brain could anything more savage, more appalling, more hellish be conceived than that dark form and savage face which broke upon us out of the wall of fog.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Hound of the Baskervilles, Chapter 14 (p. 100)

Wings Books. New York, New York, USA. 1967

### Nash, Ogden 1902–71

American writer of humorous poetry

The truth I do not stretch or shove

When I state the dog is full of love.

I've also proved by actual test,

A wet dog is the lovingest.

*Everyone but Thee and Me*

The Dog (p. 71)

Little, Brown & Company. Boston, Massachusetts, USA. 1962

### Twain, Mark (Samuel Langhorne Clemens) 1835–1910

American writer and humorist

Heaven goes by favor. If it went by merit, you would stay out and your dog would go in.

In Albert Bigelow Paine

*Mark Twain: A Biography* (Volume 4)

Chapter CCXCII (p. 1567)

Harper & Brothers Publishers. New York, New York, USA. 1912

If you pick up a starving dog and make him prosperous, he will not bite you. This is the principal difference between a dog and a man.

*Pudd'nhead Wilson's Calendar*

Chapter XVI (p. 158)

Harper & Brothers Publishers. New York, New York, USA. 1904

A composite dog is a dog that's made up of all the valuable qualities that's in the dog breed — kind of a syndicate; and a mongrel is made up of the riffraff that's left over.

*Mark Twain in Eruption: Hitherto Unpublished Pages About Men and Events*

In a Writer's Workshop

Platform Readings (p. 222)

Harper & Brothers Publishers. New York, New York, USA. 1922

## ANIMAL: MAMMAL: DONKEY

### Twain, Mark (Samuel Langhorne Clemens) 1835–1910

American writer and humorist

I believe I would rather ride a donkey than any beast in the world. He goes briskly, he puts on no airs, he is docile, though opinionated. Satan himself could not scare him, and he is convenient — very convenient. When you are tired riding you can rest your feet on the ground and

let him gallop from under you.

*The Innocents Abroad* (Volume 2)

Chapter XXX (pp. 396–397)

Harper & Brothers Publishers. New York, New York, USA. 1904

## ANIMAL: MAMMAL: ELEPHANT

**Cuppy, Will** 1884–1929

American humorist and critic

In the Pleistocene Era, there were more than twenty kinds of elephants. Now there are only two. That's plenty.

*How to Get from January to December*

April 24 (p. 85)

Henry Holt & Company. New York, New York, USA. 1951

**Donne, John** 1572–1631

English poet and divine

Nature's great masterpiece, an Elephant.

The only harmless great thing; the giant of beasts.

In A.J. Smith (ed.)

*The Complete English Poems*

The Progress of the Soul, Stanza 39

St. Martin's Press. New York, New York, USA. 1971

**Heinlein, Robert A.** 1907–88

American science fiction writer

An elephant: A mouse built to government specifications.

*The Notebooks of Lazarus Long* (p. 9)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Kipling, Rudyard** 1865–1936

British writer and poet

In the High and Far-Off Times the Elephant, O Best Beloved, had no trunk. He had only a blackish, bulgy nose, as big as a boot, that he could wiggle about from side to side; but he couldn't pick up things with it.

*The Elephant's Child* (p. 1)

A.P. Watt. London, England. 1900

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The elephant hath joints, but none for courtesy. His legs are legs for necessity, not for flexure.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Troilus and Cressida

Act II, Scene iii, l. 113–115

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Swift, Jonathan** 1667–1745

Irish-born English writer

So Geographers in Afric-Maps  
With Savage Pictures fill their gaps;  
And o'er unhabitable Downs

Place Elephants for want of Towns.

*The Poetical Works of Jonathan Swift* (Volume 2)

On Poetry

A Rhapsody, l. 177–180

William Pickering. London, England. 1833

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

I could easily learn to prefer an elephant to any other vehicle, partly because of that immunity from collisions, and partly because of the fine view one has from up there, and partly because of the dignity one feels in that high place, and partly because one can look in at the windows and see what is going on privately among the family. The Lahore horses were used to elephants, but they were rapturously afraid of them just the same. It seemed curious. Perhaps the better they know the elephant the more they respect him in that peculiar way. In our own case we are not afraid of dynamite till we get acquainted with it.

*Following the Equator* (Volume 2)

Chapter XXIV (p. 282)

Harper & Brothers Publishers. New York, New York, USA. 1899

## ANIMAL: MAMMAL: GIRAFFE

**Young, Roland** 1887–1953

English actor

Now, children, you must never laugh

At the stately tall giraffe.

She's sensitive, as you can tell;

But, my dears, she kicks like hell!

*Not for Children*

The Giraffe

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1930

## ANIMAL: MAMMAL: GORILLA

**Bradley, Mary Hastings**

Geographer, traveler, and writer

The gorilla is a strict vegetarian like the elephant and buffalo — three of the four most dangerous animals in Africa. It behooves one to walk softly with vegetarians.

*On the Gorilla Trail*

Chapter IX (p. 131)

D. Appleton & Company. London, England. 1922

**Fossey, Dian** 1932–85

American zoologist

The more you learn about the dignity of the gorilla, the more you want to avoid people.

In W.E. Smith

The Case of the Gorilla Lady Murder

*Time*, September 1, 1986 (p. 18)

**ANIMAL: MAMMAL: GUANACO**

**Simpson, George Gaylord** 1902–84  
American paleontologist

The guanaco is a camel but  
He hasn't got a hump.  
He's about three-quarters mountain goat  
And seven-eighths a chump.

*Concession to the Improbable: An Unconventional Autobiography*  
Chapter 8 (p. 72)  
Yale University Press. New Haven, Connecticut, USA. 1978

**ANIMAL: MAMMAL: HIPPOPOTAMUS**

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

I shoot the Hippopotamus  
With bullets made of platinum,  
Because if I use leaden ones  
His hide is sure to flatten 'em.

*Complete Verse*  
The Hippopotamus (p. 237)  
Gerald Duckworth. London, England. 1970

**Macaulay, Thomas Babington** 1800–59  
English historian and writer

I have seen the hippopotamus, both asleep and awake;  
and I can assure you that, awake or asleep, he is the ugliest of the works of God.

In G. Otto Trevelyan  
*The Life and Letters of Lord Macaulay* (Volume 2)  
Chapter XIII, March 9, 1850 (p. 222)  
Harper & Brothers. New York, New York, USA. 1876

**ANIMAL: MAMMAL: HORSE**

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

The horse is a very gregarious creature.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
Silver Blaze (p. 273)  
Wings Books. New York, New York, USA. 1967

**Melville, Herman** 1819–91  
American novelist, essayist, and poet

... what is a horse but a species of four-footed dumb man,  
in a leathern overall, who happens to live upon oats, and  
toils for his masters, half-requted or abused, like the biped  
hewers of wood and drawers of water?

*Redburn*  
Chapter XL (p. 26)  
Jonathan Cape. London, England. 1937

**Moore, George** 1852–1933  
Irish novelist

There is a touch of divinity even in brutes, and a special halo about a horse, that should forever exempt him from indignities. For as those majestic, magisterial truck-horses of the docks, I would as soon think of striking a judge on the bench, as to lay violent hand upon their holy hides.

*Evelyn Innes*  
Chapter XIX  
T. Fisher Unwin. London, England. 1898

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

A horse! A horse! My kingdom for a horse!  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The Tragedy of King Richard the Third  
Act V, Scene iv, l. 7  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American writer and humorist

I have known the horse in war and in peace, and there is no place where a horse is comfortable. The horse has too many caprices, and he is too much given to initiative. He invents too many ideas. No, I don't want anything to do with a horse.

*The Complete Works of Mark Twain* (Volume 24)  
Mark Twain's Speeches, Welcome Home (p. 201)  
Harper & Brothers Publishers. New York, New York, USA. 1899

**ANIMAL: MAMMAL: JACKAL**

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
English Romantic poet and satirist

The jackal's troop, in gather'd cry,  
Bay'd from afar complainingly,  
With a mix'd and mournful sound,  
Like crying babe, and beaten hound.

*The Complete Poetical Works of Byron*  
Siege of Corinth, Stanza 33, l. 1024–27  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**ANIMAL: MAMMAL: LEOPARD**

**Wells, Carolyn** 1862–1942  
American writer

If strolling forth, a beast you view,  
Whose hide with spots is peppered,  
As soon as he has lept on you,  
You'll know it is the leopard.  
'Twill do no good to roar with pain,  
He'll only lep and lep again.

*Baubles*  
How to Tell the Wild Animals  
Dodd, Mead. New York, New York, USA. 1917

**ANIMAL: MAMMAL: LION**

**Gay, John** 1685–1732  
English poet and dramatist

The Lion is (beyond dispute)  
Allow'd the most majestic brute;  
His valor and his gen'rous mind  
Prove him superior of his kind.  
*The Poetical Works of John Gay* (Volume 2)  
The Fables, Volume the Second, Fable IX, The Jackal, Leopard, and  
Other Beasts  
Lawrence & Bullen. London, England. 1893

**Pringle, Thomas** 1789–1834  
Scottish poet

Wouldst thou view the Lion's den?  
Search afar from haunts of men —  
Where the reed-encircled rill,  
Oozes from the rocky hill,  
By its verdure far descried  
'Mid the desert brown and wide.  
*Afar in the Desert: And Other South African Poems; With a Memoir  
and Notes*  
The Lion and the Giraffe  
Stanza 1  
Longmans. London, England. 1881

**ANIMAL: MAMMAL: LLAMA**

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

The Llama is a woolly sort of fleecy hairy goat,  
With an indolent expression and an undulating throat  
Like an unsuccessful literary man.  
*Complete Verse*  
The Llama (p. 245)  
Gerald Duckworth. London, England. 1970

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The one-l lama,  
He's a priest.  
The two-l llama,  
He's a beast.  
And I will bet  
A silk pajama  
There isn't any three-l llama.  
*Verses from 1929 On*  
The Lama  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**ANIMAL: MAMMAL: MAMMOTH**

**Blackie, John Stuart** 1809–95  
Scottish scholar

Mammoth, Mammoth! mighty old Mammoth!  
Strike with your hatchet and cut a good slice;

The bones you will find, and the hide of the mammoth,  
Packed in stiff cakes of Siberian ice.

*Lays and Legends of Ancient Greece: With Other Poems*  
A Song of Geology (p. 24)  
Sutherland & Knox. Edinburgh, Scotland. 1857

**ANIMAL: MAMMAL: MANATEE**

**Nash, Ogden** 1902–71  
American writer of humorous poetry

The manatee is harmless  
And conspicuously charmless.  
Luckily the manatee  
Is quite devoid of vanity.  
*Verses from 1929 On*  
The Manatee  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**ANIMAL: MAMMAL: MOUSE****Author undetermined**

Of mice there are many,  
Their kinds are profuse,  
We'd be lost without any  
Yet we ponder their use!  
In William H. Carr  
*The Stir of Nature*  
Chapter Seven (p. 92)  
Oxford University Press, Inc. New York, New York, USA. 1930

**Cuppy, Will** 1884–1929  
American humorist and critic

I have nothing against mice, in moderation.... My own  
mice just eat whatever I have in the place, including soap.  
Not an ideal diet, but they'll have to make it do or move  
elsewhere.  
*How to Get From January to December*  
January 20  
Henry Holt & Company. New York, New York, USA. 1951

**ANIMAL: MAMMAL: OPOSSUM**

**Cuppy, Will** 1884–1929  
American humorist and critic

The opossum is a marsupial and marsupials are animals  
who carry their young around in an abdominal pouch or  
marsupium. As they have done this for millions and mil-  
lions of years, they are not likely to stop, no matter how  
you and I feel about it. Baby opossums are born in a rudi-  
mentary or unfinished state, from four to twenty at once.  
They are only half an inch long and smaller around than a  
honey bee. This seems hardly worth while, but it suits the  
mother opossum, and she is the one directly involved.  
*How to Attract the Wombat*  
The Opossum (pp. 49–50)  
Rinehart & Company, Inc. New York, New York, USA. 1949



**ANIMAL: MAMMAL: OTTER****Colum, Padraic** 1881–1972

Irish poet and writer

I'll be an otter, and I'll let you swim  
 A mate beside me; we will venture down  
 A deep, full river when the sky above  
 Is shut of the sun; spoilers are we;  
 Thick-coated; no dog's tooth can bite at our veins —  
 With ears and eyes of poachers; deep-earthed ones  
 Turned hunters; let him slip past,  
 The little vole, my teeth are on an edge  
 For the King-fish of the River!

*Collected Poems*

Otters

Devin-Adair. New York, New York, USA. 1953

**ANIMAL: MAMMAL: PANDA****Schaller, George B.** 1933–

American zoologist

**Jinchu, Hu**

Chinese biologist

There are two giant pandas, the one that exists in our mind and the one that lives in its wilderness home. Soft, furry, and strangely patterned in black and white, with a large, round head and a clumsy, cuddly body, a panda seems like something to play with and hug. No other animal has so entranced the public...The real panda, however, the panda as it lives in the wild, has remained essentially a mystery.

*The Giant Pandas of Wolong*

Preface (p. xiii)

The University Press of Chicago. Chicago, Illinois, USA. 1985

**ANIMAL: MAMMAL: PANTHER****Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

Lifting her eyes she saw two bright objects starring the darkness with a reddish-green glow. She took them to be two coals on the hearth, but with her returning sense of direction came the disquieting consciousness that they were not in that quarter of the room, more-over were too high, being nearly at the level of the eyes — of her own eyes. For these were the eyes of a panther.

*The Eyes of the Panther*

The Eyes of the Panther (pp. 18–19)

Books for Libraries Press. Plainview, New York, USA. 1976

**ANIMAL: MAMMAL: PECCARY****Wilson, Edward O.** 1929–

American biologist and writer

A tame peccary watched me with beady concentration from beneath the shadowed eaves of a house. With my own, taxonomist's eye I registered the defining traits of the collared species, *Dicotyles tajacu*: head too large for the piglike body, fur coarse and brindled, neck circled by a pale thin stripe, snout tapered, ears erect, tail reduced to a nub. Poised on still little dancer's legs, the young male seemed perpetually fierce and ready to charge yet frozen in place, like the metal boar on an ancient Gallic standard.

*Biophilia*

Bernhardsdorp (p. 4)

Harvard University Press. Cambridge, Massachusetts. 1984

**ANIMAL: MAMMAL: PIG****Perrin, Noel** 1927–2004

American essayist

Pigs get bad press. Pigs are regarded as selfish and greedy — as living garbage pails. Pigs are the villains in George Orwell's *Animal Farm*. Pigs have little mean eyes. There is truth in this account — not that it's entirely the fault of the pigs. For perhaps five thousand generations pigs have been deliberately bred to be gluttonous.... Do the same thing with human beings for five thousand generations, and it would be interesting to see what kind of people resulted.

*Second Person Rural: More Essays of a Sometime Farmer*

Pig Tales (p. 143)

D. R. Godine. Boston, Massachusetts, USA. 1980

**ANIMAL: MAMMAL: PIKAS****Muir, John** 1838–1914

American naturalist

...the mounds in front of their burrows glittering like heaps of jewelry, — romantic ground to live in or die in.

*Our National Parks*

Chapter V (p. 162)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**ANIMAL: MAMMAL: POLAR BEAR****Belloc, Hilaire** 1870–1953

French-born poet and historian

The Polar Bear is unaware  
 Of cold that cuts me through:  
 For why? He has a coat of hair,  
 I wish I had one too!

*Complete Verse*

The Polar Bear (p. 236)

Gerald Duckworth. London, England. 1970

**ANIMAL: MAMMAL: PORPOISE****Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American writer and humorist

The porpoise is the kitten of the sea: he never has a serious thought, he cares for nothing but fun and play.

*Following the Equator* (Volume 1)

Chapter IX (p. 108)

Harper & Brothers Publishers. New York, New York, USA. 1899

The porpoise is the clown of the sea — evidently does his wild antics for pure fun; there is no sordid profit in it.

*Mark Twain's Notebook*

Chapter XXIII (p. 267)

Harper & Brothers Publishers. New York, New York, USA. 1935

## ANIMAL: MAMMAL: PRAIRIE DOG

**Austin, Mary Hunter** 1868–1934

American novelist and essayist

Old Peter Prairie-Dog

Builds him a house

In Dog-Dog Town,

With a door that goes down

And down and down,

And a hall that goes under

And under and under,

Where you can't see the lightning,

You can't hear the thunder,

For they don't like thunder

In Dog-Dog Town.

*The Children Sing in the Far West*

Dog-Dog Town

Houghton Mifflin Company. Boston, Massachusetts, USA. 1928

## ANIMAL: MAMMAL: RHINOCEROS

**Belloc, Hilaire** 1870–1953

French-born poet and historian

Rhinoceros, your hide looks all undone,

You do not take my fancy in the least:

You have a horn where other brutes have none:

Rhinoceros, you are an ugly beast.

*Complete Verse*

The Rhinoceros (p. 239)

Gerald Duckworth. London, England. 1970

## ANIMAL: MAMMAL: SHEEP

**Muir, John** 1838–1914

American naturalist

No other animal seems to yield so submissively to the manipulations of culture. Jacob controlled the color of his flocks merely by causing them to stare at objects of his desired hue; and possibly Merinos may have caught their wrinkles from the perplexed brows of their breeders.

*Steep Trails*

Chapter I (p. 17)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

It is almost impossible to conceive of a devastation more universal than is produced among the plants of the Sierra by sheep.... Nine tenths of the whole surface of the Sierra has been swept by the source. It demands legislative interference.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter III, Section 6, September 19, 1873 (p. 173)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

## ANIMAL: MAMMAL: SHREW

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

Timid atom, furry shrew,

Is it a sin to prison you?

Through the runways in the grass

You and yours in hundreds pass,

An unimagined world of shrews,

A world whose hurrying twilight news

Never stirs but now and then

The striding world of booted men.

*The Captive Shrew and Other Poems of a Biologist*

The Captive Shrew

Harper & Brothers. New York, New York, USA. 1933

**Schaefer, Jack** 1907–91

American writer and journalist

Shrews are not mutual murderers. We'll just square off and touch whiskers, assessing each other. Then we'll try to out-squeak each other.

Interview with a Shrew

*Audubon*, Volume 77, Number 6, November 1975 (p. 2)

## ANIMAL: MAMMAL: SKUNK

**Adams, Roger** 1889–1971

American organic chemist

Many thanks for the sending me the book "Biology of the Striped Skunk"... Frankly, I doubt whether I shall read it or not, unless I happen to have some intimate contact with a skunk which may induce me to learn more about him.

In D.S. Tarbell and A. Tarbell

*Roger Adams, Scientist and Statesman* (p. 192)

American Chemical Society. Washington, D.C. 1981

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

I respect the skunk as a human being in a very humble sphere.

In William H. Carr

*The Stir of Nature*

Chapter Four (p. 48)

Oxford University Press, Inc. New York, New York, USA. 1930

**Young, Roland** 1887–1953

English actor

In this mechanic age the skunk  
 Inspires no terror — he's the bunk;  
 For people in cars,  
 Returning from bars,  
 Quite frequently flatten the skunk.

*Not for Children*

The Skunk

Doubleday, Doran &amp; Company, Inc. Garden City, New York, USA. 1930

**ANIMAL: MAMMAL: SQUIRREL****Prelutsky, Jack** 1940–

American poet

Squirrels, often found in parks,  
 have tails resembling question marks,  
 it's just coincidental, though...  
 there's little squirrels care to know.

*Something Big Has Been There*

Squirrels

William Morrow &amp; Company. New York, New York, USA. 1990

**ANIMAL: MAMMAL: TIGER****Charlie Chan**

Fictional character

Tiger going away from village is never feared.

*Dangerous Money*

Film (1946)

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

I consider the tiger as a being, a created being. If you kill all tigers still the tiger-soul continues.... But the point is I don't want the tiger superseded. Oh, may each she-ti-gress have seventy seven whelps, and may they all grow in strength and shine in stripes like day and night, and may each one eat at least seventy miserable featherless human birds, and lick red chops of gusto after it.

In James T. Boulton

*Selected Letters of D.H. Lawrence*

Chapter III, May 1921, Letter to Earl and Achsah Brewster, 15 May 1921 (pp. 204, 205)

Cambridge University Press. Cambridge, England. 1997

**Wells, Carolyn** 1862–1942

American writer

Or if some time when roaming round,  
 A noble wild beast greets you,  
 With black stripes on a yellow ground,  
 Just notice if he eats you.  
 This simple rule may help you learn  
 The Bengal tiger to discern.

*Baubles*

How to Tell the Wild Animals

Dodd, Mead. New York, New York, USA. 1917

**ANIMAL: MAMMAL: WALRUS****Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“The time has come,” the Walrus said,  
 “To talk of many things:  
 Of shoes — and ships — and sealing-wax —  
 Of cabbages — and kings —  
 And why the sea is boiling hot —  
 And whether pigs have wings.”

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter IV (p. 186)

The Modern Library. New York, New York, USA. 1936

**ANIMAL: MAMMAL: WHALE****Ackerman, Diane** 1948–

American writer

Whales navigate through a rich, complicated landscape at a stately pace, slow as zeppelins, majestic and alert.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 3 (p. 129)

Random House, Inc. New York, New York, USA. 1991

When a whale sleeps, it slowly tumbles in any-old-crazy, end-over-end, sideways fashion, and may even bonk its head on the bottom.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 3 (p. 174)

Random House, Inc. New York, New York, USA. 1991

The ocean transmits sound in strange and unlikely ways. There is a layer of water, known as the deep sound channel, in which sound waves can be trapped and spread great distances because they bend back into the channel over and over, without losing much energy. Under those circumstances, whale sound can travel as much as five hundred miles before blending into background noise.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

Chapter 3 (p. 118)

Random House, Inc. New York, New York, USA. 1991

**Beale, Thomas** 1807–49

English surgeon

Mad with the agonies he endures from these fresh attacks, the infuriated Sperm Whale rolls over and over; he rears his enormous head, and with wide expanded jaws snaps at everything around him; he rushes at the boats with his head; they are propelled before him with vast swiftness, and sometimes utterly destroyed.

*The Natural History of the Sperm Whale*

Dodd, Mead. New York, New York, USA. 1917

**Chief Engineer Scott**

Fictional character

Admiral, there be whales here!

*Star Trek IV*

The Voyage Home

Film

**Hart, Joseph** 1798–1856

American novelist

Suddenly a mighty mass emerged from the water, and shot up perpendicularly in the air.... It was the whale....

*Miriam Coffin; or, The Whale Fisherman* (Volume 2)

Chapter X (p. 156)

G. &amp; C. &amp; H. Carvill. New York, New York, USA. 1834

**ANIMAL: MAMMAL: WOLF****Lugosi, Bela** 1882–1956

Hungarian film star

Listen to them. Children of the night. What music they make.

*Dracula*

Film (1931)

**ANIMAL: MAMMAL: YAK****Belloc, Hilaire** 1870–1953

French-born poet and historian

As a friend to the children commend me the Yak.

You will find it exactly the thing:

It will carry and fetch, you can ride on its back,

Or lead it about with a string.

*Complete Verse*

The Yak (p. 236)

Gerald Duckworth. London, England. 1970

**Smith, William Jay** 1918–

American lyric poet

The long-haired Yak has long black hair,

He lets it grow — he doesn't care.

He lets it grow and grow and grow,

He lets it trail along the stair.

Does he ever go to the barbershop? NO!

How wild and woolly and devil-may-care

A long-haired Yak with long black hair

Would look when perched in a barber chair!

*Mr. Smith and Other Nonsense*

Yak

Delacorte Press. New York, New York, USA. 1968

**ANIMAL: MOLLUSK****Pallister, William Hales** 1877–1946

Canadian physician

Next, the MOLLUSCS present forty thousand kinds more,  
With a limited life, but adapted for it;

In the space of the tide, with the sea and the shore

And the sunshine, the Molluscs successfully fit;

Some on land, some in lakes which were seas, they exist

And though tideless for ages, the Molluscs persist.

*Poems of Science*

Beginnings, Animal Life (p. 139)

Playford Press. New York, New York, USA. 1931

**ANIMAL: MOLLUSK: CLAM****Cuppy, Will** 1884–1929

American humorist and critic

Clams lead quiet, uneventful lives for the most part. Buried in the mud and sand between the tide marks, or farther out in the water, they seldom get around much or hear any important news. Clams don't know what it's all about. They have no heads, so they do not bother with that sort of thing.... Clams are very conservative. They voted against having heads in the Ordovician Period and have stuck to it ever since. They never adopt a new idea until it has proven its worth.

*How to Attract the Wombat*

The Clam (p. 112, fn 1)

Rinehart &amp; Company, Inc. New York, New York, USA. 1949

**Nash, Ogden** 1902–71

American writer of humorous poetry

The clam, esteemed by gourmets highly,

Is said to live the life of Riley;

When you are lolling on a piazza

It's what you are as happy as a.

*Verses from 1929 On*

The Clam

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1959

**ANIMAL: MOLLUSK: GIANT SQUID****Bullen, Frank T.** 1857–1915

Writer and lecturer

The imagination can hardly picture a more terrible object than one of these huge monsters brooding in the ocean depths, the gloom of his surroundings increased by the inky fluid (sepia) which he secretes in copious quantities, every cup-shaped disc, of the hundreds with which the restless tentacles are furnished, ready at the slightest touch to grip whatever is near, not only by suction, but by the great claws set all round within its circle. And in the centre of this net-work of living traps is the chasm-like mouth, with its enormous parrot-beak, ready to rend piecemeal whatever is held by the tentaculæ. The very thought of it makes one's flesh crawl.

*The Cruise of the Cachalot*

Chapter XII (p. 101)

Penguin Books. Harmondsworth. Middlesex, England. 1945

**ANIMAL: MOLLUSK: NAUTILUS**

**Wood, Robert William** 1868–1955  
American physicist

The Argo-naut or Nautilus,  
With habits quite adventurous,  
A com-bin-a-tion of a snail,  
A jelly-fish and a paper sail.  
The parts of him that did not jell,  
Are packed securely in his shell.  
It is not strange that when I sought  
To find his double, I found Naught.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*  
Naught. Nautilus (p. 49)  
Dover Publications, Inc. New York, New York, USA. 1959

**ANIMAL: MOLLUSK: OCTOPUS**

**Cuppy, Will** 1884–1929  
American humorist and critic

Octopuses do not develop their minds. They get by and  
that's all they care.

*How to Attract the Wombat*  
The Octopus (fn 2, p. 119)  
Rinehart & Company, Inc. New York, New York, USA. 1949

**Hugo, Victor** 1802–85  
French writer, lyric poet, and dramatist

No grasp is like the sudden strain of the cephaloptera. It  
is with the sucking apparatus that it attacks. The victim  
is oppressed by a vacuum drawing at numberless points:  
it is not a clawing or a biting, but an indescribable scari-  
fication. A tearing of the flesh is terrible, but less terrible  
than a sucking of the blood. Claws are harmless com-  
pared with the horrible action of these natural air-cups.  
The talons of the wild beast enter into your flesh; but with  
the cephaloptera it is you who enters into the creature.

Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
Part II, Book Fourth, Chapter II  
Chapter II (p. 472)  
The Heritage Press. New York, New York, USA. 1961

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Tell me, O Octopus, I begs,  
Is those things arms, or is they legs?  
I marvel at thee, Octopus;  
If I were thou. I'd call me Us.

*Verses from 1929 On*  
The Octopus  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**ANIMAL: MOLLUSK: OYSTER**

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“O Oyster,” said the Carpenter,  
“You’ve had a pleasant run!  
Shall we be trotting home again?”  
But answer came there none —  
And this was scarcely odd, because  
They’d eaten every one.

*The Complete Works of Lewis Carroll*  
Through the Looking-Glass  
Chapter IV (p. 188)  
The Modern Library. New York, New York, USA. 1936

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

I cannot think why the whole bed of the ocean is not one  
solid mass of oysters so prolific the creatures seem.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
The Adventure of the Dying Detective (p. 444)  
Wings Books. New York, New York, USA. 1967

**Twain, Mark (Samuel Langhorne  
Clemens)** 1835–1910  
American writer and humorist

We know all about the habits of the ant, we know all  
about the habits of the bee, but we know nothing at all  
about the habits of the oyster. It seems almost certain that  
we have been choosing the wrong time for studying the  
oyster.

*The Tragedy of Pudd'nhead Wilson*  
Chapter XVI (p. 122)  
New American Library. New York, New York, USA. 1980

**ANIMAL: MOLLUSK: SLUG**

**Deyrup-Olsen, Ingrith** 1919–2004  
American zoologist

Most people think, “Slugs — yuk!” But I think that  
whenever you start to study an organism, you become  
overwhelmed by the beauty and complexity of it. I am  
always amazed and touched by the way these animals  
solve the tremendous problems they have, which are  
always really basically the same as ours. I have come to  
have very strong respect and admiration for them, and  
I’ve also found it’s a wonderful area to involve non-  
scientists in. The minute you begin to show them that  
slugs are very complicated, interesting animals with  
their own needs and demands, people begin to look at  
them with very different eyes. I’m very moved by the  
slug’s ingenuity and tremendous drive to continue liv-  
ing. I think in the end this is what makes me go on, no  
matter how frustrating the experiments happen to be at  
that time.

In Linda Jean Shepherd  
*Lifting the Veil: The Feminine Face of Science*  
Chapter 3 (pp. 69–70)  
Shambhala. Boston, Massachusetts, USA. 1993

**ANIMAL: MOLLUSK: SNAIL**

**Clare, John** 1793–1864  
English poet

There came the snail from his shell peeping out,  
As fearful and cautious as thieves on the rout.

*The Village Minstre, and Other Poems*  
II (p. 32)

Printed for Taylor & Hessey. London, England. 1821

**Cuppy, Will** 1884–1929  
American humorist and critic

What is the main thing about a snail? That's right, the snail is slow. He believes in just taking it easy, and he is so slow at it that one gets all tired out just watching him. Following a snail around for any length of time makes me a total wreck. I don't know why I do it. When a snail wants to go anywhere, he travels on the underside of his physique, twitching himself along by wavelike contractions of the muscles. This is not a satisfactory means of locomotion, if you've ever tried it, and carrying your house on your back at the same time would hardly improve matters. A snail never hurries to an appointment. He is sure that his date will be a day or two late, anyhow, so what's the use?

*How to Attract the Wombat*

The Snail (pp. 115–116)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...the snail, whose tender horns being hit,  
Shrinks backward in his shelly cave with pain,  
And there, all smother'd in shade, doth sit,  
Long after fearing to creep forth again.

*The Complete Works of William Shakespeare*

Venus and Adonis, l. 1033–1036

Oxford University Press. London, England. 1954

**ANIMAL: MOLLUSK: WHELK**

**Wood, Robert William** 1868–1955  
American physicist

...if you listen to the shell,  
In which the Whelk is said to dwell,  
And hear a roar, beyond a doubt  
It indicates the Whelk is out.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*  
The Elk. The Whelk (p. 43)

Dover Publications, Inc. New York, New York, USA. 1959

**ANIMAL: PROTOZOA****ANIMAL: PROTOZOA: AMOEBIA****Author undetermined**

When you were a soft amoeba, in ages past and gone,  
Ere you were Queen of Sheba, or I King Solomon,

Alone and undivided, we lived a life of sloth,  
Whatever you did, I did; one dinner served for both.  
Anon came separation, by fission and divorce,  
A lonely pseudopodium wandered on my course.

In Arnold Silcock

*Verse and Worse*

Evolution (pp. 167–168)

Faber & Faber Ltd. London, England. 1952

**Cudmore, Lorraine Lee**

American cell biologist

The amoeba had the architectural ideas of R. Buckminster Fuller before there was anyone around capable of having an idea.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 16)

New York Times Book Company. New York, New York, USA. 1977

An amoeba never is torn apart through indecision, though, for even if two parts of the amoeba are inclined to go in different directions, a choice is always made. We could interpret this a schizophrenia or just confusion, but it could also be a judicious simultaneous sampling of conditions, in order to make a wise choice of future direction.

*The Center of Life: A Natural History of the Cell*

Locomotion (p. 73)

New York Times Book Company. New York, New York, USA. 1977

Ah, the architecture of this world. Amoebas may not have backbones, brains, automobiles, plastic, television, Valium or any other of the blessings of a technologically advanced civilization; but their architecture is two billion years ahead of its time.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (pp. 15–16)

New York Times Book Company. New York, New York, USA. 1977

**Cuppy, Will** 1884–1929

American humorist and critic

Amoebas not only divide, they also blend. When it's all over there is one amoeba where there were two. Amoebas blend apparently because they enjoy blending for its own sake. The amoeba often frequents laboratories. You'll find quite a number of amoebas at Yale, Princeton, and Harvard.

*How to Get from January to December*

March 7 (p. 53)

Henry Holt & Company. New York, New York, USA. 1951

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

Amoeba has her picture in the book,  
Proud Protozoon! — Yet beware of pride,  
All she can do is fatten and divide;  
She cannot even read, or sew, or cook.

*Essays of a Biologist*

Philosophic-Ants (p. 176)

Alfred P. Knopf. New York, New York, USA. 1929

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

The difference between the amoeba and Einstein is that, although both make use of the method of trial and error elimination, the amoeba dislikes erring while Einstein is intrigued by it...

*Objective Knowledge: An Evolutionary Approach*  
Chapter 2 (p. 70)  
Clarendon Press. Oxford, England. 1972

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

A process which led from amoeba to man appeared to the philosophers to be obviously a progress — though whether the amoeba would agree with this opinion is not known.

*Our Knowledge of the External World*  
Lecture I (p. 12)  
The Open Court Publishing Company. Chicago, Illinois. 1914

## ANIMAL: REPTILE

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Reptiles, reptiles, reptiles — flying, swimming, waddling, walking...

*Sketch-Book of Popular Geology*  
Lecture Forth (p. 151)  
William P. Nimmo & Company. Edinburgh, Scotland. 1880

## ANIMAL: REPTILE: ALLIGATOR

**Ackerman, Diane** 1948–  
American writer

Nothing looks more contented than a resting alligator. The mouth falls naturally into a crumpled smile, the eyes half close in a sleepy sort of way...

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*  
Chapter 2 (p. 60)  
Random House, Inc. New York, New York, USA. 1991

## ANIMAL: REPTILE: CROCODILE

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

How cheerfully he seems to grin,  
How neatly spreads his claws,  
And welcomes little fishes in  
With gently smiling jaws!

*The Complete Works of Lewis Carroll*  
Alice's Adventures in Wonderland  
Chapter II (p. 29)  
The Modern Library. New York, New York, USA. 1936

## ANIMAL: REPTILE: LIZARD

**Gardner, John** 1933–82  
American writer and scholar

The Lizard is a timid thing  
That cannot dance or fly or sing;  
He hunts for bugs beneath the floor  
And longs to be a dinosaur.

*A Child's Bestiary*  
The Lizard  
Alfred A. Knopf. New York, New York, USA. 1977

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

A lizard ran out on a rock and looked up, listening no doubt to the sounding of spheres.  
And what a dandy fellow! The right toss of a chin for you  
And swirl of a tail!

If men were as much men as lizards are lizards they'd be worth looking at.

*The Complete Poems of D.H. Lawrence*  
The Lizard  
Viking Press. New York, New York, USA. 1973

## ANIMAL: REPTILE: LIZARD: CHAMELEON

**Wells, Carolyn** 1862–1942  
American writer

The true Chameleon is small,  
A lizard sort of thing;  
He 'asn't any ears at all,  
And not a single wing.

If there is nothing on the tree,  
'Tis the Chameleon you see.

*Baubles*  
How to Tell the Wild Animals  
Dodd, Mead. New York, New York, USA. 1917

## ANIMAL: REPTILE: SNAKE

**Boone, John Allen** 1882–1965  
Author

Even the most dreaded of poisonous snakes is a kindly disposed fellow at heart. He wants to be understood and to understand.

*Kinship with All Life*  
Tail-Rattlings (p. 94)  
Harper & Brothers. New York, New York, USA. 1954

## ANIMAL: REPTILE: SNAKE: ASP

**Flaubert, Gustave** 1821–90  
French novelist

Asp: Animal known through Cleopatra's basket of figs.

*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

## ANIMAL: REPTILE: SNAKE: COBRA

**Nash, Ogden** 1902–71

American writer of humorous poetry

This creature fills its mouth with venom  
And walks upon its duodenum.  
He who attempts to tease the cobra  
Is soon a sadder he, and sobra.

*Verses from 1929 On*

The Cobra

Little, Brown & Company. Boston, Massachusetts, USA. 1959

## ANIMAL: REPTILE: SNAKE: PYTHON

**Nash, Ogden** 1902–71

American writer of humorous poetry

The python has, and I fib no fibs,  
318 pairs of ribs.  
In stating this I place reliance  
On a séance with one who died for science.

This figure is sworn to and attested;  
He counted them while being digested.

*Verses from 1929 On*

The Python

Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Prelutsky, Jack** 1940–

American poet

A puzzled python shook its head and said, “I simply fail  
to tell if I am purely neck, or else entirely tail.”

*A Pizza the Size of the Sun: Poems*

A Puzzled Python

Greenwillow Books. New York, New York, USA. 1996

## ANIMAL: REPTILE: TURTLE

**Rudloe, Jack** 1943–

American nature writer

The timeless turtle will look on as man works feverishly  
to develop destructive nuclear weapons that will blow the  
world apart many times over. And perhaps one day when  
he pops his head up from the sea, he'll see a world empty  
of man, with barnacles growing on the ruins of the cities  
and buildings. And somewhere, perhaps on a Mexican  
beach, a handful of Kemp's ridleys filled with eggs will  
crawl out on the sand, unmolested and free.

*Time of the Turtle*

Chapter 9 (p. 106)

Alfred A. Knopf. New York, New York, USA. 1979

## ANIMAL COMMUNITY

**Elton, Charles S.** 1900–91

English biologist

...the term “animal community” is really a very elastic  
one, since we can use it to describe on the one hand the  
fauna of the equatorial forest and on the other hand the  
fauna of a mouse's caecum.

*Animal Ecology*

Chapter II (p. 17)

Sidgwick & Jackson, Ltd. London, England. 1927

## ANIMALCULA

**van Leeuwenhoek, Antony** 1632–1723

Dutch biology researcher and microscope developer

When these animalcula or living Atoms did move, they  
put forth two little horns, continually moving them-  
selves...

In Clifford Dobell

*Antony van Leeuwenhoek and His “Little Animals”*

Chapter I, Plate XVIII (p. 112)

John Bale, Sons & Danielsson Ltd. London, England. 1932

This was for me, among all the marvels that I have dis-  
covered in nature, the most marvelous of all; and I must  
say, for my part, that no more pleasant sight has ever yet  
come before my eye than these many thousands of living  
creatures, seen all alive in a little drop of water, moving  
among one another, each several creature having its own  
proper motion...

In Clifford Dobell

*Antony van Leeuwenhoek and his “Little Animals”*

Part II, Chapter I (p. 144)

John Bale, Sons & Danielsson Ltd. London, England. 1932

Here Gentlemen, you have the notes I have kept about  
my observations on duckweed and little animalcules:  
in making which I said to myself, How many crea-  
tures are still unknown to us, and how little do we yet  
understand!

In Clifford Dobell

*Antony van Leeuwenhoek and his “Little Animals”*

Part II, Chapter IV (p. 285)

John Bale, Sons & Danielsson Ltd. London, England. 1932

## ANSWER

**Adams, Henry Brooks** 1838–1918

American man of letters

Unintelligible answers to insoluble problems.

In Bert Leston Taylor

*The So-Called Human Race* (p. 154)

Alfred A. Knopf. New York, New York, USA. 1922

**Arnold, John E.** 1913–63

American mechanical engineer

...there is no one right answer to creative problems.

In Sidney J. Parnes and Harold F. Harding

*A Source Book for Creative Thinking*

Useful Creative Techniques (p. 252)

Charles Scribner's Sons. New York, New York, USA. 1962



**Atkins, Peter William** 1940–

English physical chemist and writer

The stern and stony eye of science seeks answers that are not grounded in the fundamentality of purpose.

*New Scientist*

Will Science Ever Fail?

August 8, 1992 (p. 32)

**Bauer, Henry H.** 1931–

American chemist

That science does not have all the answers does not mean that it has no answers. That science now has inadequate answers in some areas does not mean that the answers will not become adequate in the future; in fact, history teaches that science's answers become better and better as time goes by. That science is fallible does not mean that science is entirely fallible or that it is as fallible as such other modes of human knowledge and belief as folklore, religion, political ideology, or social science. That science has no answers in some matters — such as the value of human life or the purpose of living — does not mean that it has no answers in other areas — those areas that are within its purview, matters of forces and substances and natural phenomena. And that science has no direct answers on matters of human purpose does not mean that its answers on other matters have no bearing on how, and how well, we are able to think about human purpose, free will, and other such things.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 144)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

And his answer trickled through my head,  
Like water through a sieve.

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter VIII (p. 243)

The Modern Library. New York, New York, USA. 1936

**Dyson, Freeman J.** 1923–

American physicist and educator

At Cornell, I was simply puzzled and mystified by [Richard] Feynman's stuff. I couldn't figure out how he was getting all those amazing answers which turned out to be right. It was just a great mystery. I didn't understand it and, as far as I could tell, nobody else did.

In Christopher Sykes (ed.)

*No Ordinary Genius: The Illustrated Richard Feynman*

Chapter Three (p. 73)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1994

**Feynman, Richard P.** 1918–88

American theoretical physicist

Quantum Mechanics is the description of the behavior of matter in all its details and, in particular, of the hap-

penings on an atomic scale. Things on a very small scale behave like nothing that we have any direct experience about. They do not behave like waves, they do not behave like particles, they do not behave like clouds, or billiard balls, or weights or springs, or like anything that you have ever seen....

Because atomic behavior is so unlike ordinary experience, it is very difficult to get used to and it appears peculiar and mysterious to everyone, both to the novice and to the experienced physicist.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Quantum Behavior (pp. 116, 117)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Hawking, Stephen William** 1942–

English theoretical physicist

There may be ultimate answers, but if there are, I would be sorry if we were to find them. For my own sake I would like very much to find them, but their discovery would leave nothing for those coming after me to seek. Each generation builds on the advances of the previous generation, and this is as it should be. As human beings, we need the quest.

In J.L. Wilhelm

*Quest*

A Singular Man

*Quest*, April 1979 (p. 39)**Hodnett, Edward** 1901–84

English illustration historian

You have to ask a precise question to get a precise answer.

*The Art of Problem Solving*

Part I, Chapter 5 (p. 37)

Harper &amp; Brothers. New York, New York, USA. 1955

**McKuen, Rod** 1933–

American poet

Think of all the men who never knew the answers think  
of all those who never even cared.

Still there are some who ask why  
who want to know, who dare to try.

*Listen to the Warm*

Here He Comes Again

Random House, Inc. New York, New York, USA. 1967

**Pasteur, Louis** 1822–95

French chemist

Science proceeds by successive answers to questions more and more subtle, coming nearer and nearer to the very essence of phenomena.

In René Dubos

*Louis Pasteur: Free Lance of Science*

Chapter VII (p. 207)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1950

**Rothman, Tony** 1953–  
American cosmologist

You only arrive at the right answer after making all possible mistakes. The mistakes began with the Greeks.

*Instant Physics: From Aristotle to Einstein, and Beyond*  
Prologue (p. 1)  
Ballentine Books. New York, New York, USA. 1995

**Sagan, Carl** 1934–96  
American astronomer and author

We make our world significant by the courage of our questions and by the depth of our answers.

*Cosmos*  
Chapter VII (p. 193)  
Random House, Inc. New York, New York, USA. 1980

I find it more difficult, but also much more fun, to get the right answer by indirect reasoning and before all the evidence is in. It's what a theoretician does in science. But the conclusions drawn in this way are obviously more risky than those drawn by direct measurement, and most scientists withhold judgment until there is more direct evidence available. The principal function of such detective work — apart from entertaining the theoretician — is probably to so annoy and enrage the observationalists that they are forced, in a fury of disbelief, to perform the critical measurements.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 16 (p. 121)  
Dell Publishing, Inc. New York, New York, USA. 1975

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910  
American writer and humorist

I was gratified to be able to answer promptly, and I did. I said I didn't know.

*Life on the Mississippi*  
Chapter VI (p. 49)  
Harper & Row, Publishers. New York, New York, USA. 1951

**Woodson, Thomas T.**

American engineer

...it is safe money to wager that an unproven answer is wrong...

*Introduction to Engineering Design* (p. 240)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

## ANTHROPOMORPHISM

**Ardrey, Robert** 1908–80  
American anthropologist

There are times when anthropomorphisms are almost irresistible to even the most rigorous scientists. As unlikely victims as Niko Tinbergen and David Lack have found the word "righteous" inescapable when describing

the behavior of a territorial proprietor threatened by an intruder.

*The Social Contract: A Personal Inquiry into the Evolutionary Sources of Order and Disorder*  
The Alpha Fish (p. 135)  
Atheneum. New York, New York, USA. 1970

## ANTHROPIC PRINCIPLE

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

We are situated in a vast universe and are products of it. We cannot detach ourselves from it and say, "we do not want the rest of the universe; the stars are no good to us; so long as we have our sun all the rest may go." The universe is a mighty organism; its whole aspect and structure assure us of the fact. We are a portion of it, and owe our position, our surroundings, our very existence to it. Looking at it as an evolutionist, I believe that it is only by tracing it back to some necessary earlier state that we shall be able to form some rational conception of how it has evolved, how it has come to be what it is, how we have come to be where we are. Then, and then only, shall we be able to give any probable answer to the question, What advantages have we derived from our nearly central position?

*The Independent (New York)*  
Volume 55, 1903 (p. 2030)

## ANTHROPOLOGIST

**Grindal, Bruce** 1940–  
American anthropologist

**Salamone, Frank**  
Anthropologist

The dilemma for social scientists is how to apply the precision of science to the ambiguity of human relationships. The particular problem for anthropologists is how to do this among people who live in social worlds created by different assumptions about reality. It is no doubt a comment on the human condition (or nature, if you will) that this cultural abyss is regularly bridged. Scientists and native, self and Other, subject and object become friends, sometimes more.

*Bridges to Humanity: Narrative on Anthropology and Friendship*  
Remembering Cinita (p. 115)  
Waveland Press, Inc. Prospect Heights, Illinois, USA.

The relationship between the anthropologist and a fellow human being in the field is many times problematic, involving contradictory feelings and the mutual and painful exchange of personhood and value. The anthropologist's understanding of that friendship is often not realized at the time but must await a later-life maturity that awakens the deeper revelations of a life lived.

*Bridges to Humanity: Narrative on Anthropology and Friendship*  
Immortality Denied (p. 63)  
Waveland Press, Inc. Prospect Heights, Illinois, USA.

Anthropologists working in the United States must deal with a society with many different faces and voices, despite its overall familiarity. They must confront the challenge of being strangers in need of friends to guide them through the maze of assumptions that shape life just around the corner.

*Bridges to Humanity: Narrative on Anthropology and Friendship*  
Eutaw Jack (p. 7)  
Waveland Press, Inc. Prospect Heights, Illinois, USA.

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

My dentist, patching up a tooth, warned me that I must understand, of course, that this was only temporary, and he seemed startled when I replied that so, after all, was life itself. What should so temporary a creature as I want with a really permanent set of teeth? They might possibly be of interest to some future anthropologist, but I can have no need for them.

*The Twelve Seasons*  
June (p. 43)  
W. Sloane Associates. New York, New York, USA. 1949

## ANTHROPOLOGY

### Author undetermined

Unfortunately, the vast majority of artists' conceptions are based more on imagination, than evidence.... Much of the reconstruction, however, is guesswork. Bones say nothing about the fleshy parts of the nose, lips, or ears. Artists must create something between an ape and a human being: the older a specimen is said to be, the more ape-like they make it.... Hairiness is a matter of pure conjecture. The guesswork approach often leads to errors.

Anthropological Art  
*Science Digest*, Volume 89, Number 3, April, 1981 (p. 44)

**Barley, Nigel** 1947–  
English anthropologist

Anthropology is not short of facts but simply of anything intelligent to do with them. The notion of "butterfly collecting" is familiar within the discipline and serves to characterize the endeavors of many ethnographers and failed interpreters, who simply amass neat examples of curious customs arranged by area, or alphabetically, or by evolutionary order, whatever the current style may be.

*The Innocent Anthropologist: Notes from a Mud Hut*  
Chapter 1 (pp. 9–10)  
British Museum Publications. London, England. 1983

**Boas, Franz** 1858–1942  
German-born American anthropologist

Anthropology is often considered a collection of curious facts, telling about the peculiar appearance of exotic people and describing their strange customs and beliefs. It is looked upon to an entertaining diversion, apparently without any bearing upon the conduct of life of civilized communities. This opinion is mistaken. More than that, I hope to demonstrate that a clear understanding of the principles of anthropology illuminates the social process of our own times and may show us, if we are ready to listen to its teachings, what to do and what to avoid.

*Anthropology and Modern Life*  
Chapter 1 (p. 11)  
W.W. Norton & Company, Inc. New York, New York, USA. 1928

**Diamond, Stanley** 1922–

Anthropology, abstractly conceived as the study of man, is actually the study of men in crisis by men in crisis.

*In Search of the Primitive: A Critique of Civilization*  
Chapter 3 (p. 93)  
Transaction Books. New Brunswick, New Jersey, USA. 1974

**Flannery, Kent V.** 1932–  
American environmental archaeologist

Archaeology is the only branch of anthropology where we kill our informants in the process of studying them.

The Golden Marshalltown: A Parable for the Archaeology of the 1980s  
*American Anthropologist*, Volume 84, 1982

**Geertz, Clifford** 1926–  
American anthropologist

There is not much assurance or sense of closure, not even much sense of knowing what it is one precisely is after, in so indefinite a quest, amid such various people, over such a diversity of times. But it is an excellent way, interesting, dismaying, useful, and amusing, to expend a life.

*After the Fact: Two Countries, Four Decades, One Anthropologist*  
Chapter 6 (p. 168)  
Harvard University Press. Cambridge, Massachusetts, USA. 1995

**Herskovits, Melville Jean** 1895–1963  
American anthropologist

No branch of anthropology requires more inference, or the weighing of imponderables; in short, the exercise of the scientific imagination, than prehistory.

*Man and His Works*  
Chapter 7 (p. 97)  
Alfred A. Knopf. New York, New York, USA. 1949

**Huxley, Thomas Henry** 1825–95  
English biologist

Reckoned by centuries, the remoteness of the quaternary, or pleistocene, age from our own is immense, and it is difficult to form an adequate notion of its duration. Undoubtedly there is an abysmal difference between the Neanderthaloid race and the comely living specimens

of the blond long heads with whom we are familiar. But the abyss of time between the period at which North Europe was first covered with ice, when savages pursued mammoths and scratched their portraits with sharp stones in central France, and the present day, ever widens as we learn more about the events which bridge it. And, if the differences between the Neanderthaloid men and ourselves could be divided into as many parts as that time contains centuries, the progress from part to part would probably be almost imperceptible.

*Man's Place in Nature and other Anthropological Essays*

Chapter VI (p. 328)

D. Appleton & Company. New York, New York, USA. 1896

### **Kluckhohn, Clyde** 1905–60

American anthropologist

Moreover, the recipe for action that must be drawn from applied anthropology thus far is that of caution, of modest expectations as to what can be accomplished by planning, of humanity as to what may be predicted with present instruments for observing and conceptualizing, of preference for *vis medicaturix naturae* in many social situations.

*Mirror for Man: The Relation of Anthropology to Modern Life*

Chapter X (p. 262)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1949

...anthropology...has explored the gamut of human variability and can best answer the questions: what common ground is there between human beings of all tribes and nations? What differences exist? what is their source? how deep-going are they?

*Mirror for Man: The Relation of Anthropology to Modern Life*

Chapter I (p. 2)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1949

### **Kroeber, Alfred Louis** 1876–1960

American anthropologist

The residue of possible findings is a sort of condensed social history.

*Pacific Historical Review*

An Anthropologist Looks at History, Volume 26, 1957 (p. 281)

### **Leach, Edmund Ronald** 1910–89

English anthropologist

How can a modern social anthropologist...embark upon generalization with any hope of arriving at a satisfying conclusion?...thinking of the organizational ideas that are present in any society as constituting a mathematical pattern.

*Rethinking Anthropology*

Chapter I (p. 2)

The Athlone Press. London, England. 1961

### **Mead, Margaret** 1901–78

American anthropologist

Everything is grist for anthropology's mill.

In Jane Howard

*Margaret Mead: A Life*

Chapter Twenty-One (p. 319)

Simon & Schuster. New York, New York, USA. 1984

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Isolated amidst a nature where everything was a mystery to him, terrified at each unexpected manifestation of incomprehensible forces, he [primitive man] was incapable of seeing in the conduct of the universe anything but caprice...

*The Foundations of Science* (p. 290)

The Science Press. New York, New York, USA. 1913

## ANTIBIOTIC

### **Fleming, Alexander** 1881–1955

Scottish bacteriologist

It seems likely that in the next few years a combination of antibiotics with different antibacterial spectra will furnish a "*cribrum therapeuticum*" from which fewer and fewer infecting bacteria will escape.

*Chemotherapy: Yesterday, Today, and Tomorrow* (p. 36)

Cambridge University Press. Cambridge, England. 1946

## ANTI-MATTER

### **Furth, Harold P.** 1930–2002

Austrian-American physicist

Well beyond the tropostrata

There is a region stark and stellar

Where, on a streak of anti-matter

Lived Dr. Edward Anti-Teller.

Perils of Modern Living

*The New Yorker*, November 10, 1956 (The Talk of the Town, p. 56)

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

I think that this discovery of antimatter was perhaps the biggest jump of all the big jumps in physics in our century. In J. Mehra (ed.)

*The Physicist's Conception of Nature: Symposium on the Development*

*of the Physicist's Conception of Nature in the Twentieth Century*

Chapter 11 (p. 271)

Reidel. Boston, Massachusetts, USA. 1973

### **Schuster, Sir Arthur** 1851–1934

English physicist

Astronomy, the oldest and most juvenile of the sciences, may still have some surprises in store. May anti-matter be commended to its care!

Letter to the Editor, Potential Matter — A Holiday Dream

*Nature*, Volume 58, Number 1503, August 18, 1898 (p. 367)

### **Updike, John** 1932–

American novelist, short story writer, and poet

Think binary. When matter meets antimatter, both vanish, into pure energy. But both existed; I mean, there was a condition we'll call "existence." Think of one and minus one. Together they add up to zero, nothing, nada, niente, right? Picture them together, then picture them separating — peeling apart.... Now you have something, you have two somethings, where you once had nothing.

*Roger's Version*

Chapter V (p. 304)

Alfred A. Knopf. New York, New York, USA. 1986

## ANTIQUITY

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Antiquities, or remnants of history, are, as was said, "*tantquam tabula naufragii*": when industrious persons, by an exact and scrupulous diligence and observation, out of monuments, names, words, proverbs, traditions, private records and evidences, fragments of stories, passages of books that concern not story, and the like, do not save and recover somewhat from the deluge of time.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter II, Section 3 (p. 34)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...antiquities are history defaced, or some remnants of history, which have casually escaped the shipwreck of time.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter II, Section 1 (p. 34)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bury, John Bagnell** 1861–1927

English historian and classical scholar

All the epochs of the past are only a few of the front carriages, and probably the least wonderful, in the van of an interminable procession.

*An Inaugural Lecture*

The Science of History (pp. 28–29)

**Cuvier, Georges** 1769–1832

French zoologist and statesman

As an antiquity of a new order, I have been obliged to learn the art of deciphering and restoring these remains, of discovering and bringing together, in their primitive arrangements, the scattered and mutilated fragments of which they are composed, of reproducing, in all their original proportions and characters, the animals to which these fragments formerly belonged, and then of comparing them with those animals which [are] still on the surface of the earth, an art which is almost unknown, and which presupposes, what had scarcely been obtained before, an acquaintance with those laws which regulate

the coexistence of the forms by which the different parts of organized beings are distinguished.

*An Essay on the Theory of the Earth*

Section 1 (pp. 1–2)

Kirk & Mercein. New York, New York, USA. 1818

**Eiseley, Loren C.** 1907–77

American anthropologist, educator and writer

The door to the past is a strange door. It swings open and things pass through it, but they pass in one direction only. No man can return across that threshold, though he can look down still and see the green light waver in the water weeds.

*The Immense Journey*

The Snout (p. 54)

Vintage Books. New York, New York, USA. 1957

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

How cunningly nature hides every wrinkle of her inconceivable antiquity under roses and violets and morning dews.

Address

Literary Societies of Dartmouth College, 22 July 1863

**Erzinclioglu, Zakaria** 1951–2002

Turkish forensic entomologist

One of the most absurd and persistent misuses of words in science is the use of the word "ancient" to describe species that flourished millions of years ago. The truth is that organisms that lived long ago are "young" relative to those alive today. The animals themselves are not ancient in any sense at all. They died out a long time ago when the Earth was young. Why do we persist in misusing the term in this way.

Ancient Error

*Nature*, Volume 355, Number 6357, January 16, 1992 (p. 195)

**Fuller, Thomas** 1608–61

English clergyman and writer

...the pyramids themselves, dotting with age, have forgotten the names of their founders.

*The Holy and Profane State*

Book III, Chapter XIV, Maxim VI (p. 180)

Printed for Thomas Tegg. London, England. 1841

**Joubert, Joseph** 1754–1824

French moralist

Antiquity! I love your ruins better than your restorations.

Translated by H.P. Collins

*Pensées and Letters of Joseph Joubert*

Chapter XVI (p. 108)

Books for Libraries Press, Freeport, New York, USA. 1972

**Oldfield, E.**

Within no very distant period the study of antiquities has passed, in popular esteem, from contempt to comparative honour.

Introductory Address

*Archaeological Journal*, Volume IX, March 1852 (p. 1)

**Pallister, William Hales** 1877–1946

Canadian physician

The ruined tombs of Egypt tell their tale,  
Survival-hopes of what was once mankind.  
Now sands are drifted deep as we unwind  
The bones of former rulers, now for sale:  
Thus does the splendor of the tomb avail!

*Poems of Science*

Men and the Stars, In Egypt (p. 91)

Playford Press. New York, New York, USA. 1931

**Pope, Alexander** 1688–1744

English poet

With sharpen'd sight pale Antiquaries pore,  
Th' inscription value, but the rust adore.  
This the blue varnish, that the green endears;  
The sacred rust of twice ten hundred years.

*The Complete Poetical Works*

Epistle to Mr. Addison, l. 35

Houghton Mifflin Company. New York, New York, USA. 1903

**Prior, Matthew** 1664–1721

English poet and diplomat

My copper-lamps, at any rate,  
For being true antique, I bought;  
Yet wisely melted down my plate,  
On modern models to be wrought;  
And trifles I alike pursue,  
Because they're old, because they're new.

*The Poetical Works of Matthew Prior*

Alma, Canto III, l. 458–463

Oxford University Press, Inc. New York, New York, USA. 1950

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

True the billiard-tables were of the Old Silurian Period  
and the cues and balls of the Post-Pliocene; but there was  
refreshment in this, not discomfort; for there are rest and  
healing in the contemplation of antiquities.

*Life on the Mississippi*

Chapter XXII (p. 189)

Harper & Row, Publishers. New York, New York, USA. 1951

## ANTI-SCIENCE

**Asimov, Isaac** 1920–92

American author and biochemist

A public that does not understand how science works can,  
all too easily, fall prey to those ignoramus...who make  
fun of what they do not understand, or to the sloganeers  
who proclaim scientists to be the mercenary warriors of  
today, and the tools of the military. The difference...

between...understanding and not understanding...is also  
the difference between respect and admiration on the one  
side, and hate and fear on the other.

In Lewis Wolpert

*The Unnatural Nature of Science*

Introduction (p. ix)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

**France, Anatole (Jean Jacques Brousson)** 1844–1924

French writer

I hate science...for having loved it too much, after the  
manner of voluptuaries who reproach women with not  
having come up to the dream they formed of them.

*The Opinions of Jérôme Coignard* (Volume 2)

Chapter 9 (p. 113)

John Lane. London, England. 1923

**Gissing, George** 1857–1903

English novelist

I hate and fear science because of my conviction that for  
long to come if not for ever, it will be the remorseless enemy  
of mankind. I see it destroying all simplicity and gentleness  
of life, all the beauty of the world; I see it restoring barba-  
rism under a mask of civilization; I see it darkening men's  
minds and hardening their hearts; I see it bringing a time  
of vast conflicts which will pale into insignificance "the  
thousand wars of old" and, as likely as not, will wheel all the  
laborious advances of mankind in blood-drenched chaos.

In Morris Goran

*Science and Anti-Science*

Chapter 3 (p. 23)

Ann Arbor Science Publishers Inc. Ann Arbor, Michigan, USA. 1974

**Green, Celia** 1935–

English philosopher and psychologist

The object of modern science is to make all aspects of  
reality equally boring, so that no one will be tempted to  
think about them.

*The Decline and Fall of Science*

Aphorisms (p. 2)

Hamilton. London, England. 1976

## APOTHECARY

**Colman, George (the Younger)** 1762–1836

English playwright

A man, in a country town, we know,  
Professes openly with death to wrestle;  
Ent'ring the field against the grimly foe,  
Armed with a mortar and a pestle.  
Yet, some affirm, no enemies they are;  
But meet just like prize-fighters, in a fair,  
Who first shake hands before they box,  
Then give each other plaguy knocks,  
With all the love and kindness of a brother:  
So, many a suff'ring patient saith,

Though the Apothecary fights with Death,  
Still they're sworn friends to one another.  
In Helen and Lewis Melville  
*An Anthology of Humorous Verse*  
The Newcastle Apothecary  
Dodd, Mead & Company New York, New York, USA. 1924

**Hazlitt, William Carew** 1834–1913  
English bibliographer

One said an Apothecaries house must needs be healthful,  
because the windows, benches, boxes, and almost all the  
things in the house, tooke physick.  
*Shakespeare Jest Books* (Volume 3)  
Conceit, Clichés, Flashes and Whimzies, Number 41  
Willis & Sotheran. London, England. 1864

**Pope, Alexander** 1688–1744  
English poet

So modern Pothecaries taught the Art  
By Doctor's Bills to play the Doctor's Part,  
Bold in the Practice of mistaken Rules,  
Prescribe, apply, and call their Masters Fools.  
*The Complete Poetical Works*  
An Essay on Criticism, Part I, l. 108–111  
Houghton Mifflin Company. New York, New York, USA. 1903

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

I do remember an apothecary —  
And hereabouts he dwells — which late I noted  
In tatter'd weeds, with overwhelming brows,  
Culling of simples; meager were his looks,  
Sharp misery had worn him to the bones:  
And in his needy shop a tortoise hung,  
An Alligator stuff'd, and other skins  
Of ill-shaped fishes; and about his shelves  
A beggarly account of empty boxes,  
Green earthen pots, bladders and musty seeds,  
Remnants of packthread and old cakes of roses,  
Were thinly scatter'd to make up a show.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
Romeo and Juliet  
Act V, Scene i, l. 37–48  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## APPEARANCE

**Balfour, Arthur James** 1848–1930  
English prime minister

Unless appearances are to be trusted, why should we  
believe in Science? If Science is true, how can we trust  
to appearances?  
In Wilfred M. Short  
*Arthur James Balfour: As Philosopher and Thinker*  
Science; and Science and Theology (p. 449)  
Longmans, Green & Company. New York, New York, USA. 1912

**Leclerc, George-Louis, Comte de Buffon** 1707–88  
French naturalist

There is a strange variety in the appearance of individuals,  
and at the same time a constant resemblance in the whole  
species.  
*Buffon's Natural History* (Volume 5) (pp. 128–129)  
London, England. 1812

## APPLICATION

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

There cannot be a greater mistake than that of looking  
superciliously upon practical applications of science.  
The life and soul of science is its practical application,  
and just as the great advances in mathematics have  
been made through the desire of discovering the solu-  
tion of problems which were of a highly practical kind  
in mathematical science, so in physical science many  
of the greatest advances that have been made from the  
beginning of the world to the present time have been  
made in the earnest desire to turn the knowledge of the  
properties of matter to some purpose useful to man-  
kind.

*Popular Lectures and Addresses* (Volume 1)  
Lecture, Institution of Civil Engineers  
May 3, 1883 (pp. 79–80)  
Macmillan & Company Ltd. London, England. 1894

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

It is no paradox to say that in our most theoretical moods  
we may be nearest to our most practical applications.  
*An Introduction to Mathematics*  
Chapter 7 (p. 71)  
Oxford University Press, Inc. New York, New York, USA. 1958

## APPARATUS

**Davy, Sir Humphry** 1778–1829  
English chemist

The apparatus essential to the modern chemical philoso-  
pher is much less bulky and expensive than that used by  
the ancients. An air pump, an electrical machine, a vol-  
taic battery (all of which may be upon a small scale),  
a blow-pipe apparatus, a bellows and forge, a mercurial  
and water gas apparatus, cups and basins of platinum and  
glass, and the common reagents of chemistry, are what  
are required. All the implements absolutely necessary  
may be carried in a small trunk; and some of the best and  
most refined researches of modern chemists have been  
made by means of an apparatus which might with ease be  
contained in a small traveling carriage, and the expense  
of which is only a few pounds.

*Consolations in Travel, or the Last Days of a Philosopher*  
Dialogue V (p. 250)  
J. Murray. London, England. 1830

## APPROXIMATION

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

We live in a system of approximations. Every end is prospective of some other end, which is also temporary; a round and final success nowhere. We are encamped in nature, not domesticated.

*Ralph Waldo Emerson: Essays and Lectures*  
Essays: Second Series  
Nature (p. 552)  
The Library of America. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

Each piece, or part, of the whole of nature is always merely an approximation to the complete truth, or the complete truth so far as we know it. In fact, everything we know is only some kind of approximation, because we know that we do not know all the laws as yet. Therefore, things must be learned only to be unlearned again or, more likely, to be corrected.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 1–1 (p. 1–1)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Hammer, P. C.**  
No biographical data available

One grievous error in interpreting approximations is to allow only good approximations.

Mind Pollution  
*Cybernetics*, Volume 14, 1971

## ARBITRARY

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

Are the law of acceleration, the rule of the composition of forces only arbitrary conventions? Conventions, yes; arbitrary, no; they would be so if we lost sight of the experiments which led the creators of the science to adopt them, and which, imperfect as they may be, suffice to justify them. It is well that from time to time our attention is carried back to the experimental origin of these conventions.

*The Foundations of Science*  
Science and Hypothesis, Part III

Chapter VI (p. 106)  
The Science Press. New York, New York, USA. 1913

## ARCHAEOASTRONOMY

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

The intellectual activity of mankind during prehistory is a vast almost uncharted ocean.... There have been only about 200 generations of history [but] upwards of 10,000 generations of prehistory.... Among the great throng, it seems to me likely that some must have gazed up at the sky and wondered earnestly about the sun, moon, and the stars. They would have done so with a basic intelligence equal to our own....

*On Stonehenge*  
Chapter 6 (p. 115)  
W.H. Freeman & Company. San Francisco, California, USA. 1977

## ARCHAEOLOGICAL RECORD

**Binford, Lewis R.** 1930–  
American archaeologist

The archaeological record is here with us in the present.  
*In Pursuit of the Past*  
Chapter I (p. 1) University of California Press. Berkeley, California, USA. 2002

## ARCHAEOLOGIST

**Bahn, Paul**  
English archaeologist and writer

Field Archaeologists dig up rubbish,  
Theoretical Archaeologists write it down.  
*Bluff Your Way in Archaeology* (p. 15)  
Ravette Books. West Sussex, England. 1989

**Berryman, John** 1914–72  
American poet and critic

Collating bones: I would have liked to do.  
Henry would have been hot at that.  
I missed his profession.

As a little boy I always thought  
“I’m an archaeologist”; who  
Could be more respected peaceful serious than that?

*77 Dream Songs*  
No. 30 (p. 30)  
Farrar, Straus & Giroux. New York, New York, USA. 1964

**Crawford, Osbert Guy Stanhope** 1886–1957  
English archaeologist

The archaeologist has work to do for the good of the race; he is making bricks for the mansions that others build after him shall build. That is his justification for devoting



a lifetime to “unpractical” pursuits. He may be wrong, but you will not lightly convince him of his error.

*Man and His Past*

Chapter II (p. 37)

Oxford University Press, Inc. London, England. 1921

It is to the archaeologist that one must look for the completion of the outline the historian has sketched.

*Man and His Past*

Chapter III (p. 42)

Oxford University Press, Inc. London, England. 1921

**Daniel, Glyn** 1914–86

Archaeologist and writer

We are all historians, we are all studying the past of man, whether we concentrate on Walpole, Beowulf, Stonehenge or Lascaux. Manuscripta, microliths, megaliths — it is all one. The past is the goal of the historian whether he is text abided or not...there are historians, in the strict sense of the word, who are frightened when they see archaeologists advancing toward them with dirt on their boots and a brief case full of air photographs and Carbon 14 dates. Dugdale, Aubrey, Lhwyd and Stukeley did not think they were other than historians, and for that matter, historians who could be members of the Royal Society. We have taken the distinction between a history that is mainly derived from material sources and one that is derived from the aid of texts, too far.

*Antiquity*

Editorial

*Antiquity*, Volume 41, 1967 (p. 170)

**Day, David Howard**

American anthropologist, educator, and writer

The past, at whatever level and at whatever time, has lost none of its power to inspire. Archaeologists, whether on screen or off, hold a key to that treasure box.

*A Treasure Hard to Attain: Images of Archaeology in Popular Film*

Part I, Chapter Nine (p. 44)

Scarecrow Press. Lanham, Maryland. 1997

**Dillehay, Thomas D.**

American anthropologist, educator, and writer

Archaeologists are, by necessity, masters of inference. From the meanest, most innocuous of things-discarded oyster shells, broken pots, the subtle bands of color and texture in an excavation wall—we try to re-create an entire world and its inhabitants.

The Battle of Mount Verde

*The Sciences*, Volume 37, Number 1, Jan/Feb 1997 (p. 29)

**Dr. Watson**

Fictional character

Archaeologists. They might have been dug up themselves.

*Pursuit to Algiers*

Film (1945)

**Durrell, Lawrence** 1912–90

English writer

Like earnest mastodons petrified in the forest of their own apparatus the archaeologists come and go, each with his pocket Odyssey and his lack of modern Greek. Diligently working upon the refuse-heaps of some township for a number of years they erect on the basis of a few sherds or a piece of dramatic drainage, a sickly and enfeebled portrait of a way of life. How true it is we cannot say: but if an Eskimo were asked to describe our way of life, deducing all his evidence from a search in a contemporary refuse dump, his picture might lack certain formidable essentials.

*Prospero's Cell and Reflections on a Marine Venus*

Prospero's Cell, Chapter V (p. 59)

E.P. Dutton & Company, Inc. New York, New York, USA. 1960

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and writer

The archaeologist, it is said, is a student of the artifact. That harsh, unlovely word, as sharply angled as a fist ax or a brick, denudes us of human sympathy. In the eye of the public we loom, I suppose, as slightly befuddled graybeards scavenging in grave heaps. We caw like crows over a bit of jade or a broken potsherd: we are eternally associated in the public mind with sharp-edged flints and broken statues. The utter uselessness of the past is somehow magnificently incorporated into our activities.

*The Night Country*

Chapter 6 (pp. 80–81)

Charles Scribner's Sons. New York, New York, USA. 1971

**Fagan, Brian**

English archaeologist

To archaeologists, the human past is owned by no one. It represents the cultural heritage of everyone who has ever lived on Earth or will live on it in the future. Archaeology puts all human societies on an equal footing.

*The Oxford Companion to Archaeology*

Introduction

Oxford University Press, Inc. New York, New York, USA. 1996

**Hawkes, Jacquetta** 1910–96

English archaeologist, historian, and writer

**Hawkes, Christopher** 1905–92

English archaeologist

[The archaeologist] handles the actual things which helped men to pass their lives: the pots from which they ate and drank, the weapons with which they hunted or killed one another, their houses, their hearthstones and their graves. Such material keeps him much closer to the essentials of history. He must be concerned with the lives and achievements of countless ordinary, anonymous people.

*Prehistoric Britain*

Forward (p. 9)

Penguin Books. London, England. 1958

**Ogutsch, Edith**

Fantasy poet

ARCHAEOLOGIST: Someone whose career lies in ruins.

*Quote, the Weekly Digest*, January 29, 1967 (p. 97)**Salmon, Merrilee H.** 1935–

American archaeologist

Surely skill in doubting the familiar and imagining the unfamiliar are every bit as important to the archaeologist as to the philosopher.

*Philosophy and Archaeology*

Concluding Remarks (p. 182)

Academic Press. New York, New York, USA. 1982

**Schrire, Carmel**

South African archaeologist

I became an archaeologist because I wanted to drive around in a big Landrover; smoking, cursing and finding treasure.

*Digging Through Darkness: Chronicles of an Archaeologist* (p. 71)

University Press of Virginia. Charlottesville, Virginia, USA. 1995

**Spaulding, Albert C.** 1914–90

American archaeologist

...truth is to be determined by some sort of polling of archaeologists, that productivity is doing what other archaeologists do, and that the only purpose of archaeology is to make archaeologists happy.

Review of James A. Ford

"Measurements of Some Prehistoric Design Developments in the Southeastern States"

*American Anthropologist*, Volume 55, Number 4, 1953 (p. 590)**Steve Banning**

Fictional character

...many people believe that we archaeologists are just a collection of old fogeys digging around in ruins after old dried up skulls and bones...

*The Mummy's Tomb*

Film (1942)

**Taylor, Walter W.** 1913–97

American archaeologist

Archeology *per se* is no more than a method and a set of specialized techniques for the gathering of cultural information. The archeologist, as archeologist, is really nothing but a technician.

*A Study of Archeology*

Part I, Chapter 2 (p. 41)

Southern Illinois University Press, Carbondale, Illinois, USA. 1967

**Weigall, Arthur Edward** 1880–1934

Egyptologist and writer

Dead men are not useless; and the excavator must not cheat the world of any part of its great prerequisite. The dead are the property of the living, and the archaeologist is the world's agent for the estate of the grave.

*The Glory of the Pharaohs*

Chapter V (p. 98)

G. Putnam's Sons. New York, New York, USA. 1923

The true archaeologist does not take pleasure in skeletons as skeletons, for his whole effort is to cover them decently with flesh and skin once more and to put some thoughts back into the empty skulls.

*The Glory of the Pharaohs*

Chapter II (p. 32)

G. Putnam's Sons. New York, New York, USA. 1923

An archaeologist must be a historian. He must conjure up the past; he must play the Witch of Endor. His lists and indices, his catalogues and notebooks, must be but the spells which he uses to invoke the dead.

*The Glory of the Pharaohs*

Chapter I (p. 19)

G. Putnam's Sons. New York, New York, USA. 1923

It is an unfortunate fact that the archaeologist is generally considered to be a kind of rag-and-bone man; one who, sitting all his life in a dusty room, shuns the touch of the wind and takes no pleasure in the vanities under the sun. Actually, this is not so very often a true description of him. The ease with which long journeys are now undertaken, the immunity from insult or peril which the traveler usually enjoys, have made it possible for the archaeologist to seek his information at its source in almost all the countries of the world.

*The Glory of the Pharaohs*

Chapter I (p. 3)

G. Putnam's Sons. New York, New York, USA. 1923

**Wheeler, Sir Mortimer** 1890–1976

English archaeologist

...the archaeologist is digging up, not things, but people.

*Archaeology from the Earth*

Preface (p. v)

At The Clarendon Press. Oxford, England. 1954

A lepidopterist is a great deal more than a butterfly-catcher, and an archaeologist who is not more than a pot-herd-catcher is unworthy of his logos. He is primarily a fact-finder, but his facts are the material records of human achievement; he is also, by the token, a humanist, and his secondary task is that of revivifying or humanizing his materials with a controlled imagination that inevitable partakes of the qualities of art and even philosophy.

*Archaeology from the Earth* (pp. 228–229)

At The Clarendon Press. Oxford, England. 1954

**Wiley, Gordon R.** 1913–2002

American archaeologist and writer

**Sabloff, Jeremy**

American museum director

Any attempt on the part of the archaeologist to contribute to the larger problems of cultural understanding was met with an astonishment like that in the classic case of the “talking dog”; it was not what the dog said that was so amazing but the fact that he could do it at all.

*A History of American Archaeology*

Chapter Five (p. 131)

W.H. Freeman & Company. San Francisco, California, USA. No date

**Wilson, J. A.**

No biographical data available

It is necessary that we [archaeologists] attempt to attain a measure of exactness in a study which deals so largely with the unknown and the shifting and the absent.

Archaeology as a Tool in Humanistic and Social Studies

*Journal of Near Eastern Studies*, Volume 1, 1942 (p. 4)

**Wissler, C.** 1870–1947

American archaeologist

So, in short, the real equipment of an archaeologist is a scientific mind.

The New Archaeology

*American Museum Journal*, Volume 17, 1917 (p. 101)

**Zevi, Bruno** 1918–2001

Italian architectural historian and writer

The most incredible thing is to find archaeologists dedicating their lives to the structural features of monuments who depreciate any critical contribution and exult over the discovery of the slightest technical detail, and who, at the same time, are reactionaries with respect to modern architecture.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter V (p. 186)

Horizon Press. New York, New York, USA. 1957

**ARCHAEOLOGY****Albright, William Foxwell** 1891–1971

American archaeologist and educator

There can be no doubt that archaeology has confirmed the substantial historicity of Old Testament tradition. Divergences from basic historical fact may nearly all be explained as due to the nature of oral tradition, to the vicissitudes of written transmission, and to honest, but erroneous combinations on the part of Israelite and Jewish scholars.

*Archaeology and the Religion of Israel*

Postscript (p. 176)

The Johns Hopkins Press, Baltimore, Maryland, USA; 1968

**Atkinson, Richard John Copeland** 1920–94

American archaeologist

Foremost among these [qualities for archaeological field work] is the power to observe, and, moreover, to observe critically, to be able to distinguish the important from the trivial. Next comes the ability to record what is observed accurately and neatly and objectively: there is no place in archaeology, any more than in other sciences, for intellectual partiality in the choice of facts. Finally, the archaeologist needs both a broad and a scientific outlook: broad to understand his work not as a subject contained in itself, but just one aspect of the wider study of man; and scientific to realize clearly the purpose and limitations of his methods, and meaning and value of his evidence.

*Field Archaeology*

Introduction (pp. 13–14)

Methuen & Company Ltd. London, England. 1946

**Bahn, Paul**

English archaeologist

As Champollion said, archaeology is a beautiful mistress but she brings a poor dowry.

*Bluff Your Way in Archaeology* (p. 9)

Ravette Books. West Sussex, England. 1989

Archaeology is rather like a vast, fiendish jigsaw puzzle invented by the devil as an instrument of tantalizing torment, since:

- (a) it will never be finished
- (b) you don't know how many pieces are missing
- (c) most of them are lost forever
- (d) you can't cheat by looking at the picture.

*Bluff Your Way in Archaeology* (p. 5)

Ravette Books. West Sussex, England. 1989

**Bailey, Geoff**

English archaeologist

...archaeological study is condemned to apply concepts and theories derived from elsewhere rather than to formulate its own, and is thus reduced to an appendix — at best entertaining, at worst dispensable.

In G. Bailey and A. Sheridan (eds.)

*Economic Archaeology: Toward an Integration of Ecological and Social Approaches*

Chapter 9 (p. 104)

B.A.R. Oxford, England. 1981

**Ballard, Chris** 1963–

Australian historian

The search for unifying narratives, for a single logic that might underpin archaeological explanation universally, is a misplaced venture. Rather than grading different narratives for some form of absolute truth content, we should be asking which alternative we find the most useful relative to the immediate question at hand. One law to be left in cleaning out the legislative cupboard must be the defense against...the notion that

there is a single truth, a single narrative, a single past out there to be found, and that there is but one way of telling it.

Writing (Pre)history: Narrative and Archaeological Explanation in the New Guinea Highlands

*Archaeology in Oceania*, Volume 38, 2003

**Bishop, Jim** 1907–87

American newspaper columnist and historian

Archaeology sounds like dull sport in five syllables. It isn't. It's the Peeping Tom of the sciences. It is the sandbox of men who care not where they are going: they merely want to know where everyone else has been.

Sifting the Sea for Time's Treasures

*NY Journal-American*, 14 March 1961

**Clark, David** 1937–76

English analytical archaeologist

[Archaeology is] the discipline with the theory and practice for the recovery of unobservable hominid behavior patterns from indirect traces in bad samples.

*American Antiquity*, Volume 47, 1973 (p. 100)

**Cornwall, I. W.** 1909–94

British archaeologist

If archaeology itself is popularly regarded as a dry-as-dust study, that of fossil and sub-fossil bones may well seem, in the eyes of the general public, to be the quintessence of dryness and dustiness, the preserve of imaginary bearded professors and museum curators.

*Bones for the Archaeologist*

Introduction (p. 19)

The Macmillan Company. New York, New York, USA. 1956

**Crawford, Osbert Guy Stanhope** 1886–1957

English archaeologist

Archaeology is an art which employs scientific technique.

In Sir Mortimer Wheeler

*Archaeology from the Earth*

Chapter XVII (pp. 201–202)

At The Clarendon Press. Oxford, England. 1954

**Deuel, Leo**

No biographical data available

By nature and purpose — and almost by definition — archaeology belongs to the ground. Down on their knees, shoveling dirt, raising clouds of dust, burrowing into layers of soil, cutting trenches, tunneling warrens through man-made mounds, opening tombs, and divesting the dead of their travel goods to the nether world — amateurs and professionals have toiled for generations to wrest buried relics from lost civilizations.

*Flights into Yesterday: The Story of Aerial Archaeology*

Chapter 1 (p. 3)

St. Martin's Press. New York, New York, USA. 1969

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and writer

Archaeology is the science of man's evening, not of his midday triumphs.

*The Unexpected Universe*

Chapter 2, Section 4 (p. 39)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

A man who has once looked with the archaeological eye will never see quite normally. He will be wounded by what other men call trifles. It is possible to refine the sense of time until an old show in the bunch of grass or a pile of nineteenth-century beer bottles in an abandoned mining town tolls in one's head like a hall clock. This is the price one pays for learning to read time from surfaces other than an illuminated dial. It is the melancholy secret of the artifact, the humanly touched thing.

*The Night Country*

Chapter 6 (p. 81)

Charles Scribner's Sons. New York, New York, USA. 1971

**Flannery, Kent V.** 1932–

American environmental archaeologist

Is it too late for salvation? If not, please let me have the analytical expertise of the New Archaeology — and the humility and common sense of the Old.

*The Early Mesoamerican Village*

Chapter 12 (p. 373)

Academic Press. New York, New York, USA. 1976

**Fowler, Peter J.**

No biographical data available

Archaeology in particular has an escapist value offering the chance of academic retreat into the study of times and things past and of intellectual withdrawal similar to the absorbing unrealities of detective fiction and cross-word puzzles.

*Approaches to Archaeology*

Chapter 1 (p. 32)

St. Martin's Press. New York, New York, USA. 1977

**Glob, Peter Vilhelm** 1911–85

Danish archaeologist

The ground is like a beautiful woman. If you treat her gently, she'll tell you all her secrets.

*Washington Post*, 18 December 1991

**Gordon, Alexander** 1793–1826

Scottish explorer

Seeing Reason and Knowledge are the Characteristicks which distinguish Mankind from the more ignoble Part of the Animal Creation, those Studies, which are the most improving, deserve our greatest application: In the number of which, Antiquity claims a great share, particularly Archeology, which consists of Monuments, or rather Inscriptions, still subsisting...

*Itinerarium Septentrionale; or, A Journey Thro' Most of the Counties and Those in the North of England*

Preface

Printed for the writer. London, England. 1726

### Hester, Thomas R.

American anthropologist

### Heizer, Robert F. 1915–79

American archaeologist and anthropologist

It is obvious that there is more to archaeology than finding bones and tools once used by the former inhabitants of an area. If the collecting of artifacts, the thrill of discovery, and the satisfying of curiosity were the primary objectives of excavation, then the archaeologist would be no better than the “pot hunter” or vandal who collects for personal gain or private pleasure.

*Field Methods in Archaeology*

Introduction (p. 3)

Mayfield Publishing Company. Palo Alto, California, USA. 1975

### Indiana Jones

Fictional character

Archaeology is the search for fact. Not truth. If it's truth you're interested in, Doctor Tyree's Philosophy class is right down the hall. So forget any idea's you've got about lost cities, exotic travels and digging up the world. We do not follow maps to buried treasure and “X” never, ever, marks the spot. Seventy percent of all archaeology is done in the library.

*Indiana Jones and the Last Crusade*

Film (1989)

...one of the great dangers of archaeology [is]...not to life and limb, although that does sometimes take place... [but] folklore.

*Raiders of the Lost Ark*

Film (1981)

### Isaac, Gyan Llwilyn 1937–85

South African archaeologist

Archaeological studies are at their most significant when they attempt to elucidate the development of relations both amongst men, and between man and the material world.... Prehistoric archaeology is thus in its total aims not a natural science, a social science or a branch of the humanities; rather it is a distinctive pursuit in which all of these meet.

Whither Archaeology?

*Antiquity*, Volume 45, Number 178, June 1971 (p. 125)

### Johnson, Matthew

No biographical data available

Archaeology can be very boring, distressing and physically uncomfortable. Every year we excavate thousands of sites, some with painstaking and mind-numbing patience, some in a great and undignified hurry. Every

year we get chilled to the marrow or bitten half to death by mosquitoes while visiting some unprepossessing, grassy mound in the middle of nowhere. Miles from a decent restaurant or even a warm bath, we try to look interested while the rain comes down in sheets and some great professor whose best work was twenty years ago witters on in a monotone about what was found in Trench 4B. Every year we churn out thousands of interminable, stultifying dull site reports, fretting over the accuracy of plans and diagrams, collating lists of grubby artifacts to go to microfiche that few will ever consult or use again.

*Archaeological Theory: An Introduction*

Chapter 1 (p. 1)

Blackwell Publishers. Oxford, England. 1999

### Kehoe, Alice Beck

American anthropologist

American archaeology is ready to be a mature science, one that accepts the primacy of its empirical data — for these can outlast theories — and the political and human ramifications of its actions, as it reflectively constructs and compares interpretations. Tolerance for ambiguity is as essential as the Marshalltown trowel.

*The Land of Prehistory: A Critical History of American Archaeology*

Chapter 12 (p. 230)

Routledge. New York, New York, USA. 1998

### Leakey, Mary 1913–96

English archaeologist

Archaeologists often divide things into three stages, usually ‘lower’, ‘middle’ and ‘upper’ if they are thinking stratigraphically. Afterwards, of course, they argue that the whole thing was continuous anyhow and that the divisions are arbitrary and for convenience only.

*Disclosing the Past: An Autobiography*

By way of prelude (p. 13)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

### Murray, Margaret 1863–1963

Anthropologist, archaeologist, and Egyptologist

The trend of all knowledge at the present is to specialize, but archaeology has in it all the qualities that call for the wide view of the human race, or its growth from the savage to the civilized, which is seen in all stages of social and religious developments. Archaeology is the study of humanity itself, and unless that attitude toward the subject is kept in mind archaeology will be overwhelmed by impossible theories or a welter of flint chips.

First Steps in Archaeology

*Antiquity*, Volume 35, 1961 (p. 13)

### Paglia, Camille 1947–

American social critic, intellectual, and writer

Archaeology is our voyage to the past, where we discover who we were and therefore who we are.

Mummy Dearest: Archaeology Is Unfairly Maligned by Trendy Academics  
*Wall Street Journal*, September 30, 1999 (p. A–26)

### Sir Joseph

Fictional character

Much more is learned from bits of broken pottery than from all the sensational finds. Our job is to increase the sum of human knowledge of the past, not to satisfy our curiosity.

*The Mummy*  
Film (1940)

### Spaulding, Albert C. 1914–1990

American anthropologist

Archaeology can be defined minimally as the study of interrelationships of forms, temporal locus, and spatial locus exhibited by artifacts. In other words, archaeologists are always concerned with these interrelationships, whatever broader interests they may have, and these interrelationships are the special business of archaeology.

In Gertrude E. Dole and Robert L. Carneiro (eds.)

*Essays in the Science of Culture: In Honor of Leslie A. White*

The Dimension of Archaeology (p. 439)

Thomas Y. Crowell. New York, New York, USA. 1960

### Taylor, Walter W. 1913–97

American archaeologist

Archaeology is neither history nor anthropology. As an autonomous discipline, it consists of a method and a set of specialized techniques for the gathering or “production” of cultural information.

A Study of Archaeology, Memoir Number 69, Part 2

*American Anthropologist*, Volume 50, Number 3, 1948 (p. 44)

### Weigall, Arthur Edward 1880–1934

Egyptologist and writer

Nothing is more paralyzing to a student of archaeology than continuous book-work. A collection of facts is an extremely beneficial mental exercise, but the deductions drawn from such a collection should be regarded as an integral part of the work.

*The Glory of the Pharaohs*

Chapter I (p. 18)

G. Putnam’s Sons. New York, New York, USA. 1923

Archaeology is too often considered to be the pursuit of weak-chested youths and eccentric old men; it is seldom regarded as a possible vocation for normal persons of sound health and balanced mind.

*The Glory of the Pharaohs*

Chapter I (p. 8)

G. Putnam’s Sons. New York, New York, USA. 1923

Archaeology...is a science which bars its doors to all but the most erudite; for, to the layman who has not been

vouchsafed the opportunity of studying the dusty volumes of the learned, the bones of the dead will not reveal their secrets, nor will the crumbling pediments of naos and cenotaph, the obliterated tombstones, or the worm-eaten parchments, tell us their story.

*The Glory of the Pharaohs*

Chapter II (p. 31)

G.P. Putnam’s Sons. New York, New York, USA. 1923

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

Out of the litter of muds and gravels that makes the soil of the world we have picked some traces of the past of our race and the past of life. In our observatories and laboratories we have gleaned some hints of its future. We have a vision of the opening of the story, but the first pages we cannot read.

*The Undying Fire*

Chapter the Fourth, Section 1 (pp. 106–107)

The Macmillan Company. New York, New York, USA. 1919

### Wheeler, Sir Mortimer 1890–1976

English archaeologist

...archaeology is a science that must be lived, must be “seasoned with humanity”. Dead archaeology is the driest dust that blows.

*Archaeology from the Earth*

Preface (p. v)

At The Clarendon Press. Oxford, England. 1954

Archaeology is not a science, it’s a vendetta.

In Peter Hopkirk

*Foreign Devils on the Silk Road: The Search for the Lost Treasures of Central Asia*

Chapter 12 (p. 170)

Murray. London, England. 1980

### Wilde, Oscar 1854–1900

Irish wit, poet, and dramatist

I can understand archaeology being attacked on the ground of its excessive realism, but to attack it as pedantic seems to be very much beside the mark. However, to attack it for any reason is foolish; one might just as well speak disrespectfully of the equator.

*Intentions*

The Truth of Masks (p. 242)

Thomas B. Mosher. Portland, Maine, USA. 1904

### Wiley, Gordon R. 1913–2002

American archaeologist and writer

### Phillips, Philip 1900–94

American archaeologist

American Archaeology is anthropology or it is nothing.

*Method and Theory in American Archaeology*

Introduction (p. 2)

The University of Chicago Press. Chicago, Illinois, USA. 1958

## ARCHITECT

**Carr-Saunders, Sir A. M. (Alexander****Morris)**, 1886–1966

English sociologist

**Wilson, Paul A.** 1903–

No biographical data available

The architect therefore is not only a professional man but also an artist, and he shares in some measure both the problems and the qualities of temperament commonly associated with artists. Thus he lives in a world which is dominated by fashion and split up into cliques and coteries, and he brings to the consideration of professional business something of the outlook which characterizes his interest in the subject-matter of his art.

*The Professions*

Architects (p. 184)

Frank Cass &amp; Company Ltd. London, England. 1964

**Cowper, William** 1731–1800

English poet

But 'tis not timber, lead and stone,  
An architect requires alone,  
To finish a fine building —  
The palace were but half complete,  
If he could possibly forget  
The carving and the gilding.

*The Poetical Works of William Cowper*

Friendship (pp. 163–168)

John W. Lovell Company. New York, New York, USA. No date

**de Bergerac, Cyrano** 1619–55

French satirist and dramatist

The Architector that built my Prison, having made my  
Entries into it, did not bethink himself of making one  
Outlet.

*The Comical History of the States and Empires of the Worlds of the  
Moon and Sun* (pp. 25–26)

Printed for Henry Rhodes. London, England. 1687

**Esar, Evan** 1899–1995

American humorist

The architect makes an old house look better just by  
talking about the cost of a new one.

*20,000 Quips and Quotes* (p. 40)

Doubleday. Garden City, New York, USA. 1968

The architect who always talks shop is probably suffering  
from an edifice complex.

*20,000 Quips and Quotes* (p. 40)

Doubleday. Garden City, New York, USA. 1968

**Keate, George** 1729–97

When Troy was built, you recollect  
I dabbled as an Architect;

A very sorry one, you'll say,  
But worse since then have come in play,  
And of the art I've understood  
Enough, to do more harm than good...

*The Distressed Poet*

Canto the Second, l. 332

Printed for J. Dodsley. London, England. 1787

**Le Corbusier (Charles-Edouard****Jeanneret)** 1887–1965

Swiss architect and city planner

The Architect, by his arrangement of forms, realizes an order which is a pure creation of his spirit; by forms and shapes he affects our senses to an acute degree and provokes plastic emotions; by the relationships which he creates he wakes profound echoes in us, he gives us the measure of an order which we feel to be in accordance with that of our world, he determines the various movements of our heart and of our understanding; it is then that we experience beauty.

Translated by Frederick Etchells

*Towards a New Architecture*

Argument (p. 7)

The Architectural Press. London, England. 1965

**Longfellow, Henry Wadsworth** 1807–82

American poet

...The architect  
Built his great heart into these sculptured stones,  
And with him toiled his children, and their lives  
Were builded, with his own, into the walls,  
As offerings unto God.

*The Poetical Works of Henry Wadsworth Longfellow*

Christus: A Mystery

The Golden Legend, In the Cathedral (p. 431)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Mangan, James Clarence** 1803–49

Irish poet

“Architect! my handsome country villa  
Yesterday took fire, and naught could save it.  
It now lies a ruin!” —  
“Allah-el-illah!  
Fire, like Air, will find or force expansion —  
Fire must burn, and woodwork may not brave it!  
But — I'll build thee a far handsomer mansion.”  
— “Thanks, good Architect! The cost may make me  
Poorer, but, Inshallah! 'twill not break me.”

*Poems of James Clarence Mangan*

The Worst Loss, Stanza II, l. 9–16

O'Donoghue. Dublin, Ireland. 1903

**Milton, John** 1608–74

English poet

The hasty multitude  
Admiring enter'd, and the work some praise  
And some the architect: his hand was known

In heaven by many a tower'd structure high,  
Where scepter'd angels held their residence,  
And sat as princes.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*

Book I, l. 730

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**North, Roger** 1585–1652

English biographer

For a profest architect is proud, opiniative and troublesome, seldom at hand, and a head workman pretending to the designing part, is full of paltry vulgar contrivances; therefore be your owne architect, or sitt still.

In H.M. Colvin

*A Biographical Dictionary of English Architects, 1600–1840*

Introduction (p. 13)

John Murray. London, England. 1954

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

An architect should live as little in cities as a painter. Send him to our hills, and let him study there what nature understands by a buttress, and what by a dome.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 3, The Lamp of Power (p. 129)

John Wiley & Sons, Inc. New York, New York, USA. 1860

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

Believe me, that was a happy age, before the days of architects, before the days of builders.

Translated by Richard M. Gummere

*Ad Lucilium Epistulae Morales* (Volume 1)

Epistle xc

Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shipman, T.** 1632–80

English poet

An Architect should chiefly try

To please the Owner's Mind and Eye...

*Carolina: or Loyal Poems*

To the Reader of the following Poem (p. 234)

S. Heyrick & W. Crook. London, England. 1683

**Shute, John** ?–1563

English architect

It belongeth also to an Architect, to have sight in Philosophie, which teaching to be of a noble courage as Virtuuius saith, and also gentil, curtious, faithfull and modest, not geuen to auarice and filthy lucre, as not to be troubled or corrupted with rewardes or giftes, but with grauity and Sagenes to coceiue al honor and dignity in al things conseruinge his good name and estimation. Let him also take a charge of workes in hand, being desired and not desirous of workers.

*The First and Chief Groundes of Architecturefolio*

Chapter iii

Gregg Press. London, England. 1965

...an Architecte must be sharpe of understandinge and both quicke and apte to conceive the trewe Instructions and meaninges of them that have written thereof: and must also be a perfect distributor of the great misteries that he hath perceued and experymented, that playnlye and briefly he may discusse and open demonstrations of that which shallbe done....

*The First and Chief Groundes of Architecturefolio*

Chapter iii

Gregg Press. London, England. 1965

**Swift, Jonathan** 1667–1745

Irish-born English writer

There was a most ingenious architect who had contrived a new method for building houses, by beginning at the roof, and working downward to the foundation.

*Gulliver's Travels*

Part III, Chapter V (pp. 107–108)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

True, there are architects so called in this country, and I have heard of one at least possessed with the idea of making architectural ornaments have a core of truth, a necessity, and hence a beauty, as if it were a revelation to him. All very well perhaps from his point of view, but only a little better than the common dilettantism.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter I (p. 75)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Vitruvius** ca 70–ca 25 BCE

Roman architect

...architects who without culture aim at manual skill cannot gain a prestige corresponding to their labours, while those who trust to theory and literature obviously follow a shadow and not reality. But those who have mastered both, like men equipped in full armor, soon acquire influence and attain their purpose.

*Vitruvius on Architecture* (Volume 1)

Book I, Chapter I, 2 (p. 7)

W. Heinemann Ltd. London, England. 1931–34

**Wightwick, George** 1802–72

English civil engineer

It is presumed your primary object in securing the services of an Architect involves the recognition of his pretensions as an Artist. The ordinary Builder may construct the edifice required: you apply to an Architect for the superadded graces of correct design and suitable



decoration. In matters of Taste he engages to give you what he conceives to be correct, and to the amount only which your means allow, and not to sacrifice without reluctance his repute as an Artist to your individual wishes, not to suffer under your censure for limiting his decorations to their just proportion in the general outlay.

*Royal Institute of British Architects Proceedings, New Series*  
Letter to prospective clients, circa 1825, Volume VII, 161, 1891

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

Today the difference between a good and a poor architect is that the poor architect succumbs to every temptation and the good one resists it.

Translated by Peter Winch  
*Culture and Value* (p. 3e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wright, Frank Lloyd** 1867–1959  
American architect

The physician can bury his mistakes, but the architect can only advise his client to plant vines.

Frank Lloyd Wright and His Art  
*New York Times Magazine*, 4 October, 1953 (p. 47)

Any good architect is by nature a physicist as a matter of fact, but as a matter of reality, as things are, he must be a philosopher and a physician.

*Frank Lloyd Wright: An Autobiography*  
The Character of Form (p. 380)  
Duell, Sloan & Pearce. New York, New York, USA. 1943

**Zevi, Bruno** 1918–2001  
Italian architectural historian and writer

Professional architects, who, in order to explore the problems of contemporary architecture, must necessarily have a profound passion for architecture in the living sense of the word, are largely lacking today in the specific cultural background which would qualify them for a knowledgeable entry into the arena of historical and critical debate.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
Chapter 1 (pp. 16–17)  
Horizon Press. New York, New York, USA. 1957

## ARCHITECTURE

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

He that builds a fair house upon an ill seat, committeth himself to prison.

In Brian Vickers (ed.)  
*Francis Bacon*  
Essays of Buildings (p. 427)  
Published for the British Council by Longman. Harlow, England. 1978

Houses are built to live in, and not to look on: therefore let use be preferred before uniformity.

In Brian Vickers (ed.)  
*Francis Bacon*  
Essays of Buildings (p. 427)  
Published for the British Council by Longman. Harlow, England. 1978

**Bragdon, Claude** 1866–1946  
American architect, painter, and writer

Architecture is preeminently the art of significant forms in space — that is, forms significant of their functions.

Wake Up and Dream  
*Outlook*, May 27, 1931

**Buchanan, Robert Williams** 1841–1901  
English poet and novelist

Thus I taught them architecture —  
How to hew the rocks and fashion  
Monuments that stand for ever  
In despite of God and Time.

*The Complete Poetical Works of Robert Buchanan*  
The Devil's Case, XVI, l. 1377–80  
Chatto & Windus. London, England. 1901

**Carr-Saunders, A. M. (Alexander Morris), Sir** 1886–1966  
English sociologist

**Wilson, Paul A.** 1903–  
No biographical data available

Architecture differs from every other profession...in that the technique contains an aesthetic element. Indeed, the aesthetic element is fundamental; and no matter how complex the science of building construction is or may become, the architect is only concerned with that science in order to apply it to aesthetic purposes.

*The Professions*  
Architects (p. 184)  
Frank Cass & Company. Ltd. London, England. 1964

**Cibber, Colley** 1671–1757  
English dramatist and actor-manager

Old houses mended,  
Cost little less than new, before they're ended.

*Prologue to the Double Gallant*, l. 15  
Printed at the Chiswick Press. London, England. 1817

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

The principle of the Gothic architecture is infinity made imaginable.

In Henry Nelson Coleridge (ed.)  
*The Table Talk and Omniana of Samuel Taylor Coleridge*  
Table Talk  
June 29, 1833 (p. 231)  
George Bell & Sons. London, England. 1884

**Cowper, William** 1731–1800  
English poet

Silently as a dream the fabric rose;

No sound of hammer or of saw was there.

*The Poetical Works of William Cowper*

The Task

Book V, l. 144

John W. Lovell Company. New York, New York, USA. No date

**Dickens, Charles** 1812–70

English novelist

We didn't find that it [London] came to its likeness in the red bills at the shop doors; which I meantersay, added Joe, in an explanatory manner, as it is there drawd too architectooralooral.

*Great Expectations*

Chapter XXVII (p. 224)

Rinehart & Company, Inc. New York, New York, USA. 1948

A man who could build a church, as one may say, by squinting at a sheet of paper.

*Martin Chuzzlewit*

Chapter XXXI (p. 458)

Dodd, Mead & Company. New York, New York, USA. 1944

**Dimnet, Ernest** 1866–1954

French cleric

Architecture, of all the arts, is the one which acts the most slowly, but the most surely, on the soul.

*What We Live By*

Chapter VII (p. 141)

Simon & Schuster. New York, New York, USA. 1932

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The Gothic cathedral is a blossoming in stone subdued by the insatiable demand of harmony in man. The mountain of granite blooms into an eternal flower.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

History (p. 246)

The Library of America. New York, New York, USA. 1983

The hand that rounded Peter's dome  
And groined the aisles of Christian Rome,  
Wrought in a sad sincerity;

Himself from God he could not free;

He builded better than he knew;

The conscious stone to beauty grew.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

The Problem (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Earth proudly wears the Parthenon

As best gem upon her zone.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

The Problem (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Gray, Thomas** 1716–71

English poet

Rich windows that exclude the light,

And passages that lead to nothing.

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*

A Long Story

J. Blackwood. London, England. 1800

**Johnson, Philip**

American law professor

Architecture is the art of how to waste space.

Article in *Ideas and Men*,

*New York Times*, Section E, December 1964 (p. 927)

**Kingsley, Charles** 1819–75

English clergyman and writer

Grandeur...consists in form, and not in size: and to the eye of the philosopher, the curve drawn on a paper two inches long, is just as magnificent, just as symbolic of divine mysteries and melodies, as when embodied in the span of some cathedral roof.

*Prose Idylls: New and Old*

My Winter Garden

Macmillan & Company. London, England. 1889

**Le Corbusier (Charles-Edouard Jeanneret)** 1887–1965

Swiss architect and city planner

The house is a machine for living in.

Translated by Frederick Etchells

*Towards a New Architecture*

Argument (p. 4)

The Architectural Press. London, England. 1965

There is one profession and one only, namely architecture, in which progress is not considered necessary, where laziness is enthroned, and in which the reference is always to yesterday.

Translated by Frederick Etchells

*Towards a New Architecture*

Eyes Which Do Not See (p. 101)

The Architectural Press. London, England. 1965

Architecture is the first manifestation of man creating his own universe, creating it in the image of nature, submitting to the laws of nature, the laws which govern our own nature, our universe. The laws of gravity, of statics and of dynamics, impose themselves by a *reductio ad absurdum*: everything must hold together or it will collapse.

Translated by Frederick Etchells

*Towards a New Architecture*

Regulating Lines (pp. 69–70)

The Architectural Press. London, England. 1965

**Longfellow, Henry Wadsworth** 1807–82

American poet

In the elder days of Art,  
Builders wrought with greatest care  
Each minute and unseen part;  
For the Gods see everywhere.

*The Poetical Works of Henry Wadsworth Longfellow*

The Builders

Stanza 5

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

Ah, to build, to build!

That is the noblest of all the arts.

*The Poetical Works of Henry Wadsworth Longfellow*

Michael Angelo

Part I, II, I. 54

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Milton, John** 1608–74

English poet

...nor did there want

Cornice or frieze with bossy sculpture graven.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book I, I. 715

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nietzsche, Friedrich** 1844–1900

German philosopher

...architecture is a kind of oratory in forms, sometimes persuading or even flattering, sometimes simply commanding.

Translated by Richard Polt

*Twilight of the Idols or, How to Philosophize with the Hammer*

Raids of an Untimely Man, 11 (p. 57)

Hackett Publishing Company, Inc. Indianapolis, Indiana, USA. 1997

**Pope, Alexander** 1688–1744

English poet

Thus when we view some well-proportion'd dome...

No single parts unequally surprise,

All comes united to th' admiring eyes.

*The Complete Poetical Works*

Essay on Criticism, pt. II, I. 47

Houghton Mifflin Company. New York, New York, USA. 1903

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

We may live without her [architecture], and worship without her, but we cannot remember without her.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 3, The Lamp of Memory (p. 140)

John Wiley & Sons, Inc. New York, New York, USA. 1860

Ornamentation is the principal part of architecture, considered as a subject of fine art.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 4, Sculpture (p. 208)

John Wiley & Sons, Inc. New York, New York, USA. 1860

[T]he value of architecture depended on two distinct characters: — the one, the impression it receives from human power; the other, the image it bears of the natural creation.

*The Seven Lamps of Architecture*

The Lamp of Beauty

Smith, Elder & Company. London, England. 1849

Architecture is the work of nations...

*The Complete Works*

*The Stones of Venice*

Part 4, Sculpture (p. 241)

Bryan Taylor & Company. New York, New York, USA. 1894

I would have, then, our ordinary dwelling-houses built to last, and built to be lovely; as rich and full of pleasantness as may be within and without...with such differences as might suit and express each man's character and occupation, and partly his history.

*The Seven Lamps of Architecture*

The Lamp of Memory

Smith, Elder & Company. London, England. 1849

**Smart, Christopher** 1722–71

English poet

Ma'm, architecture you're not skill'd in,

I don't approve your way of building;

In this there's nothing like design,

Pray learn the use of Gunter's line.

*The Poetical Works of Christopher Smart*

The Blockhead and Beehive, Fable X, l. 59–62

Clarendon Press. Oxford, England. 1980

**Sullivan, Louis Henry** 1856–1924

American architect

Form ever follows function.

*Lippincott's Magazine*

The Tall Office Building Artistically Considered

*Lippincott's Magazine*, March 1896

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

I have found a paper of mine...in which I call architecture "petrified music".

In Johann Peter Eckermann

*Conversations with Goethe*

Monday, March 23, 1829 (p. 303)

J.M. Dent & Sons Ltd. London, England. 1970

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

If Nature had been comfortable, mankind would never have invented architecture...

*The Works of Oscar Wilde* (Volume 10)

Intentions

The Decay of Lying (p. 291)

AMS Press. New York, New York, USA. 1909

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Remember the impression one gets from good architecture, that it expresses a thought. It makes one want to respond with a gesture.

Translated by Peter Winch  
*Culture and Value* (p. 22e)  
 The University of Chicago Press. Chicago, Illinois, USA. 1980

Architecture is a gesture. Not every purposive movement of the human body is a gesture. And no more is every building designed for a purpose architecture.

Translated by Peter Winch  
*Culture and Value* (p. 42e)  
 The University of Chicago Press. Chicago, Illinois, USA. 1980

Architecture immortalizes and glorifies something. Hence there can be no architecture where there is nothing to glorify.

Translated by Peter Winch  
*Culture and Value* (p. 69e)  
 The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wright, Frank Lloyd** 1867–1959  
 American architect

The only thing wrong with architecture [is] the architects.  
 In Evan Esar  
*20,000 Quips and Quotes* (p. 40)  
 Doubleday. Garden City, New York, USA. 1968

Machinery, materials and men — yes — these are the stuff by means of which the so-called American architect will get his architecture.... Only by the strength of his spirit's grasp upon all three — machinery, materials and men — will the architect be able so to build that his work may be worthy the great name architecture.

In Bruce Brooks Pfeiffer and Gerald Nordland (eds.)  
*Frank Lloyd Wright: In the Realm of Ideas* (p. 48)  
 Southern Illinois University Press, Carbondale, Illinois, USA. 1988

Bring out the nature of the materials, let their nature intimately into your scheme.... Reveal the nature of the wood, plaster, brick or stone in your designs; they are all by nature friendly and beautiful.

In Bruce Brooks Pfeiffer and Gerald Nordland (eds.)  
*Frank Lloyd Wright: In the Realm of Ideas* (p. 48)  
 Southern Illinois University Press, Carbondale, Illinois, USA. 1988

Architecture is the triumph of human imagination over materials, methods and men, to put man into possession of his own earth.

In Bruce Brooks Pfeiffer and Gerald Nordland (eds.)  
*Frank Lloyd Wright: In the Realm of Ideas* (p. 48)  
 Southern Illinois University Press, Carbondale, Illinois, USA. 1988

**Wyatt, Mrs. James**  
 No biographical data available

You must be aware that Architecture is the profession of a Gentleman, and that none is more lucrative when it is properly attended to.

*Egerton Manuscript*  
 3515, Letter to son Philip, 1808

**Zevi, Bruno** 1918–2001  
 Italian architectural historian and writer

To look at architecture with any system and intelligence one must already have a lively interest in the subject and be provided with a good deal of good will.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
 Chapter I (p. 16)  
 Horizon Press. New York, New York, USA. 1957

Decorating, sculpture and painting enter into the grammar of architecture in their proper places as adjectives, not as substantives.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
 Chapter II (p. 32)  
 Horizon Press. New York, New York, USA. 1957

*Les yeux qui ne voient pas*, the eyes which do not see the beauty of Purist forms are eyes that today do not see and do not understand the lessons of traditional architecture.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
 Chapter I (p. 17)  
 Horizon Press. New York, New York, USA. 1957

Architecture is not art alone, it is not merely a reflection of conceptions of life or a portrait of systems of living. Architecture is environment, the stage on which our lives unfold.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
 Chapter II (p. 32)  
 Horizon Press. New York, New York, USA. 1957

Among the planets of the arts, architecture is the dark side of the moon.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
 Chapter VI (p. 227)  
 Horizon Press. New York, New York, USA. 1957

Architecture...does not consist in the sum of the width, length and height of the structural elements which enclose space, but in the void itself, the enclosed space in which man lives and moves.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
 Chapter II (pp. 22–23)  
 Horizon Press. New York, New York, USA. 1957

All the techniques of representation and all the paths to architecture which do not include direct experience are pedagogically useful, of practical necessity and intellectually fruitful; but their function is no more than allusive and preparatory to that moment in which we, with everything in us that is physical and spiritual and, above all, human, enter and experience the spaces we have been studying. That is the moment of architecture.

Translated by Milton Gendel  
*Architecture as Space: How to Look at Architecture*  
 Chapter III (p. 60)  
 Horizon Press. New York, New York, USA. 1957

Architecture... is like a great hollowed-out sculpture which man enters and apprehends by moving about within it.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter II (p. 22)

Horizon Press. New York, New York, USA. 1957

A satisfactory history of architecture has not yet been written, because we are still not accustomed to thinking in terms of space, and because historians of architecture have failed to apply a coherent method of studying buildings from a spatial point of view.

Translated by Milton Gendel

*Architecture as Space: How to Look at Architecture*

Chapter II (p. 22)

Horizon Press. New York, New York, USA. 1957

## ARGYRIA

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

So we must keep doctors awake by telling them that they have not yet shaken off astrology and the doctrine of signatures, as is shown by the form of their prescriptions, and their use of nitrate of silver, which turns epileptics into Ethiopians.

*The Professor at the Breakfast Table*

Chapter V (p. 132)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

## ARITHMETIC

### Author undetermined

Arithmetic, then, means dealing logically with certain facts that we know, about numbers, with a view to arriving at knowledge which as yet we do not possess.

*Philosophy & Fun of Algebra*

Chapter 1 (p. 11)

C.W. Daniel Ltd. London, England.

**Brandeis, Louis D.** 1856–1941

American lawyer, reformer, and associate justice

...obsessed with the delusion that two and two make five, he fell at last a victim of the relentless rules of humble arithmetic.

Remember, O Stranger!

Arithmetic is the first of the sciences and the mother of safety.

In Alpheus T. Mason

*Brandeis: A Free Man's Life*

Chapter Thirteen (p. 200)

The Viking Press. New York, New York, USA. 1956

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

I know that two and two make four — & should be glad to prove it too if I could — though I must say if by any sort of process I could convert 2 & 2 into five it would give me much greater pleasure.

In Leslie A. Marchand (ed.)

*Byron's Letters and Journals* (Volume 3)

No. 10, Letter to Annabella Milbanke, November 10<sup>th</sup>, 1813 (p. 159)

Harvard University Press. Cambridge, Massachusetts, USA. 1973-82

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

...the different branches of Arithmetic — Ambition, Distraction, Uglification, and Derision.

*The Complete Works of Lewis Carroll*

Alice's Adventures in Wonderland

Chapter IX (p. 103)

The Modern Library. New York, New York, USA. 1936

**Churchill, Sir Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and writer

You cannot ask us to take sides against arithmetic.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Bias (p. 44)

George Allen & Unwin Ltd. London, England. 1956

**Dewey, John** 1859–1952

American philosopher and educator

The way to enable a student to apprehend the instrumental value of arithmetic is not to lecture him on the benefit it will be to him in some remote and uncertain future, but to let him discover that success in something he is interested in doing depends on ability to use numbers.

*Democracy and Education: An Introduction to the Philosophy of Education*

Chapter Eighteen (p. 240)

The Free Press, New York, New York, USA. 1916

**Dickens, Charles** 1812–70

English novelist

Herein lay the spring of the mechanical art and mystery of educating the reason without stooping to the cultivation of the sentiments and affections. Never wonder. By means of addition, subtraction, multiplication, and division, settle everything somehow, and never wonder.

*Hard Times*

Book the First, Chapter VIII (p. 43)

J.M. Dent & Sons Ltd. London, England. 1966

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

For we do not listen with the best regard to the verses of a man who is only a poet, nor to his problems if he is only an algebraist; but if a man is at once acquainted with the geometric foundations of things and with their festal splendor, his poetry is exact and his arithmetic musical.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Society and Solitude  
Works and Days (p. 179)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Frege, Friedrich Ludwig Gottlob** 1848–1925  
German logician

I compare arithmetic with a tree that unfolds upwards in a multitude of techniques and theorems while the root drives into the depths.

In I. Grattan-Guinness  
*The Search For Mathematical Roots*  
Chapter 1 (p. 3)  
Princeton University Press. Princeton, New Jersey, USA. 2000

**Heinlein, Robert A.** 1907–88  
American science fiction writer

...an intellectual is a highly educated man who can't do arithmetic with his shoes on, and is proud of his lack.

*The Cat Who Walks Through Walls: A Comedy of Manners*  
Chapter XXVIII (p. 359)  
G.P. Putnam's Sons. New York, New York, USA. 1985

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

I was just going to say, when I was interrupted, that one of the many ways of classifying minds is under the heads of arithmetical and algebraical intellects. All economical and practical wisdom is an extension or variation of the following arithmetical formula:  $2 + 2 = 4$ . Every philosophical proposition has the more general character of the expression  $a + b = c$ . We are the mere operatives, empirics, and egoists, until we learn to think in letters instead of figures.

*The Autocrat of the Breakfast-Table*  
Chapter I (p. 1)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hugo, Victor** 1802–85  
French writer, lyric poet, and dramatist

Arithmetic, like the sea, is an undulation without any possible end.

Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
Part II, Book Third, Chapter III (p. 407)  
The Heritage Press. New York, New York, USA. 1961

**Kipling, Rudyard** 1865–1936  
British writer and poet

A rule to trick th' arithmetic.

*Rudyard Kipling's Verse*  
To the True Romance  
Hodder & Stroughton. London, England. 1919

**La Touche, Mrs.**  
No biographical data available

I do hate sums. There is no greater mistake than to call arithmetic an exact science. There are Permutations and

Aberrations discernible to minds entirely noble like mine; subtle variations which ordinary accountants fail to discover; hidden laws of Numbers which it requires a mind like mine to perceive. For instance, if you add a sum from the bottom up, and then again from the top down, the result is always different.

In Maria Price La Touche  
*The Letters of a Noble Woman*  
Letter dated July 1878 (p. 49)  
George Allen & Sons. London, England, 1908

**Leacock, Stephen** 1869–1944  
Canadian humorist

The student of arithmetic who has mastered the first four rules of his art, and successfully striven with money sums and fractions, finds himself confronted by an unbroken expanse of questions known as problems.

*Literary Lapses*  
A, B, and C (p. 237)  
John Lane. London, England. 1911

His brain trained by long years of high living and plain thinking had become too subtle, too refined an instrument for arithmetic....

*Literary Lapses*  
Lord Oxhead's Secret (p. 23)  
John Lane. London, England. 1911

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

The pleasure we obtain from music comes from counting, but counting unconsciously. Music is nothing but unconscious arithmetic.

In Oliver Sacks  
*The Man Who Mistook His Wife for a Hat and Other Clinical Tales*  
The Twins (p. 195)  
Summit Books. New York, New York, USA. 1985

**Lieber, Lillian R.**  
Mathematician

In other words, without a theory, a plan, the mere mechanical manipulation of the numbers in a problem does not necessarily make sense just because you are using Arithmetic!

*The Education of T.C. MITS*  
Part I, Chapter III (p. 36)  
W.W. Norton & Company, Inc. New York, New York, USA. 1944

**Nash, Ogden** 1902–71  
American writer of humorous poetry

...the only way I can distinguish proper from improper fractions

Is by their actions.  
*Parents Keep Out, Elderly Poems for Youngerly Readers*  
Ask Daddy, He Won't Know  
Little, Brown Publishers. Boston, Massachusetts, USA. 1951

**Parker, Francis Wayland** 1837–1902  
American educator

The science of Arithmetic may be called the science of exact limitation of matter and things in space, force, and time.

*Talks on Pedagogics*

Chapter IV (p. 64)

A.S. Barnes & Company. New York, New York, USA. 1909

**Plato** 428 BCE–347 BCE  
Greek philosopher

SOC: ...if arithmetic, mensuration, and weighing be taken away from any art, that which remains will not be much.

In *Great Books of the Western World* (Volume 7)

*Philebus*

Section 55 (p. 633)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

SOC: ...“And so, Gorgias, you call arithmetic rhetoric.” But I do not think that you really call arithmetic rhetoric any more than geometry would be so called by you.

In *Great Books of the Western World* (Volume 7)

*Gorgias*

Section 450 (p. 254)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Can we deny that a warrior should have a knowledge of arithmetic?

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 522 (p. 392)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...arithmetic has a very great and elevating effect, compelling the soul to reason about abstract number, and rebelling against the introduction of visible or tangible objects into the argument.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 525 (p. 393)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...those who have a natural talent for calculation are generally quick at every other kind of knowledge; and even the dull, if they have had an arithmetical training, although they may derive no other advantage from it, always become much quicker than they would otherwise have been...

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 526 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...arithmetic is a kind of knowledge in which the best natures should be trained, and which must not be given up.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 526 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

Arithmetic does not present to us that feeling of continuity which is such a precious guide; each whole number is separate from the next of its kind and has in a sense individuality; each in a manner is an exception and that is why general theorems are rare in the theory of numbers; and that is why those theorems which may exist are more hidden and longer escape those who are searching for them.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 131)

Government Printing Office. Washington, D.C. 1910

**Rosenblatt, Roger**  
American journalist, writer and playwright

...Uncle Scrooge preferred to let the poor die “and decrease the surplus population.” Scrooge may not have God on his side, but his arithmetic was impeccable.

*The Man in the Water: Essays and Stories*

Do You Feel the Deaths of Strangers? (p. 177)

Random House, Inc. New York, New York, USA. 1994

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

All knowledge must be recognition, on pain of being mere delusion; Arithmetic must be discovered in just the same sense in which Columbus discovered the West Indies, and we no more create numbers than he created the Indians... Whatever can be thought of has being and its [arithmetic] being is a precondition, not a result, of its being thought of.

Is Position in Space and Time Absolute or Relative

*Mind*, Volume X, 1901 (p. 312)

**Sandburg, Carl** 1878–1967  
American poet and biographer

Arithmetic is where numbers fly like pigeons in and out of your head.

*Complete Poems*

Arithmetic

Harcourt, Brace. New York, New York, USA. 1950

Arithmetic is numbers you squeeze from your head to your hand to your pencil to your paper till you get the answer.

*Complete Poems*

Arithmetic

Harcourt, Brace. New York, New York, USA. 1950

If you ask your mother for one fried egg for breakfast and she gives you two fried eggs and you eat both of them, who is better in arithmetic, you or your mother?

*Complete Poems*

Arithmetic

Harcourt, Brace. New York, New York, USA. 1950

**Schopenhauer, Arthur** 1788–1860  
German philosopher

That arithmetic is the basest of all mental activities is proved by the fact that it is the only one that can be accomplished by means of a machine.

Translated by Mrs. Rudolph Dircks  
*Essays of Schopenhauer*  
Psychological Observations  
W. Scott. London, England. 1897

**Smith, Henry J. S.** 1826–83  
Irish mathematician

[Arithmetic] is one of the oldest branches, perhaps the very oldest branch, of human knowledge; and yet some of its most abstruse secrets lie close to its tritest truths.

In E.T. Bell  
*Men of Mathematics* (p. xv)  
Simon & Schuster. New York, New York, USA. 1937

**Smith, Sydney** 1771–1845  
English clergyman, writer, and wit

What would life be like without arithmetic, but a scene of horrors?

*The Letters of Sydney Smith* (Volume 2)  
Letter 692, To Miss Lucie Austin, 22 July 1835 (p. 622)  
At The Clarendon Press. Oxford, England. 1953

**Steinbeck, John** 1902–68  
American novelist

He was an arithmetician rather than a mathematician. None of the humor, the music, or the mysticism of higher mathematics ever entered his head.

*The Moon Is Down*  
Chapter Two (p. 22)  
Hinemann. London, England. 1968

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The territory of arithmetic ends where the two ideas of “variables” and of “algebraic form” commence their sway.

*An Introduction to Mathematics*  
Chapter 5 (p. 48)  
Oxford University Press, Inc. New York, New York, USA. 1958

## ARROGANCE

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

Even the best fathers are not without shortcomings. If we must accept arrogance, stubbornness, invective-ness, and vanity along with genius, so be it. If modern science must have a father, let it be Galileo.

*Blind Watchers of the Sky*  
Chapter Four (p. 112)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

## ARTERY

**Barnes, Djuna** 1892–1982  
American writer

But the great doctor, he’s a divine idiot and a wise man. He closes one eye, the eye that he studied with, and putting his finger on the arteries of the body says: “God whose roadway this is, has given me permission to travel on it also,” which, Heaven help the patient, is true...

*Nightwood*  
La Somnambule (p. 40)  
Harcourt, Brace & Company. New York, New York, USA. 1937

## ARTIFACT

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Little comes to us through time as a complete monument; much comes as remnants; much as techniques, as practical manual; some things because of their close affinity to man, like mathematics; other things because they are always encouraged, like astronomy and geography; other things because of man’s needs, like medicine; and finally some things, because the human being, without wanting to, continues to produce them, like music and the other fine arts.

In Karl J. Fink  
*Goethe’s History of Science*  
Chapter 5 (p. 66)  
Cambridge University Press. Cambridge, England. 1991

## ARTIFICIAL LIMBS

**Melville, Herman** 1819–91  
American novelist

Now, for most folks one pair of legs lasts a lifetime, and that must be because they use them mercifully, as a tender-hearted old lady uses her roly-poly old coach horses. But Ahab; oh he’s a hard driver. Look, driven one leg to death, and sprained the other for life, and now wears out bone legs by the cord.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 108 (p. 348)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ASSERTION

**Goddard, Robert H.** 1882–1945  
American physicist

It is dangerous to believe hastily that anything is either possible or impossible, for there are few scientific



assertions which have been proved to universal satisfaction. Our firmest scientific beliefs of today may be shattered tomorrow.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted (p. 65)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

## ASSUMPTION

**Aristotle** 384 BCE–322 BCE

Greek philosopher

When the consequences of either assumption are the same, we should always assume that things are finite rather than infinite in number, since in things constituted by nature that which is infinite and that which is better ought, if possible, to be present rather than the reverse...

In *Great Books of the Western World* (Volume 8)

*Physics*

Book VIII, Chapter 7, 259a [5]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Pick the assumptions to pieces till the stuff they are made of is exposed to plain view — this is the cardinal rule for understanding the basis of our beliefs.

*The Search for Truth*

Chapter I, Section 5 (p. 25)

George Allen & Unwin Ltd. London, England. 1935

**Clarke, Arthur C.** 1917–

English science and science fiction writer

No equation, however impressive and complex, can arrive at the truth if the initial assumptions are incorrect.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 1 (p. 7)

Harper & Row, Publishers. New York, New York, USA. 1973

**Crick, Francis Harry Compton** 1916–2004

English biochemist

It is all too easy to make some plausible simplifying assumptions, do some elaborate mathematics that appear to give a rough fit with at least some experimental data, and think one has achieved something. The chance of such an approach doing anything useful, apart from soothing the theorist's ego, is rather small....

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 10 (pp. 113–114)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Donghia, Angelo** 1935–85

Italian-American interior designer

Assumption is the mother of screw-up...

Behind Angelo Donghia's Gray Flannel Success

*New York Times*, Section C, January 20, 1983 (p. 6)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Interesting fallacies are often subtle, often based upon hidden assumptions, unstated and probably unconsciously held.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Seven, Chapter 25 (p. 333)

Random House, Inc. New York, New York, USA. 1995

**Savage-Rumbaugh, Sue**

American psychologist

**Lewin, Roger Amos** 1946–

Anthropologist and science writer

We do not realize how deeply our starting assumptions affect the way we go about looking for and interpreting the data we collect. We should recognize that nonhuman organisms need not meet every new definition of human language, tool use, mind, or consciousness in order to have versions of their own that are worthy of serious study. We have set ourselves too much apart, grasping for definitions that will distinguish man from all other life on the planet. We must rejoin the great stream of life from whence we arose and strive to see within it the seeds of all we are and all we may become.

*Kanzi: The Ape at the Brink of the Human Mind*

Chapter 10 (p. 264)

John Wiley & Sons, Inc. New York, New York, USA. 1994

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

An assumption, as such, is really not more daring than the facts.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #33 (p. 21)

Definition Press. New York, New York, USA. 1972

**Tinker, John F.**

No biographical data available

It is well to consider the basic assumptions of science, but unless the consequences are more far reaching than the peace of mind of the philosophers, it seems to me that the emphasis of this consideration should be shifted in favor of more immediate assumptions.

On Scientific Assumptions

*American Scientist*, Volume 40, Number 3, July 1952 (p. 502)

**Wilford, John Noble**

American science writer

Dying dinosaurs and Martian dust storms, atmospheric physics and smoky fires in Brazil — important ideas can have the unlikeliest provenance. It is unwise to assume that any course of study of exploration is irrelevant.

*The Riddle of the Dinosaur*

Chapter 18 (p. 271)

Alfred A. Knopf. New York, New York, USA. 1986

**ASTEROID****Asphaug, Erik**

American planetary scientist

Neither rocks nor planets, they are something of Earth and Heaven.

The Small Planets

*Scientific American*

Volume 282, Number 5, May 2000 (p. 55)

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Is he not the celebrated author of the Dynamics of an Asteroid, a book which ascends to such rarefied heights of pure mathematics that it is said that there was no man in the scientific press capable of criticizing it?

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Valley of Fear (p. 472)

Wings Books. New York, New York, USA. 1967

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The asteroids are the chips of an old star, and a meteoric stone is a chip of an asteroid.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Chapter VII (p. 224)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Kowal, Charles T.** 1940–

American astronomer

In fact, it is safe to say that the situation has degenerated to the point of absurdity. Asteroids have been named after girlfriends, financial supporters, cats, and computers. For the traditionalist like myself, it seems a pity that the naming of asteroids has become so trivialized.

*Asteroids: Their Nature and Utilization*

Chapter 1 (p. 17)

Ellis Horwood Ltd. Chichester, England. 1988

**Peebles, Curtis**

American aerospace historian

Lost amid the stars, there are mountains in the sky.

*Asteroids: A History*

Chapter 1 (p. 1)

Smithsonian Institution Press. Washington, D.C. 2000

**Sagan, Carl** 1934–96

American astronomer and author

The asteroid belt may be a place where a planet was once prevented from forming because of the gravitational tides of the giant nearby planet Jupiter; or it may be the shattered remains of a planet that blew itself up. This seems improbable because no scientist on Earth knows how a planet might blow itself up, which is probably just as well.

*Cosmos*

Chapter IV (p. 87)

Random House, Inc. New York, New York, USA. 1980

**Shoemaker, Eugene** 1928–97

American geologist

If all the potentially threatening asteroids were discovered, however, the risk to Earth would no longer be a matter of chance. We would know whether a collision is imminent. The time of impact could be predicted centuries in advance, and the place of impact could be predicted fairly accurately decades in advance.

Plaque at Meteor Crater, Arizona, United States of America

Statement

Near-Earth Asteroids

April 19, 1997

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

Noise proves nothing, often a hen that has merely laid an egg cackles as if she had laid an asteroid.

In Albert Bigelow Paine (ed.)

*Mark Twain's Notebook*

Chapter XXI (p. 241)

Harper &amp; Brothers Publishers. New York, New York, USA. 1899

**ASTROGEOLOGY****Chapman, Clark R.**

American astronomer and asteroid researcher

Yet it seems to me an intellectual accomplishment of the most awe-inspiring sort that in the few centuries since Galileo invented the telescope we learned so much about the planets merely by studying their faint shimmering light reaching us across the vastness of space. And it is a technological marvel of the space age that we now study pieces of the Moon in our laboratories or direct our remote-controlled robots sitting on ground millions of miles away to hammer at a Martian rock.

*The Inner Planets: New Light on the Rocky Worlds of Mercury, Venus, Earth, the Moon, Mars, and the Asteroids*

Chapter 9 (p. 161)

Charles Scribner's Sons. New York, New York, USA. 1977

**Sagan, Carl** 1934–96

American astronomer and author

Apart from an understanding of the solar system as a whole, it is becoming clear that information about any planet or satellite illuminates our knowledge of the others. In particular, if we are to understand the Earth, we must have a comprehensive knowledge of the other planets.

The Solar System

*Scientific American*, Volume 233, Number 3, September 1975 (p. 27)

**ASTROLOGER****Charlie Chan**

Fictional character

Friend of stars may possess unusual wisdom.

*Castle in the Desert*

Film (1942)

**ASTROLOGY****Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

Ye stars! Which are the poetry of Heaven,  
 If in your bright leaves we would read the fate  
 Of men and empires, — 'tis to be forgiven,  
 That in our aspirations to be great,  
 Our destinies o'erleap their mortal state,  
 And claim a kindred with you.

*The Complete Poetical Works of Byron*

Child Harold, Canto iii, Stanza 88

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Durant, William James** 1885–1981

American historian and essayist

...astrology antedated — and perhaps will survive  
 — astronomy; simple souls are more interested in telling  
 futures than in telling time.

*The Story of Civilization*

Part I

Our Oriental Heritage

Introduction Chapter I (p. 80)

Simon &amp; Schuster. New York, New York, USA. 1954

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Astronomy to the selfish becomes astrology...

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

Nature (p. 546)

The Library of America. New York, New York, USA. 1983

**Johnson, Severance** 1696–1772

English critic, biographer, and essayist

Astronomy

Is for the mind of gods, astrology

For simpletons.

*The Dictator and the Devil*

Ecnareves Press. New York, New York, USA. 1943

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The fault, dear Brutus, is not in the stars, but in  
 ourselves.

*In Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)

Julius Caesar

Act I, Scene ii, l. 134

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Astrology: This is the excellent foppery of the world:  
 that when we are sick in fortune — often the surfeits of  
 our own behavior — we make guilty of our disasters the  
 sun, the moon, and stars, as if we were villains on neces-  
 sity, fools by heavenly compulsion, knaves, thieves, and  
 treachers by spherical predominance, drunkards, liars,  
 and adulterers by an enforced obedience of planetary  
 influence.... An admirable evasion of whoremaster man,  
 to lay his goatish disposition on the charge of a star!

*In Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

King Lear

Act I, Scene ii, l. 128 &amp; 137

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is the stars,

The stars above us, govern our condition.

*In Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

King Lear

Act IV, Scene iii, l. 34–35

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smullyan, Raymond** 1919–

American mathematician and logician

Recently, someone asked me if I believed in astrology.  
 He seemed somewhat puzzled when I explained that the  
 reason that I don't is because I'm a Gemini.

*5000 B.C. and Other Philosophical Fantasies*

Chapter 3 (p. 23)

St. Martin's Press. New York, New York, USA. 1983

**ASTRONAUT****Apollo 11**

Here men from the planet Earth first set foot upon the  
 Moon July 1969, A.D. WE CAME IN PEACE FOR ALL  
 MANKIND.

Plaque left behind on the moon's surface

**Cernan, Gene** 1934–

American astronaut

Bob, this is Gene, and I'm on the surface; and, as I take  
 man's last step from the surface, back home for some  
 time to come — but we believe not too long into the  
 future — I'd like to just (say) what I believe history will  
 record. That America's challenge of today has forged  
 man's destiny of tomorrow. And, as we leave the Moon  
 at Taurus-Littrow, we leave as we came and, God willing,  
 as we shall return, with peace and hope for all mankind.  
 Godspeed the crew of Apollo 17.

Transcript of flight of Apollo 17

**Conrad, Pete** 1930–99

American astronaut

Whoopee! Man, that may have been a small one for Neil, but it's a long one for me.

Transcript of flight of Apollo 12

**Ward, Fred** 1942–

American actor

Gus Grissom: What the hell's "astronaut" mean anyway?

*The Right Stuff*

Film (1983)

**Scott, Dave** 1932–

American astronaut

Man must explore. And this is exploration at its greatest.

Transcript of flight of Apollo 15

**Shepherd, Alan** 1923–98

American astronaut

It's been a long way, but we're here.

Transcript of flight of Apollo 14

**Swigert, Jack** 1931–1982

American astronaut

Okay, Houston; we've had a problem.

Transcript of flight of Apollo 13

**Young, John** 1930–

American astronaut

There you are:

Mysterious and Unknown

Descartes.

Highland plains. Apollo 16 is gonna change your image.

I'm sure glad they got ol' Brer Rabbit,

here, back in the briar patch where he belongs.

Transcript of flight of Apollo 16

## ASTRONOMER

**Bennett, Jeffrey O.**

American astrophysicist and writer

This is how astronomers might imagine the set of instructions used by a Creator: Start with a Big Bang, run it through a fraction of a second of inflation to sprinkle it with seeds for structure, throw in a few simple laws of physics and voila! — 10 billion years or so of cosmic evolution and out pops humanity.

*On the Cosmic Horizon: Ten Great Mysteries for Third Millennium*

*Astronomers*

Mystery 2 (p. 153)

Addison Wesley Longman. New York, New York, USA. 2001

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

Arithmetic and geometry, those wings on which the astronomer soars as high as heaven.

*Works* (Volume 3)

Usefulness of Mathematics to Natural Philosophy (p. 429)

Printed for A. Millary. London, England. 1744

**Crichton-Browne, Sir James** 1840–1938

English physician

We follow with awe and thrilling interest the prodigious revelation of our astronomers, but after all, our conception of the Stellar Universe does not go much further than: Twinkle, twinkle little star...

*From the Doctor's Notebook*

Matrimonial Obedience (p. 152)

Duckworth. London, England. 1937

The astronomers with all their hypotheses give us no satisfying or abiding conception of the Universe. We are left as bewildered as ever.

*From the Doctor's Notebook*

Tea (p. 224)

Duckworth. London, England. 1937

The astronomers are wonderful and impressive in their own sphere, but when they stray into literature they become annoying. We have all rejoiced in that beautiful elegy on the Burial of Sir John Moore, and know the essential line:

"By the struggling moonbeam's misty light."

Well, the astronomers have worked it out and found there was no moon the night of the Battle of Corunna.

*From the Doctor's Notebook*

The Astronomers (p. 192)

Duckworth. London, England. 1937

**Calder, Nigel** 1931–

English science writer

When astronomers express dissatisfaction with both the Big Bang and the Steady State concepts of the universe, they are in trouble, because it is hard to imagine radical alternatives.

*Violent Universe: An Eyewitness Account of The New Astronomy*

Chapter III (p. 121–122)

Viking Press. New York, New York, USA. 1970

**Cunningham, Clifford J.**

Canadian amateur astronomer and writer

Today's astronomers live and die by journals and conferences.

The Baron and His Celestial Police

*Sky & Telescope*, Volume 75, Number 3, March 1988 (p. 271)

**D'Avenant, Sir William** 1606–68

English poet, playwright, and theatrical producer

You that so wisely studious are  
To measure and to trace each Starr,  
How swift they travaile, and how farr,  
Now number your celestially store,  
Planets, or lesser lights, and trie

If in the face of all the skie  
You count so many as before!

*Salmacida Spolia*

III, Song, Stanza I

Printed by T.H. for Thomas Walkley. London, England. 1639

**de Fontenelle, Bernard le Bovier** 1657–1757

French writer

...since the princes have seized on the earth, it is fit the philosophers (who are as proud as the best of them) should reserve the heavens for themselves, without any competitors.

*Conversations on the Plurality of Worlds*

The Fourth Evening (p. 113)

Printed for Peter Wilson. Dublin, Ireland. 1761

**de Morgan, Augustus** 1806–71

English mathematician and logician

Astronomers! What can avail

Those who calumniate us;

Experiment can never fail

With such an apparatus.

*A Budget of Paradoxes*

The Astronomer's Drinking Song (p. 234)

Longmans, Green. London, England. 1872

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

This asteroid has only once been seen through the telescope. That was by a Turkish astronomer, in 1909. On making his discovery, the astronomer had presented it to the International Astronomical Congress, in a great demonstration. But he was in Turkish costume, and so nobody would believe what he said.

Translated by Katherine Woods

*The Little Prince*

Chapter IV (p. 17)

Harcourt, Brace & Company. New York, New York, USA. 1943

**D'Israeli, Isaac** 1766–1848

English critic and historian

It does at first appear that an astronomer rapt in abstraction, while he gazes on a star, must feel more exquisite delight than a farmer who is conducting his team.

*Literary Character of Men of Genius: Dravn from Their Own Feelings and Confessions*

On Habituating Ourselves to an Individual Pursuit

James Eastburn & Company. New York, New York, USA. 1818

**Donne, John** 1572–1631

English poet and divine

If then th' Astronomers, whereas they spie  
A new-found Starre, their Opticks magnifie,  
How brave are those, who with their Engine, can  
Bring man to heaven, and heaven againe to man?

*The Complete Poetry and Selected Prose of John Donne*

To Mr. Tilman After He Had Taken Orders

Random House, Inc. New York, New York, USA. 1941

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

The sun was enter'd into Capricorn;

Which, by their bad astronomer's account,

That week the Virgin Balance should remount.

*The Poetical Works of Dryden*

The Hind and the Panther, l. 1892

The Riverside Press. Cambridge, Massachusetts, USA. 1949

As the true height and bigness of a star

Exceeds the measures of th' astronomer.

*The Poetical Works of Dryden*

Eleonora, l. 264–265

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Dunne, Finley Peter** 1867–1936

American journalist and humorist

...I know about marredge th' way an asthronomer knows  
about th' stars.

*Mr. Dooley at His Best*

Marriage

Charles Scribner's Sons. New York, New York, USA. 1938

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The astronomer, the geometer, rely on their irrefragable  
analysis, and disdain the results of observation.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Idealism (p. 37)

The Library of America. New York, New York, USA. 1983

**Fort, Charles** 1874–1932

American writer

...if nobody looks up, or checks up, what the astrono-  
mers tell us, they are free to tell us anything that they  
want to tell us.

*The Books of Charles Fort*

Lo, Part 2, Chapter XX

Henry Holt & Company. New York, New York, USA. 1941

**Friedman, Herbert** 1916–2000

American space scientist and astrophysicist

To the astronomer of today, probing ever deeper with  
mind and telescope, the universe is more than beauti-  
ful: it is amazing, violent, and endlessly mysterious. The  
revelations of recent research have been so dramatic and  
so extreme as to leave both scientists and laymen bewil-  
dered. Modern astronomy deals with the birth and death  
of stars; with exotic matter and fantastic energies; with  
near-infinities of space and time; with creation, evolu-  
tion, and the ultimate destiny of the universe. As the  
sum of knowledge grows, the astronomer continues to  
seek answers to man's most profound questions: what is  
grand design of the universe? How was it created? How  
did we get here? What are we? Are we alone?

*The Amazing Universe*

Chapter 1 (p. 10)  
National Geographic Society. Washington, D.C. 1980

**Frost, Robert** 1874–1963  
American poet

As a confirmed astronomer  
I'm always for a better sky.  
*Complete Poems of Robert Frost*  
A-Wishing Well  
Henry Holt & Company. New York, New York, USA. 1949

**Geminus of Rhodes** fl.110 BCE–40 BCE  
Greek astronomer and mathematician

For it is no part of the business of an astronomer to know what is by nature suited to a position of rest, and what sort of bodies are apt to move, but he introduces hypotheses under which some bodies remain fixed, while others move, and then considers to which hypotheses the phenomena actually observed in the heavens will correspond.

In T. Heath  
*Greek Astronomy* (p. 125)  
Dover Publications, Inc. New York, New York, USA. 1991

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

The astronomer may speak to you of his understanding of space, but he cannot give you his understanding.

*The Prophet*  
On Teaching (p. 56)  
Alfred A. Knopf. New York, New York, USA. 1969

**Gronal, Florence Armstrong**  
American astronomer and photographer

How thrilling to read of great hunts for treasure! Yet the pirates who dug their spades into the earthy loam never cached such jewels as are hidden along the dark slopes of the sky. Armed with a chart of the heavens, the fledgling astronomer prods about in the depths of the gloom, shovels the dark with the aid of his telescope, and discovers,—even more surely than the pirate his chest,—some wonderful treasure. Sometimes the find is a star-like diamond, a twinkling emerald, a fire-filled ruby or a cluster of star gems of colorful hues, but it may be, too, a profusion of riches, heaped in a magnificence that leaves one breathless.

*The Music of the Spheres: A Nature Lover's Astronomy*  
Chapter I (p. 3)  
The Macmillan Company. New York, New York, USA. 1926

**Halley, Edmond** 1656–1742  
English astronomer and mathematician

We therefore recommend again and again, to the curious investigators of the stars to whom, when our lives are over, these observations are entrusted, that they, mindful of our advice, apply themselves to the understanding of these

observations vigorously. And for them we desire and pray for all good luck, especially that they not be deprived of this coveted spectacle by the unfortunate obscuration of cloudy heavens, and that the immensities of the celestial spheres, compelled to more precise boundaries, may at last yield to their glory and eternal fame.

*Philosophical Transactions of the Royal Society of London*  
A Unique Method by Which the Parallax of the Sun, or Its Distance from the Earth, May Be Securely Determined by Means of Observing Venus Against the Sun, Number 348, April, May, June, 1716 (p. 460)

**Harrington, Sir John** 1560?–1612  
English writer

Astronomers, Painters and Poets may lye by authoritie.

In G. Gregory Smith  
*Elizabethan Critical Essays* (Volume 2)  
Sir John Harrington, A Brief Apology for Poetry (p. 201)  
Oxford University Press, Inc. London, England. 1904

**Herbert, George** 1593–1633  
English metaphysical poet

The fleet Astronomer can bore,  
And thred the spheres with his quick-piercing mind:  
He views their stations, walks from dore to dore,  
Surveys, as if he had design'd  
To make a purchase there: hee sees their dances,  
And knoweth long before,  
Both their full ey'd aspects, & secret glances.

*The Temple*  
The Church, Vanity, l. 1–7 (p. 126)  
Medieval & Renaissance Texts & Studies. Binghamton, New York, USA. 1995

**Hodgson, Ralph** 1871–1962  
English poet

Reason has moons,  
but moons not hers  
Lie mirrored on her sea,  
Confounding her astronomers,  
But O! delighting me.

*Collected Poems*  
Reason Has Moons  
Macmillan & Company Ltd. London, England. 1961

**Howard, Neale E.**  
No biographical data available

Astronomers work always with the past; because light takes time to move from one place to another, they see things as they were, not as they are.

*The Telescope Handbook and Star Atlas*  
The Sky, Chapter III (p. 33)  
Crowell. New York, New York, USA. 1975

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

The astronomer seems at first sight to be the most helpless of all scientists. He cannot experiment with the

Universe. It is a significant matter of nomenclature that whereas we speak of experimental work in other sciences we speak of observational work in astronomy.

*Frontiers of Astronomy*

Prologue (p. xv)

Harper & Row, Publishers. New York, New York, USA. 1955

The astronomer is severely handicapped as compared with other scientists. He is forced into a comparatively passive role. He cannot invent his own experiments as the physicists, the chemist or the biologist can. He cannot travel about the Universe examining the items that interest him. He cannot, for example, skin a star like an onion and see how it works inside.

*The Nature of the Universe*

Chapter 1 (pp. 3–4)

At The University Press. Cambridge, England. 1933

Here is an example of what seems to be general practice in astronomy: when two alternatives are available, choose the more trivial. It was so with the discovery of pulsars — white dwarfs, everybody said they were, until confrontations with fact showed otherwise. And it is so today throughout cosmology. Astronomers seem to live in terror that someday they will discover something important.

*Home Is Where the Wind Blows: Chapters from a Cosmologist's Life*

Part Two, Chapter 19 (p. 269)

University Science Books, Mill Valley, California, USA. 1994

### **Jacoby, Harold** 1865–1932

American astronomer

The beginner in astronomy is always modest as to his abilities, and blames himself if the universe fails to fit the printed directions. Nor does any real astronomer ever lose this modest characteristic of the beginner; for he who has studied this science most deeply is ever most of all convinced that he is still a beginner.

*Astronomy: A Popular Handbook*

Chapter III (p. 46)

The Macmillan Company. New York, New York, USA. 1926

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The task of the observational astronomer is to survey and explore the universe, and to describe and classify the various types of objects which it is constituted, discovering what law and order he may in their observed arrangement and behavior. But only the dullest of human minds can rest content with a mere catalogue of observed facts; an alert mind asks always for the why and the wherefore.

*Astronomy and Cosmogony*

Chapter I (p. 1)

Dover Publications, Inc. New York, New York, USA. 1961

### **Jeffers, Robinson** 1887–1962

American poet

Or as mathematics, a human invention

...parallels but never touches reality, gives the astronomer

Metaphors through which he may comprehend

The powers and the flow of things...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 260)

Stanford University Press. Stanford, California, USA. 1988

Nor can the astronomer see his moon-dazzled

Constellations: let him give one night in the month to earth and the moon,

Women and games.

*The Beginning and the End and Other Poems*

Full Moon (p. 41)

Random House, Inc. New York, New York, USA. 1963

### **Jones, Sir Harold Spencer** 1890–1960

10<sup>th</sup> Astronomer Royal of England

The task of the astronomer is to learn what he can about the universe as he finds it. To endeavor to understand the purpose behind it and to explain why the universe is built as it is, rather than on some different pattern which might have accorded better with our expectations, is a more difficult task; for this the astronomer is no better qualified than anybody else.

*Life on Other Worlds*

Chapter X (p. 253)

The Macmillan Company. New York, New York, USA. 1954

### **Keats, John** 1795–1821

English Romantic lyric poet

Then I felt like some watcher of the skies

When a new planet swims into his ken.

*The Complete Poetical Works and Letters of John Keats*

On First Looking into Chapman's Homer

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

### **Kepler, Johannes** 1571–1630

German astronomer

That astronomer well performs his office who predicts with the greatest measure of approximation the motions and situations of the stars: but he does better and is held worthy of the greater praise who in addition to this furnishes us with true opinions concerning the form of the world.

*Opera Omnia* (Volume 1) (p. 242)

For astronomers ought not simply to enjoy a licence of making any fictions they choose without rational grounds.

*Opera Omnia* (Volume 6) (p. 121)

### **Kirshner, Robert P.**

American astronomer

Like the fifteenth-century navigators, astronomers today are embarked on voyages of exploration, charting unknown regions. The aim of this adventure is to bring back

not gold or spices or silks but something more valuable: a map of the universe that will tell of its origin, its texture, and its fate.

In Marcia Bartusiak  
*Thursday's Universe*  
Chapter 7 (p. 167)  
Random House, Inc. New York, New York, USA. 1986

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

...knowledge about the universe is not easily won. In spite of tremendous effort, almost all of the time we fail to find an answer. Most of the time we even fail to ask the right question. But occasionally, through some combination of serendipity, work, genius, and insight, we do see the sky a little more clearly. It is the hope of seeing something no one else has seen, or understanding something no one has understood before that keep astronomers awake so many nights.

*Blind Watchers of the Sky*  
Chapter Eleven (pp. 293–294)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Kühnert, Franz** 1852–1918  
No biographical data available

Probably another reason why many Europeans consider the Chinese such barbarians is on account of the support they give to their Astronomers — people regarded by our cultivated Western mortals as completely useless. Yet there they rank with Heads of Departments and Secretaries of State. What frightful barbarism!

In Joseph Needham  
*Science and Civilisation in China* (Volume 3)  
Preface (p. iii)  
University Press. Cambridge, England. 1954

**Mackay, Charles** 1814–89  
English poet and journalist

Upon thy lofty tower,  
O lonely Sage,  
Reading at midnight hour  
Heaven's awful page!

*The Collected Songs of Charles Mackay*  
The Astronomer  
G. Routledge & Company. London, England. 1859

**Malin, David**  
No biographical data available

Work on faint objects or that involving the blue end of the spectrum can only be done in dark time. Thus one is more likely to find astronomers whose research involves the infrared part of the spectrum working on nights of the full Moon, which only confirms what we always believed about infrared astronomers.

*A View of the Universe*  
Chapter 3

Photographing the Sky at Night (p. 37)  
Cambridge University Press. Cambridge, Massachusetts, USA. 1993

**Marschall, Laurence A.**  
American physicist

The earliest astronomers...were celestial lookouts, scanning the skies like seamen in a crow's nest.

*The Supernova Story*  
Chapter 1 (p. 4)  
Plenum Press. New York, New York, USA. 1988

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

Astronomers and physicists, dealing habitually with objects and quantities far beyond the reach of the senses, even with the aid of the most powerful aids that ingenuity has been able to devise, tend almost inevitably to fall into the ways of thinking of men dealing with objects and quantities that do not exist at all, e.g., theologians and metaphysicians.

*Minority Report: H.L. Mencken's Notebooks*  
No. 74 (p. 60)  
Alfred A. Knopf. New York, New York, USA. 1956

**Mitchell, Maria** 1818–89  
American astronomer and educator

The Astronomer breaks up the starlight just as the geologist breaks up the rock with his hammer, and with similar results, he finds copper, sodium and other elements in sun and stars. ... If you look at the beautiful ribbon of colors which a ray of sunlight gives when passed through a prism, you see that it is crossed by dark bands, sometimes single, sometimes crowded close together — each of these is a black-lettered message from the sun.

In Helen Wright  
*Sweeper in the Sky*  
Chapter 10 (pp. 188–189)  
The Macmillan Company. New York, New York, USA. 1949

I cannot expect to make astronomers, but I do expect that you will invigorate your minds by the effort at healthy modes of thinking.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter VII (p. 138)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

**Newcomb, Simon** 1835–1909  
Canadian-born American astronomer

As the great captain of industry is moved by the love of wealth, and the politician by the love of power, so the astronomer is moved by the love of knowledge for its own sake, and not for the sake of its application.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1895*  
Aspect of American Astronomy (p. 87)  
Government Printing Office. Washington, D.C. 1896



He who through vast immensity can pierce,  
 See worlds on worlds compose one universe;  
 Observe how system into system runs,  
 What other planets circle suns,  
 What varied being peoples every star,  
 May tell why Heaven has made us as we are.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*  
 The Problems of Astronomy (p. 92)  
 Government Printing Office. Washington, D.C. 1898

**Osiander, Andrew** 1498–1552  
 Lutheran minister

...it is the job of the astronomer to use painstaking and skilled observation in gathering together the history of the celestial movements, and then — since he cannot by any line of reasoning reach the true causes of these movements — to think up or construct whatever causes or hypotheses he pleases such that, by the assumptions of these causes, those same movements can be calculated from the principles of geometry for the past and for the future too...

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
 Introduction, To the Reader Concerning the Hypothesis of this Work (p. 505)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Prior, Matthew** 1664–1721  
 English poet and diplomat

At night astronomers agree...  
*The Literary Works of Matthew Prior*  
 Volume VI, Phillis's Age, Stanza 3, l. 2  
 Clarendon Press. Oxford, England. 1959

**Prudhomme, Sully** 1839–1907  
 French poet

Tis late; the astronomer in his lonely height  
 Exploring all the dark, descries from far  
 Orbs that like distant isles of splendor are.

In Morris Kline  
*Mathematics in Western Culture*  
 Chapter V (p. 60)  
 Oxford University Press, Inc. New York, New York, USA. 1953

**Ptolemy** ca. 90–168  
 Greek astronomer, geographer, and astrologer

Although a mortal I breathe the air of mortals and also am confined by the boundaries of human knowledge, yet, since with mind uplifted I traverse the paths of heaven and the stars revolving with their incessant motions, I am not a mortal nor is my mind debased in mortal body nor does my foot touch the soil of this earth. But, raising my head aloft in the heavens beyond the clouds, I enjoy ambrosia with celestial Jove.

*On Mathematical Studies*  
 Translated by Raymond H. Coon  
 In *Popular Astronomy*, Volume 37, Number 6, June–July 1929 (p. 319)

**Rees, Martin John** 1942–  
 15<sup>th</sup> Astronomer Royal of England

Everything astronomers observe turns out to be a small and atypical fraction of what exists.

*Before the Beginning*  
 Chapter 6 (p. 103)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

**Rheticus, Georg Joachim** 1514–74  
 Austrian-born astronomer and mathematician

The astronomer who studies the motion of the stars is surely like a blind man who, with only a staff [mathematics] to guide him, must make a great, endless, hazardous journey that winds through innumerable desolate places. What will be the result? Proceeding anxiously for a while and groping his way with his staff, he will at some time, leaning upon it, cry out in despair to Heaven, Earth and all the Gods to aid him in his misery.

In Arthur Koestler  
*The Sleepwalkers*  
 Part Three, Chapter I, Section 10 (p. 161)  
 The Macmillan Company. New York, New York, USA. 1966

**Robinson, Edwin Arlington** 1869–1935  
 American poet

And thus we die,  
 Still searching, like poor old astronomers,  
 Who totter off to bed and go to sleep  
 To dream of untriangulated stars.

*Collected Poems of Edwin Arlington Robinson*  
 Octaves, XI (p. 100)  
 The Macmillan Company. New York, New York, USA. 1922

**Sandage, Allan** 1926–  
 American astronomer

What are galaxies? No one knew before 1900. Very few people knew in 1920. All astronomers knew after 1924.

*The Hubble Atlas of Galaxies*  
 Galaxies (p. 1)  
 Carnegie Institute of Washington. Washington, D.C. 1961

**Sayers, Dorothy L.** 1893–1957  
 English novelist and essayist

**Eustace, R.**  
 No biographical data available

The biologist can push it back to the original protist, and the chemist can push it back to the crystal, but none of them touch the real question of why or how the thing began at all. The astronomer goes back untold million of years and ends in gas and emptiness, and then the mathematician sweeps the whole cosmos into unreality and leaves one with mind as the only thing of which we have any immediate apprehension. *Cogito ergo sum, ergo omnia esse videntur*. All this bother, and we are no further than Descartes. Have you noticed that the

astronomers and mathematicians are much the most cheerful people of the lot? I suppose that perpetually contemplating things on so vast a scale makes them feel either that it doesn't matter a hoot anyway, or that anything so large and elaborate must have some sense in it somewhere.

*The Documents in the Case*

Letter 22, John Munting to Elizabeth Drake (p. 70)

Victor Gollancz Ltd., London, England. 1978

### Schawlow, Arthur 1921–99

American physicist

Astronomers are very brave and bold, and make vast assumptions based on very little data. Very clever, though.

In Dennis Brian

*Genius Talk: Conversation with Noble Scientists and Other Luminaries*

Chapter 11 (p. 249)

Plenum Press. New York, New York, USA. 1995

### Schlesinger, Frank 1871–1943

American astronomer

The astronomer has borrowed almost all his tools from the physicist; the prism, the grating, the photoelectric cell, the interferometer, the photographic plate, even the telescope itself, were all used in the laboratory before they were applied to the sky.

In Lorande Woodruff

*The Development of the Sciences*

Chapter IV (p. 166)

### Schneider, Don

American astronomer

How anyone can go out at night and look up and not want to be an astronomer is beyond me.

In Richard Preston

*First Light*

Part 3 (p. 182)

Random House, Inc. New York, New York, USA. 1996

### Shakespeare, William 1564–1616

English poet, playwright, and actor

These earthly godfathers of heaven's lights,  
That give a name to every fixed star  
Have no more profit of their shining nights  
Than those that walk, and wot not what they are.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Love's Labor's Lost

Act I, Scene i, l. 86–89

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...but when he performs astronomers foretell it.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Troilus and Cressida

Act V, Scene i, l. 102–103

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Shapley, Harlow 1885–1972

American astronomer

### Upton, Winslow 1853–1914

American astronomer

His knees should bend and his neck should curl,  
His back should twist and his face should scowl,  
One eye should squint and the other protrude,  
And this should be his customary attitude.

Harvard Observatory Pinafore

*Popular Astronomy*, Volume 38, Number 3, March 1930 (pp. 125–127)

### Shelley, Percy Bysshe 1792–1822

English poet

Heaven's utmost deep  
Gives up her stars, and like a flock of sheep  
They pass before his eye, are numbered, and roll on.

*The Complete Poetical Works of Percy Bysshe Shelley*

Prometheus Unbound

Act IV, l. 418–420

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### Silk, Joseph 1942–

American astronomer and physicist

To many astronomers, the search for intergalactic matter resembles the quest for the holy grail.

*Cosmic Enigmas*

The Intergalactic Medium (p. 177)

AIP Press. Woodbury, New York, USA. 1994

### Stoll, Clifford

American astronomer

The astronomer's rule of thumb: if you don't write it down, it didn't happen.

*The Cuckoo's Egg: Tracking a Spy Through the Maze of Computer Espionage*

Chapter 5 (p. 28)

Doubleday. New York, New York, USA. 1989

### Swift, Jonathan 1667–1745

Irish-born English writer

This load-stone is under the care of certain astronomers, who from time to time give it such positions as the monarch directs. They spend the greatest part of their lives in observing the celestial bodies, which they do by the assistance of glasses, far excelling ours in goodness.

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter III (p. 102)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There was an astronomer who had undertaken to place a sun-dial upon the great weather-cock on the town-house, by adjusting the annual and diurnal motions of the earth and sun, so as to answer and coincide with all accidental turnings of the wind.

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter V (p. 108)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thompson, Francis** 1859–1907  
English writer

Starry amorist, starward gone,  
Thou art — what thou didst gaze upon!  
Passed through thy golden garden's bars,  
Thou seest the Gardner of the Stars.

*Complete Poetical Works of Francis Thompson*

A Dead Astronomer, Stanza 1

Boni & Liveright, Inc., Publishers. New York, New York, USA. 1923

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The astronomer is as blind to the significant phenomena,  
or the significance of phenomena, as the wood-sawyer  
who wears glasses to defend his eyes from the sawdust.

*Journal (Volume 3: 1848–1851)*

August 5, 1851 (p. 354)

Princeton University Press. Princeton, New Jersey, USA. 1981

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American writer and humorist

For three hundred years now, the Christian astronomer  
has known that his Deity didn't make the stars in  
those tremendous six days; but the Christian astronomer  
doesn't enlarge upon that detail. Neither does the priest.

In Bernard Devoto (ed.)

*Letters from the Earth*

Letter III (p. 16)

Harper & Row, Publishers. New York, New York, USA. 1959

I do not see how astronomers can help feeling exquisitely  
insignificant, for every new page of the Book of the Heavens  
they open reveals to them more & more that the world  
we are so proud of is to the universe of careering globes  
as is one mosquito to the winged & hooved flocks & herds  
that darken the air & populate the plains & forests of all the  
earth. If you killed the mosquito, would it be missed? Verily,  
What is Man, that he should be considered of God?

*Mark Twain's Letters (Volume 4, 1870–1871)*

Letter to Olivia L. Langdon

8 January 1870 (p. 12)

University of California Press. Berkeley, California, USA. 1995

**Walcott, Derek** 1930–  
West Indian dramatist and poet

I try to forget what happiness was,  
and when that don't work, I study the stars.

*The Star-apple Kingdom*

The Star-apple Kingdom

The Schooner, Flight, Section 11

Farrar, Straus & Giroux. New York, New York, USA. 1979

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

When I heard the learn'd astronomer,  
When the proofs, the figures, were ranged in columns  
before me,

When I was shown the charts and diagrams to add,  
divide, and measure them,

When I sitting heard the astronomer where he lectured  
with much applause in the lecture-room,

How soon unaccountable I became tired and sick...

*Complete Poetry and Collected Prose*

When I Heard the Learn'd Astronomer

The Library of America. New York, New York, USA. 1982

**Wordsworth, William** 1770–1850  
English poet

Spirits that crowd the intellectual sphere  
With mazy boundaries, as the astronomer  
With orb and cycle girds the starry throng.

*The Complete Poetical Works of William Wordsworth*

Ecclesiastical Sonnets, Part II, Section 5, l. 12–14

Crowell. New York, New York, USA. 1888

Eyes of some men travel far  
For the finding of a star;  
Up and down the heavens they go...

Like a sage astronomer.

*The Complete Poetical Works of William Wordsworth*

To the Small Celandine, l. 16–19

Crowell. New York, New York, USA. 1888

**Wright, Thomas** 1711–86  
English cosmologist

In this great Celestial Creation, the Catastrophy of a World  
such as ours, or even the total Dissolution of a System of  
Worlds, may possibly be no more to the great Author of  
Nature, than the most common Accident in Life with us,  
and in all Probability such final and general Doom-Days  
may be as frequent there as even Birthdays, or Mortality  
with us upon the Earth. This Idea has something so  
cheerful in it, that I own I can never look upon the  
Stars without wondering why the whole World does not  
become Astronomers...

*An Original Theory or New Hypothesis of the Universe*

Letter the Eighth (p. 76)

Printed for the Author. London, England. 1750

**Young, Edward** 1683–1765  
English poet and dramatist

Devotion Daughter of Astronomy  
An undevout astronomer is mad!

*Night Thoughts*

Night IX, l. 772–773

Printed by R. Nobels for R. Edwards. London, England. 1797

...Stars malign,

Which make their fond Astronomer run mad...

*Night Thoughts*

Night IX, l. 1651

Printed by R. Nobels for R. Edwards. London, England. 1797

## ASTRONOMICAL

**Boethius** ca. 475–524  
Roman philosopher and statesman

Think then thus upon it, and see that it is but a slight thing of no weight. As you have learnt from astronomers' shewing, the whole circumference of the earth is but as a point compared with the size of the heavens. That is, if you compare the earth with the circle of the universe, it must be reckoned as of no size at all.

Translated by W.W. Cooper

*The Consolation of Philosophy*

Book II, Prose VII (pp. 48–49)

J.M. Dent & Sons Ltd. London, England. 1902

### Cook, Joseph

No biographical data available

Bye Baby Bunting,

Father's gone star-hunting;

Mother's at the telescope

Casting baby's horoscope.

Bye Baby Buntoid,

Father's found an asteroid;

Mother takes by calculation

The angle of its inclination.

In Sara and John E. Brewton and John Brewton Blackburn

*Of Quarks, Quasars, and Other Quirks: Quizzical Poems for the Supersonic Age*

Boston Nursery Rhymes, Rhyme for Astronomical Baby (p. 40)

Crowell. New York, New York, USA. 1977

### Hoyle, Sir Fred 1915–2001

English mathematician and astronomer

No literary genius could have harvested a story one-hundredth part as fantastic as the sober facts that have been unearthed by astronomical science.

*The Nature of the Universe*

Chapter 7 (p. 133)

At the University Press. Cambridge, England. 1933

### Paracelsus (Theophrastus Phillippus Aureolus

**Bombastus von Hohenheim) 1493–1541**

Swiss alchemist and mystic

All this you should know exists in man and realize that the firmament is within man, the firmament with its great movements of bodily planets and stars which result in exaltations, conjunctions, oppositions and the like, as you call these phenomena as you understand them. Everything which astronomical theory has searched deeply and gravely by aspects, astronomical tables and so forth, — this self-same knowledge should be a lesson and teaching to you concerning the bodily firmament. For, none among you who is devoid of astronomical knowledge may be filled with medical knowledge.

In Allen G. Debus

*The French Paracelsians*

Chapter 1 (p. 9)

Cambridge University Press. Cambridge, England. 1991

## ASTRONOMICAL TIME

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

It was not easy to visualize the vastness of astronomical space, and it is even less easy to conceive of the immensity of astronomical time. A fairly lengthy book contains about 200,000 words averaging five letters each. Let us take the whole of such a book to represent the age of the earth. Then the whole of civilization is represented by the last word or two, and the whole of the Christian era by something less than the last letter. A single lifetime is a good deal less than the final full stop with which the book ends. Such is the age of our won planet, and, whatever view we take, the age of the whole universe, on the same scale, is a matter of volumes. If the view I put forward is correct, it must be represented by a library of some thousands of volumes.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1936*

The Size and Age of the Universe (p. 136)

Government Printing Office. Washington, D.C. 1937

## ASTRONOMY

### Abbot, Charles Greeley 1872–1973

American astrophysicist

Astronomy is the distinguished child of the gypsy-like mother, astrology.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1936*

Astronomy in Shakespeare's Time and in Ours (p. 109)

Government Printing Office. Washington, D.C. 1937

### Airy, George Biddell 1801–92

English astronomer

Astronomy is pre-eminently the science of order.

Account of Some Circumstances Historically Connected with the Discovery of the Planet Exterior to Uranus

*Monthly Notices of the Royal Astronomical Society, Volume 7, 1846*

### Arago, Francois 1786–1853

French physicist

Astronomy is the science of which the human mind may most justly boast. It owes this indisputable pre-eminence to the elevated nature of its object, to the grandeur of its means of investigation, to the certainty, the utility, and the unparalleled magnificence of its results.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1874*

Laplace (p. 131)

Government Printing Office. Washington, D.C. 1875

Astronomy is a happy science, it has not need for decorations.

In L.I. Ponomarev

*The Quantum Dice* (p. 225)

Institute of Physics Publishing. Bristol, England. 1993

Of all the sciences, none would seem to yield a purer intellectual gratification than that of Astronomy. Man cannot but feel a sense of pleasure, and even of power,

when, through the instruments constructed by his ingenuity, he finds himself brought within reach, as it were, of the innumerable orbs that roll through the domains of space. He cannot but feel a sense of pleasure, and even of power, when the telescope reveals to his gaze not only the worlds that constitute his own so-called Solar System, but the suns that light up the borders of the Universe, system upon system, sun upon sun, covering the unbounded area almost as thickly as the daisies cover a meadow in spring.

*The Story of The Herschels: A Family of Astronomers*  
Chapter I  
T. Nelson & Sons. London, England. 1889

It may indeed appear extraordinary that no mention should yet have been made of the great desiderata of astronomy — those questions which have exercised the curiosity and employed the time and attention of astronomers ever since the science has assumed its present character — such as the parallax of the fixed stars, their proper motion, the motion or rest of our own system, and its connection with the rest of the universe. But these and many other points are too obviously suggested by their importance to need any distinction which this society can bestow: the applause of the human race attends his labours; and no additional stimulus can be offered to those by which he is impelled.

Report to the First Annual General Meeting  
*Memoirs of the Astronomical Society of London*, 9 February 1821,  
Volume I, 1822–25 (pp. 24–25)

Astronomy, although the oldest and in many respects the most perfect of the sciences, in many of its questions is still in its infancy.

Scientific Miscellany  
*The Galaxy*, Volume XIII, March 1872 (p. 419)

GURU: Today I will discourse upon the violence in astronomy.

DISCIPLE: Revered Sir! Will you be describing the violent phenomena in the Universe?

GURU: Yes, and I will also dwell upon the controversies amongst the astronomers about what these events imply — controversies which are no less violent than the phenomena themselves.

In Jayant Narlikar  
*Violent Phenomena in the Universe*  
Chapter 1 (p. 1)  
Oxford University Press. Oxford, England. 1982

**Bennett, Arnold** 1867–1931  
English novelist and playwright

He knew not how to look at a landscape nor at a sky. Of plants and trees he was as exquisitely ignorant as of astronomy. It had not occurred to him to wonder why the days are longer in summer, and he vaguely supposed that the cold of winter was due to an increased distance of the

earth from the sun. Still, he had learnt that Saturn had a ring and sometimes he unconsciously looked for it in the firmament, as for a tea-tray.

*Clayhanger*  
Book I, Chapter II, Section III (p. 14)  
E.P. Dutton & Company. New York, New York, USA. 1910

**Bichat, Xavier** 1771–1802  
French physician and pathologist

To say that physiology is made up of the physics of animals is to give a very inaccurate idea of it; as well might we say that astronomy is the physiology of the stars.

*Physiological Researches on Life and Death*  
Chapter VII, Section I (p. 81)  
Arno Press. New York, New York, USA. 1977

**Brewster, David** 1781–1868  
English physicist

Of all the sciences cultivated by mankind, astronomy is acknowledged to be, and undoubtedly is, the most sublime, the most interesting, and the most useful; for, by knowledge derived from this science, not only the bulk of the earth is discovered, the situation and extent of the countries and kingdoms upon it ascertained, trade and commerce carried on to the remotest parts of the world, and the various products of several countries distributed for the health, comfort, and conveniency of its inhabitants; but our very faculties are enlarged with the grandeur of the ideas it conveys, our minds exalted above the low contracted prejudices of the vulgar, and our understandings clearly convinced, and affected with the conviction of the existence, wisdom, power, goodness, immutability, and superintendency of the Supreme Being!

*Ferguson's Astronomy, Explained upon Sir Isaac Newton's Principles*  
(Volume 1)  
Chapter I (p. 1)  
Printed for the author. London, England. 1756

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Astronomy is not the apex of science or of invention. But it is a test of the cast of temperament and mind that underlies a culture.

*The Ascent of Man*  
Chapter 6 (p. 190)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Burnham, Robert, Jr.** 1931–93  
American astronomer

No one can date that remote epoch when astronomy “began” — we can say only that the fascination of the heaven is as old as man’s ability to think; as ancient as his capacity to wonder and to dream. And in company with most of the special enchantments of human life, the unique appeal of astronomy is incommunicable; easily understood through direct experience, but not to be

precisely defined or explained. Nor should any explanation be thought necessary. The area of astronomy is both intellectual and aesthetic; it combines the thrill of exploration and discovery, the fun of sight-seeing, and the sheer pleasure of firsthand acquaintance with incredibly wonderful and beautiful things.

*Burnham's Celestial Handbook* (Volume 1)

Chapter 1 (p. 5)

Celestial Handbook Publications. Flagstaff, Arizona, USA.

**Byrd, Deborah** 1951–

American radio host

Astronomy is something a culture does when it wants to understand itself.

Focus

*Sky and Telescope*, Volume 80, Number 6, December 1990 (p. 580)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Thus, astronomy was probably the first exact science, practiced long before the concept of science as such had been formulated. (Mathematics may have been earlier, but I do not consider it a natural science: the mother of many kings is not necessarily a queen.)

*Serious Questions*

Nature (p. 153)

Birkhäuser. Boston, Massachusetts, USA. 1986

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Astronomy, as nothing else can do, teaches men humility.

*The Challenge of the Spaceship*

The Star of the Magi (p. 86)

Harper & Brothers. New York, New York, USA. 1959

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

[Astronomy] is a science of hairbreadths and fractions of a second. It exists only by the rigid enforcement of arduous accuracy and unwearying diligence. Whatever secrets the universe still has in store for man will only be communicated on these terms.

*A Popular History of Astronomy During the Nineteenth Century*

Part I, Chapter VI (p. 123)

A. & C. Black. London, England. 1908

...the science of the nature of the heavenly bodies... is full of the audacities, the inconsistencies, the imperfections, the possibilities of youth... It promises everything; it has already performed much; it will doubtless perform much more.

*A Popular History of Astronomy During the Nineteenth Century*

Part II, Chapter I (p. 142)

A. & C. Black. London, England. 1908

**Comte, Auguste** 1798–1857

French philosopher

We may therefore define Astronomy as the science by which we discover the laws of the geometrical and mechanical phenomena presented by the heavenly bodies.

*The Positive Philosophy of Auguste Comte*

Book II, Chapter I (p. 138)

John Chapman. London, England. 1853

**Conrad, Joseph** 1857–1924

Polish-born English novelist

The demonstration must be against learning-science. But not every science will do. The attack must have all the shocking senselessness of gratuitous blasphemy. Since bombs are your means of expression, it would be really telling if one could throw a bomb into pure mathematics. But that is impossible...What do you think of having a go at astronomy?

*The Secret Agent: A Simple Tale*

Chapter II (p. 38)

Doubleday, Page & Company. Garden City, New York, USA. 1916

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

And as far as hypotheses go, let no one expect anything in the way of certainty from astronomy, since astronomy can offer us nothing certain, lest, if anyone take as true that which has been constructed for another use, he go away from this discipline a bigger fool than when he came to it.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, To the Reader Concerning the Hypotheses of this Work (p. 506)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Fontenelle, Bernard le Bovier** 1657–1757

French writer

...astronomy was the daughter of idleness, geometry the daughter of interest; and if we did but examine poetry, we should certainly find her to be the daughter of love.

*Conversations on the Plurality of Worlds*

The First Evening (p. 11)

Printed for Peter Wilson. Dublin, Ireland. 1761

...my soul is not mercenary enough for geometry, nor is it tender enough for poetry; but I have as much time to spare as astronomy requires...

*Conversations on the Plurality of Worlds*

The First Evening (p. 12)

Printed for Peter Wilson. Dublin, Ireland. 1761

...astronomy is the offspring of idleness...

*Conversations on the Plurality of Worlds*

First Evening (p. 12)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Dick, Thomas** 1600–80

Scottish theologian and philosopher

The objects which astronomy discloses afford subjects

of sublime contemplation, and tend to elevate the soul above vicious passions and groveling pursuits.

In Elijah H. Burritt

*The Geography of the Heavens, and a Class-book of Astronomy: Accompanied by a Celestial Atlas*

Introduction

Mason Brothers. New York, New York, USA. 1863

Astronomy is that department of knowledge which has for its object to investigate the motions, the magnitudes, and distances of the heavenly bodies; the laws by which their movements are directed, and the ends they are intended to subserve in the fabric of the universe. This is a science which has in all ages engaged the attention of the poet, the philosopher, and the divine, and has been the subject of their study and admiration. Kings have descended from their thrones to render it homage, and have sometimes enriched it with their labours; and humble shepherds, while watching their flocks by night, have beheld with rapture the blue vault of heaven, with its thousand shining orbs, moving in silent grandeur, till the morning star announced the approach of day.

*The Complete Works of Thomas Dick, LL.D.*

Volume VII, Celestial Scenery, Introduction (p. 8)

Edwards & Bushnell. St. Louis, Missouri, USA. 1857

### Dickson, Frank

No biographical data available

The little boy had received his first lesson in astronomy and was proudly exhibiting his knowledge to his still smaller sister.

“That star,” he said, pointing to one of the most brilliant ornaments of the heavens, “is much larger than the earth.”

“You can’t make me believe that.” the sister replied. “If it’s as big as that, why doesn’t it keep the rain off us?”

Good Stories You Can Use

*Quote, the Weekly Digest*, July 17, 1966 (p. 14)

### Donne, John 1572–1631

English poet and divine

We think the heavens enjoy their Spherical,  
Their round proportion embracing all.  
But yet their various and perplexed course,  
Observ’d in divers ages doth enforce  
Men to finde out so many Eccentrique parts,  
Such divers downe-right lines, such overthwarts,  
As disproportion that pure forme. It teares  
The Firmament in eight and forty sneers.

In A. J. Smith (ed.)

*The Complete English Poems of John Donne*

An Anatomie of the World, First Anniversary, l. 251–258

St. Martin’s Press. New York, New York, USA. 1971

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

No one can read the history of astronomy without perceiving that Copernicus, Newton, Laplace, are not new men, or a new kind of men, but that Thales, Anaximenes, Hipparchus, Empedocles, Aristorchus, Pythagoras, Oenipodes, had anticipated them...

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Fate (p. 951)

The Library of America. New York, New York, USA. 1983

The sciences, even the best, — mathematics and astronomy, — are like sportsmen, who seize whatever prey offers, even without being able to make any use of it.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

Representative Men

Chapter II (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Astronomy taught us our insignificance in Nature...

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Lectures and Biographical Sketches

Historic Notes of Life and Letters in New England (p. 336)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Astronomy is a cold, desert science...

*The Complete Works of Ralph Waldo Emerson* (Volume 12)

Natural History of Intellect

Chapter V (p. 166)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

It is noticed, that the consideration of the great periods and spaces of astronomy induces a dignity of mind, and an indifference to death.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Culture (p. 1030)

The Library of America. New York, New York, USA. 1983

Astronomy is the science which treats of the motions of the heavenly bodies, and all the phenomena arising therefrom.

*A System of Astronomy: Containing the Investigation and Demonstration of the Elements of that Science*

Astronomy (p. 1)

Printed for J. Nourse. London, England. 1769

### Everett, Edward 1794–1865

American statesman, educator, and orator

...the unspeakable glories of the rising and the setting sun; the serene majesty of the moon, as she walks in full-orbed brightness through the heavens; the soft witchery of the morning and the evening star; the imperial splendors of the firmament on a bright, unclouded night; the comet, whose streaming banner floats over half the sky, — these are objects which charm and astonish alike the philosopher and the peasant, the mathematician who weighs the masses and defines the orbits of the heavenly bodies, and the untutored observer who sees nothing beyond the images painted upon the eye.

An Oration

The Uses of Astronomy, Albany, New York, 28 July 1856 (p. 20)  
Ross & Tousey. New York, New York, USA. 1856

**Flammarion, Camille** 1842–1925  
French astronomer and writer

Astronomy is the most accurate of the sciences. All the truths which it teaches are absolutely demonstrated, and cannot be disputed by any mind which gives itself the trouble, or rather the pleasure, to gain information in the study of this admirable science.

*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter VI (p. 53)  
Chatto & Windus. London, England. 1894

Far from being a difficult and inaccessible science, Astronomy is the science which concerns us most, the one most necessary for our general instruction, and at the same time the one which offers for our study the greatest charms and keeps in reserve the highest enjoyments. We cannot be indifferent to it, for it alone teaches us where we are and what we are; and, moreover, it need not bristle with figures, as some severe savants would wish us to believe. The algebraical formulæ are merely scaffoldings analogous to those which are used to construct an admirably designed palace. The figures drop off, and the palace of Urania shines in the azure, displaying to our wondering eyes all its grandeur and all its magnificence.

*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter I (p. 1)  
Chatto & Windus. London, England. 1894

**Frost, Robert** 1874–1963  
American poet

“But Cygnus isn’t in the Zodiac,”

Dick longed to say, but wasn’t sure enough  
Of his astronomy...

*Complete Poems of Robert Frost*  
From Plane to Plane  
Henry Holt & Company. New York, New York, USA. 1949

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

Astronomy, for instance, is hardly mentioned, and only the sun, and the moon, and Lucifer are named. Surely, if the holy writers had intended us to derive our astronomical knowledge from the Sacred Books, they would not have left us so uninformed. That they intentionally forbore to speak of the movements and constitution of the stars is the opinion of the most holy and most learned fathers. And if the Holy Spirit has omitted to teach us those matters as not pertinent to our salvation, how can it be said that one view is de Fide and the other heretical? I might here insert the opinion of an ecclesiastic raised to the degree of Eminen-tissimo: That the intention of the Holy Ghost is to teach us how we shall go to Heaven, and not how the heavens go.

In Arthur Mee and J.A. Hammerton (eds.)

*The World’s Greatest Books* (Volume 13)  
*The Authority of Scripture in Philosophical Controversies*  
Section I

The Defenders of Fallacy (p. 133)  
W.H. Wise. New York, New York, USA. 1910

It is surely harmful to souls to make it a heresy to believe what is proved. The prohibition of astronomy would be an open contempt of a hundred texts of the Holy Scriptures, which teach us that the glory and the greatness of Almighty God are admirably discerned in all His works, and divinely read in the open book of the heavens.

In Arthur Mee and J.A. Hammerton (eds.)  
*The World’s Greatest Books* (Volume 13)  
*The Authority of Scripture in Philosophical Controversies*  
Section II  
Scripture and Experimental Truth (p. 134)  
W.H. Wise. New York, New York, USA. 1910

...to command the professors of astronomy to confute their own observations is to enjoin an impossibility, for it is to command them to not see what they do see, and not to understand what they do understand, and to find what they do not discover.

In Arthur Mee and J.A. Hammerton (eds.)  
*The World’s Greatest Books* (Volume 13)  
*The Authority of Scripture in Philosophical Controversies*  
Section II  
Scripture and Experimental Truth (p. 134)  
W.H. Wise. New York, New York, USA. 1910

**Grant, Robert** 1814–92  
English astronomer

Astronomy is not only one of the most ancient of the physical sciences, but also one of those which present the most alluring invitations to the contemplative mind. The starry heavens, spangling with countless luminaries of every shade of brilliancy, and revolving in eternal harmony round the earth, constitute one of the most imposing spectacles which nature offers to our observation.

*History of Physical Astronomy, from the Earliest Ages to the Middle of the Nineteenth Century*  
Introduction (p. 1)  
Robert Baldwin. London, England. 1852

**Hale, George Ellery** 1868–1938  
American astronomer

At any period in the progress of observational astronomy there are two most important subjects for consideration. One relates to the accomplishment of a great amount of routine observation and the discussion of results, and the other relates to the introduction of new ideas and to the beginnings of the new methods which will make the astronomy of the future.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*  
Some Opportunities for Astronomical Work with Inexpensive Apparatus (p. 267)  
Government Printing Office. Washington, D.C. 1908



**Harrington, Thomas**

No biographical data available

Each Branch of the human Literature hath had its admirers; but Men of Wisdom in every Age have been unanimous in assigning a Preference to Astronomy.

*Science Improved; or, The Theory of the Universe*

To His Royal Highness George, Prince of Wales (p. 1)

Printed for the Author. London, England. 1774

Astronomy is that refined Science which teaches us a knowledge of the Stars, and in general, of all the heavenly bodies, their form, structure, appearances and motions, their positions in the Heavens, their magnitude and their distance, periods and Eclipses; a large and extensive field!

*Science Improved; or, The Theory of the Universe*

Section XIII (p. 82)

Printed for the Author. London, England. 1774

Astronomy, with the utmost propriety, may be said to enlarge the mind in submitting the very course of the heavenly bodies to our understanding...

*Science Improved; or, The Theory of the Universe*

Section XIV (p. 86)

Printed for the Author. London, England. 1774

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

If proof were wanted of the inexhaustible fertility of astronomical science in points of novelty and interest, it would suffice to adduce the addition to the list of members of our system of no less than eight new planets and satellites during the preparation of these sheets for the press.

*Outlines of Astronomy*

Preface (p. 5)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1849

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If I were asked to define theoretical astronomy in one sentence I should say that it consists of discovering the properties of matter, partly by experiments carried out on the Earth and partly through the detailed observation of near-by space, and in then applying the results to the Universe as a whole.

*The Nature of the Universe*

Chapter 1 (p. 5)

At the University Press. Cambridge, England. 1933

**Hubble, Edwin Powell** 1889–1953

American astronomer

Astronomy is something like the ministry.... No one should go into it without a "call."

In Barry Parker

*Creation: The Story of the Origin and Evolution of the Universe*

Chapter 2 (p. 29)

Plenum Press. New York, New York, USA. 1998

...the history of astronomy is a history of receding horizons.

*Science News Letter*

Volume 11, Number 306 (p. 1)

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

I turn the handle and the story starts:

Reel after reel is all astronomy,  
Till life, enkindled in a niche of sky,  
Leaps on the stage to play a million parts.  
Life leaves the slime and through the oceans darts;  
She conquers earth, and raises wings to fly;  
Then spirit blooms, and learns how not to die,  
Nesting beyond the grave in others' hearts.  
I turn the handle; other men like me  
Have made the film; and now I sit and look  
In quiet, privileged like Divinity  
To read the roaring world as in a book.  
If this thy past, where shall thy future climb,  
O Spirit, built of Elements and Time!

*Essays of a Biologist*

Evolution: At the Mind's Cinema (p. 2)

Alfred A. Knopf. New York, New York, USA. 1929

**Huxley, Thomas Henry** 1825–95

English biologist

When Astronomy was young "the morning stars sang together for joy," and the planets were guided in their courses by celestial hands. Now, the harmony of the stars has resolved itself into gravitation according to the inverse squares of the distances, and the orbits of the planets are deducible from the laws of the forces which allow a schoolboy's stone to break a window.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 56)

Macmillan & Company Ltd. London, England. 1904

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Most sciences progress by pursuing nature into the realms of infinitely small, but for astronomy and cosmogony progress lies in the direction of the infinitely great, or, to be more exact, of the unthinkable great.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1926*

The New Outlook in Cosmogony (p. 151)

Government Printing Office. Washington, D.C. 1928

Astronomy has always stood aloof from the other sciences; her field of research is apart, her methods are entirely her own, and, most significant of all, her results have different values from those of other sciences. While these reward mankind by utilitarian gifts, new methods for

the production of wealth, the increase of pleasure or the avoidance of pain, astronomy has so far given us only food for intellectual contemplation.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1926*

The New Outlook in Cosmogony (p. 151)  
Government Printing Office. Washington, D.C. 1928

**Jeffers, Robinson** 1887–1962

American poet

There is nothing like astronomy to pull the stuff out of man,

His stupid dreams and red-rooster importance: let him count the star-swirls.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Polar Ice-Caps Are Melting (p. 476)  
Stanford University Press. Stanford, California. USA. 1988

Therefore astronomy is the most noble science: is the most useless.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 291)  
Stanford University Press. Stanford, California. USA. 1988

**Keill, John** 1671–1721

Scottish mathematician and natural philosopher

There is nothing in Nature that does more show the piercing Force of Human Understanding, the sublimity of its Speculations and deep researchers, than true Astronomy. It raises our Minds above our Senses, and even in contradiction to them, shows us the true System of the World: the faculty of Reason by which we have made these great discoveries in the Heavens must needs be derived from Heaven, since no Earthly Principle can attain so great a Perfection.

*An Introduction to the True Astronomy*

Lecture IV (pp. 27–28)

Printed for Bernard Lintot. London, England. 1721

Among all the Mathematical Sciences which have been continually improved, and are daily improving in the World, the First Place has, as it were, by general Consent, Been always given to Astronomy.

*An Introduction to the True Astronomy*

To His Grace Jones Duke of Chandos

Printed for Bernard Lintot. London, England. 1721

Astronomy teaches us to observe and discover the Motions of the Heavenly Bodies, and it weighs and considers the Force and Vigor by which they circulate in their Orbs. It is a Science which the greatest Heroes from the beginning of the World have taken Pleasure to Study and improve; so that it was always esteemed as a Science fit for Kings and Emperors to employ themselves in.

*An Introduction to the True Astronomy*

The Preface (p. I)

Printed for Bernard Lintot. London, England. 1721

**Kepler, Johannes** 1571–1630

German astronomer

It is true that a divine voice, which enjoins humans to study astronomy, is expressed in the world itself, not in words or syllables, but in things themselves and in the conformity of the human intellect and senses with the sequence of celestial bodies and their disposition.

*New Astronomy*

Part II, 7 (p. 183)

At the University Press. Cambridge, England. 1992

Astronomy has two ends, to save the appearances and to contemplate the true form of the edifice of the world.

In Michael Zeilik

*Astronomy: The Evolving Universe* (6th Edition)

Chapter Three, The New Cosmic Order (p. 43)  
John Wiley & Sons, Inc. New York, New York, USA. 1991

But whoever is too stupid to understand astronomical science, or too weak to believe Copernicus without affecting his faith, I would advise him that, having dismissed astronomical studies and having damned whatever philosophical opinions he pleases, he minds his own business and betakes himself home to scratch in his own dirt patch, abandoning this wandering about the world.

*New Astronomy*

Author's introduction (pp. 65–66)

At the University Press. Cambridge, England. 1992

As in every discipline, so in astronomy, too, the conclusions that we teach the reader are seriously intended, and our discussion is no mere game.

*Opera Omnia* (Volume 1) (p. 239)

I am much occupied with the investigation of physical causes. My aim in this is to show that the celestial machine is to be likened not to a divine organism, but rather a clockwork...

In Michael Zeilik

*Astronomy: The Evolving Universe* (6th Edition)

Chapter Four, The Clockwork Universe (p. 51)

John Wiley & Sons, Inc. New York, New York, USA. 1991

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Of all the natural sciences, astronomy is that which presents the longest series of discoveries. The first appearance of the heavens is indeed far removed from that enlarged view, by which we comprehend at the present day, the past and future states of the system of the world.

Translated Henry H. Harte

*The Systems of the World* (Volume 1) (pp. 1, 2)

University Press. Dublin, Ireland. 1830

The progress of astronomy depends on these three things: the measure of time, that of angles, and the perfection of optical instruments. The two first are nearly as perfect as we could wish; it is therefore to the improvement of the latter that our attention should be directed.

Translated Henry H. Harte  
*The Systems of the World* (Volume 2) (p. 339)  
 University Press. Dublin, Ireland. 1830

Astronomy has already made an important step, in making us acquainted with the motion of the Earth, and the epicycles which the Moon and the satellites describe on the orbits of their respective planets. But if ages were necessary in order to know the motions of the planetary system, what a great length of time must be required for the determination of the motions of the Sun and the stars; notwithstanding this, such motions appear to be already indicated by observations.

Translated Henry H. Harte  
*The Systems of the World* (Volume 2) (p. 338)  
 University Press. Dublin, Ireland. 1830

Astronomy, considered in the most general way, is a great problem of mechanics, the arbitrary data of which are the elements of the celestial movements; its solution depends both on the accuracy of observations and on the perfection of analysis.

*Celestial Mechanics*  
 Preface  
 Chelsea Publishing Company. Bronx, New York, USA. 1966

**Larrabee, Eric** 1922–90  
 American historian

Astronomy was independently discovered by Copernicus and Kepler, who sent the news to each other (*de nova stella*) by sidereal messenger.

*Humor from Harper's*  
 Easy Road to Culture, Sort of (p. 89)  
 Harper. New York, New York, USA. 1961

**Leacock, Stephen** 1869–1944  
 Canadian humorist

Astronomy teaches the correct use of the sun and the planets.

*Literary Lapses*  
 A Manual of Education (p. 127)  
 John Lane. London, England. 1911

**Lichtenberg, Georg Christoph** 1742–99  
 German physicist and satirical writer

Astronomy is perhaps the science whose discoveries owe least to chance, in which human understanding appears in its whole magnitude, and through which man can best learn how small he is.

*Lichtenberg: Aphorisms & Letters*  
 Notebook c, Aphorism 23  
 Jonathan Cape. London, England. 1969

**Long, Roger** 1680–1770  
 English astronomer

Astronomy is a science which, in all ages and countries flourishing in arts and politeness, has engaged the attention

of the curious: it has not only employed the pens of the most eloquent orators and embellished the writings of poets of the most elevated genius; but has also been cultivated by the greatest princes, the ablest statesmen, and the wisest philosophers...

*Astronomy, In Five Books* (Volume 1)  
 Preface (p. iii)  
 Printed for the Writer. Cambridge, England. 1742

**Mitchell, Maria** 1818–89  
 American astronomer and educator

Nothing comes out more clearly in astronomical observation than the immense activity of the universe.

In Eve Merriam  
*Growing Up Female in America*  
 Maria Mitchell (p. 89)  
 Doubleday & Company, Inc. Garden City, New York, USA. 1971

But star-gazing is not science. The entrance to astronomy is through mathematics.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
 Chapter IX (pp. 184–185)  
 Lee & Shepard. Boston, Massachusetts, USA. 1896

I believe in women even more than I do in astronomy.

In Helen Wright  
*Sweeper in the Sky*  
 Chapter 10 (p. 190)  
 The Macmillan Company. New York, New York, USA. 1949

**Muirden, James**

No biographical data available

Astronomy is a science, but it is also an exciting voyage of discovery. The sky is free for all to see, town-dwellers and country-dwellers alike. Everything, from the blinding Sun to the dimmest star, waits to be discovered.

*Astronomy Handbook*  
 Introduction (p. 8)  
 Arco Publishing, Inc. New York, New York, USA. 1982

**Murdin, Paul**

British astronomer

The aims of astronomy are nothing less than to search for the origins of the Universe and of its constituent stars and galaxies.

In Derek McNally  
*The Vanishing Universe*  
 The Aims of Astronomy in Science and the Humanities: Why Astronomy Must Be Protected (p. 16)  
 Cambridge University Press. Cambridge, England. 1994

**Neugebauer, Otto** 1899–1990

Austrian-American mathematician and astronomer

I do not hesitate to assert that I consider astronomy as the most important force in the development of science since its origin sometime around 500 B.C. ...

*The Exact Sciences in Antiquity*

Introduction (p. 2)  
Princeton University Press. Princeton, New Jersey, USA. 1952

**Newcomb, Simon** 1835–1909  
Canadian-born American astronomer

[Astronomy] seems to have the strongest hold on minds which are not intimately acquainted with its work. The view taken by such minds is not distracted by the technical details which trouble the investigator, and its great outlines are seen through an atmosphere of sentiment, which softens out the algebraic formulae with which the astronomer is concerned into those magnificent conceptions of creation which are the delight of all minds, trained or untrained.

*Harper's New Monthly Magazine*  
February 1885

**Pagel, Bernard** 1930–  
British astronomer

Astronomy is a branch of science that enjoys a universal fascination. One of the reasons why it fascinates people is that the sheer romance of the night sky never palls even for the most hard-bitten observer — at least in the warm and comparatively short nights of the summer. In winter it has to be admitted that observing is not quite so romantic after one has been at it for six hours or more, but there are always enough interesting things in the sky itself to compensate one for the effort.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1963*

The Analysis of Starlight (p. 301)  
Government Printing Office. Washington, D.C. 1964

**Penrose, Roger** 1931–  
English mathematical physicist

Yet nature does not always prefer conventional explanations, least of all in astronomy.

Black Holes  
*Scientific American*, Volume 226, Number 5, May 1972 (p. 46)

**Penzias, Arno** 1933–  
German-American mathematical physicist

Astronomy leads us to a unique event, a universe which was created out of nothing, one with the very delicate balance needed to provide exactly the conditions required to permit life, and one which has an underlying (one might say “supernatural”) plan.

In Henry Margenau and Roy Abraham Varghese (eds.)  
*Cosmos, Bios, Theos*  
Chapter 16 (p. 83)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1992

**Plato** 428 BCE–347 BCE  
Greek philosopher

SOC: At the Egyptian city of Naucratis, there was a famous old god, whose name was Theuth...and he was the

inventor of many arts such as arithmetic and calculation and geometry and astronomy...

In *Great Books of the Western World* (Volume 7)  
*Phaedrus*  
Section 274 (p. 138)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

For everyone, as I think, must see that astronomy compels the soul to look upwards and leads us from this world to another.

In *Great Books of the Western World* (Volume 7)  
*The Republic*  
Book VII, Section 529 (p. 395)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But the race of birds was created out of innocent light-minded men, who, although their minds were directed toward heaven, imagined, in their simplicity, that the clearest demonstration of the things above was to be obtained by sight...

In *Great Books of the Western World* (Volume 7)  
*Timaeus*  
Section 91 (p. 476)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...astronomy tell us about the motions of the stars and sun and moon, and their relative swiftness.

In *Great Books of the Western World* (Volume 7)  
*Gorgias*  
Section 451 (p. 254)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...in astronomy, as in geometry, we should employ problems, and let the heavens alone if we would approach the subject in the right way and so make the natural gift of reason to be of any real use.

In *Great Books of the Western World* (Volume 7)  
*The Republic*  
Book VII, Section 530 (p. 396)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Proctor, Richard A.** 1837–88  
English astronomer

Astronomy...is of all others the science which seems to present to us the most striking instance of waste...

*Our Place Among the Infinities*  
Of Seeming Waste in Nature (p. 40)  
Chatto & Windus. London, England. 1879

**Raymo, Chet** 1936–  
American physicist and science writer

Astronomy is a science of faint lights. The excitement of astronomy lies in the way grand knowledge is distilled from barely luminous blurs in the night sky.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 3 (p. 28)  
The Viking Press. New York, New York, USA. 1991

It is easy to be overawed by the visions of the new astronomy. Many among us would prefer to retreat into a comfortable cloud of unknowing. But if we are truly

interested in knowing who we are, then we must be brave enough to accept what our senses and our reason tell us. We must enter into the universe of the galaxies and the light-years, even at the risk of spiritual vertigo, and know what after all must be known.

*The Soul of the Night*

Preface (p. ix)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1985

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In astronomy, the law of gravitation is plainly better worth knowing than the position of a particular planet on a particular night, or even on every night throughout a year. There are in the law a splendor and simplicity and sense of mastery which illuminate a mass of otherwise uninteresting details....

*Basic Writings of Bertrand Russell*

On History

Simon & Schuster. New York, New York, USA. 1961

**Ryle, Martin** 1918–84

English radio astronomer

Astronomy differs from most sciences in that we cannot do experiments; the astronomer must build up from his existing observations a picture or “model” of the Universe, and then look for further effects which should be observable if his model is correct.

Radio Astronomy and Cosmology

*Proceedings of the Royal Institution*, Volume 38, Number 173, 1961 (p. 439)

**Sagan, Carl** 1934–96

American astronomer and author

It has been said that astronomy is a humbling and character building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we’ve ever known.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 1 (p. 9)

Random House, Inc. New York, New York, USA. 1994

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

There’s some ill planet reigns.

I must be patient till the heavens look

With an aspect more favorable.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

The Winter’s Tale

Act II, Scene i, l. 105–107

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Not from the stars do I my judgment pluck,  
And yet methinks I have astronomy...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Sonnets

XIV

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Doubt thou the stars are fire;

Doubt that the sun doth move...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Hamlet, Prince of Denmark

Act II, Scene ii, l. 116–117

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shapley, Harlow** 1885–1972

American astronomer

...the most interesting feature of this science astronomy (and of all science) is our eager ignorance.

Astronomy

*Scientific American*, Volume 183, Number 3, September 1950 (pp. 25–26)

**Sherrod, P. Clay**

American astronomer and educator

Astronomy is a unique science in that as we learn more and more, the universe becomes even less known and more mysterious. In the theoretical end of things, astronomy allows the average person to think as far away as the mind will allow.

*A Complete Manual of Amateur Astronomy*

Preface (p. xii)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1981

Above us, the sparkling stars of the night skies stretch out like thousands of diamonds suspended on the curtain of space. Unfolding through the beauty and the mysteries of this seemingly endless expanse are patterns and answers familiar to those willing to study them... There is an affinity for the eternity of space experienced by all mankind, a kind of motherhood in the stars to those who study space.

*A Complete Manual of Amateur Astronomy*

Introduction (p. 1)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1981

**Sillman, Benjamin** 1779–1864

American chemist and geologist

Astronomy is, not without reason, regarded, by mankind, as the sublimest of the natural sciences. Its objects, so frequently visible, and therefore familiar, being always remote and inaccessible, do not lose their dignity.

*Elements of Chemistry* (Volume 1)

Introduction (p. 11)

Hezekiah Howe. New Haven, Connecticut, USA. 1830

**Somerville, Mary** 1780–1872

English mathematician

Physical astronomy is the science which compares and identifies the laws of motion observed on earth with the motions that take place in the heavens; and which

traces, by an uninterrupted chain of deduction from the great principle that governs the universe, the revolutions and rotations of the planets, and the oscillations of the fluids at their surfaces; and which estimates the changes the system has hitherto undergone, or may hereafter experience — changes which require millions of years for their accomplishment.

*The Connection of the Physical Sciences* (9th Edition)

Introduction (p. 3)

John Murray. London, England. 1858

A complete acquaintance with Physical Astronomy can only be attained by those who are well versed in the higher branches of mathematical and mechanical science: such alone can appreciate the extreme beauty of the results, and of the means by which these results are obtained.

*Mechanism of the Heavens*

Preliminary Dissertation (p. 2)

John Murray. London, England. 1831

**Struve, Otto** 1897–1963

Russian-born American chemist and geologist

Astronomy has had three great revolutions in the past four hundred years: The first was the Copernican revolution that removed the earth from the center of the solar system and placed it 150 million kilometers away from it; the second occurred between 1920 and 1930 when, as a result of the work of H. Shapley and R. J. Trumpler, we realized that the solar system is not at the center of the Milky Way but about 30,000 light years away from it, in a relatively dim spiral arm; the third is occurring now, and, whether we want it or not, we must take part in it. This is the revolution embodied in the question: Are we alone in the universe?

*The Universe*

Chapter VI (p. 157)

The MIT Press. Cambridge, Massachusetts, USA. 1962

**Tennyson, Alfred (Lord)** 1809–92

English poet

These are Astronomy and Geology, terrible Muses!

*Alfred Tennyson's Poetical Works*

Parnassus, Part II, l. 15

Oxford University Press, Inc. London, England. 1953

We fronted there the learning of all Spain,  
All their cosmogonies, their astronomies...

*Alfred Tennyson's Poetical Works*

Columbus, l. 41–42

Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Astronomy is a fashionable study, patronized by princes,  
but not fungi.

*The Journal of Henry D. Thoreau* (Volume 12)

October 15, 1859 (p. 391)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1949

**Todhunter, Isaac** 1820–84

English mathematician

Admission to its [astronomy] sanctuary, and to the privileges and feelings of a votary, it is only to be gained by one means, — sound and sufficient knowledge of mathematics, the great instrument of all exact inquiry, without which no man can ever make such advances in this or any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range.

*The Conflict of Studies and Other Essays on Subjects Connected with Education*

Private Study of Mathematics (p. 66)

Macmillan & Company Ltd. London, England. 1873

**Trumbull, John** 1756–1843

American painter

Though in astronomy survey'd,

His constant course was retrograde;

O'er Newton's system though he sleeps,

And finds his wits in dark eclipse!

In Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter II (p. 62)

Government Printing Office. Washington, D.C. 1890

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

I love to revel in philosophical matters — especially astronomy. I study astronomy more than any other foolishness there is. I am a perfect slave to it. I am at it all the time. I have got more smoked glass than clothes. I am as familiar with the stars as the comets are. I know all the facts and figures and I have all the knowledge there is concerning them. I yelp astronomy like a sun-dog, and paw the constellations like Ursa Major.

Letter from Mark Twain, San Francisco, Alta California, August 1, 1869

**Virgil** 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

...may the Muses sweet,

Whose rites I hear with mighty passion pierced,  
Receive, and show the paths and stars of heaven,

The sun's eclipses and the labouring moons...

In *Great Books of the Western World* (Volume 13)

*The Georgics*

Book II, l. 475–478

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

Superstition is to religion what astrology is to astronomy!  
a very stupid daughter of a very wise mother.

In J. de Finad

*A Thousand Flashes of French Wit, Wisdom, and Wickedness*

D. Appleton & Company. New York, New York, USA. 1890

**Warren, Henry White** 1831–1912  
American teacher, lecturer, and writer

The greatest triumphs of men's minds have been in astronomy — and ever must be. We have not learned its alphabet yet. We read only easy lessons, with as many mistakes as happy guesses. But in time we shall know all the letters, become familiar with the combinations, be apt at their interpretation, and will read with facility the lessons of wisdom and power that are written on the earth, blazoned in the skies, and pictured by the flowers below and the rainbows above.

*Recreations in Astronomy*

Chapter I (p. 5)

Chautauqua Press. New York, New York, USA. 1886

**White, William Hale (Mark Rutherford)** 1831–1913  
English novelist

The great beauty of astronomy is not what is incomprehensible in it, but its comprehensibility — its geometrical exactitude.

*Miriam's Schooling and Other Papers*

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1890

**Whitehead, Hal** 1952–  
Canadian/British biologist

Studying the behavior of large whales has been likened to astronomy. The observer glimpses his subjects, often at long range; he cannot do experiments, and he must continually try to infer from data that are usually inadequate.

Why Whales Leap

*Scientific American*, Volume 252, Number 3, March 1985 (p. 86)

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

Physics can teach us only what the laws of nature are today. It is only Astronomy that can teach us what the initial conditions for these laws are.

The Case for Astronomy

*Proceedings of the American Philosophical Society*, Volume 8, Number 1, February 1964 (p. 6)

## ASTROPHYSICIST

**de Grasse Tyson, Neil** 1958–American astrophysicist and writer

Whenever cartoonists draw biologists, chemists, or engineers, the characters typically wear protective white lab coats that have assorted pens and pencils poking out of the breast pocket. Astrophysicists use plenty of pens and pencils, but we never wear lab coats unless we are building something to launch into space. Our primary laboratory is the cosmos, and unless you have bad luck and get hit by a meteorite, you are not at risk of getting your clothes singed or otherwise sullied by caustic liquids spilling from the sky.

Over the Rainbow

*Natural History*, Volume 110, Number 7, September 2001 (p. 30)

## ASTROPHYSICS

**Douglas, A. Vibert** 1894–1988  
Canadian astronomer

On the uplifting wings of imagination the astrophysicist roams the universe from atom to atom, from star to star, from star to atom, from atom to star.

From Atoms to Stars

*Atlantic Monthly*, Volume 144, Number 2, August 1929 (p. 165)

**Greenstein, Jesse L.** 1909–2002  
American astronomer

Theory may often delay understanding of new phenomena observed with new technology unless theorists are quite open-minded as to what types of physical laws may need to be applied: conservatism is unsafe. ... In astrophysics, historically, theories have only seldom had predictive usefulness as guides to experimenters.

In W.T. Sullivan III

*The Early Years of Radio Astronomy*

Optical and Radio Astronomers in the Early Years (p. 77)

Cambridge University Press. Cambridge, England. 1982

**Luminet, Jean-Pierre** 1951–  
French astrophysicist

Astrophysicists have the formidable privilege of having the largest view of the Universe; particle detectors and large telescopes are today used to study distant stars, and throughout space and time, from the infinitely large to the infinitely small, the Universe never ceases to surprise us by revealing its structures little by little.

In Jean-Pierre Luminet

*Black Holes*

Forward to the French Edition (p. xv)

University Press. Cambridge, England. 1991

**Spenser, Edmund** 1552–99  
English poet

For who so list into the heavens looke,  
And search the courses of the rowling sphaeres,  
Shall find that from the point, where first they tooke  
Their setting forth, in these few thousand yeares  
They all are wandred much; that plaine appears.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

The Fifth Book, Introduction

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

## ASYMMETRY

**Weyl, Hermann** 1885–1955  
German mathematician

...seldom is asymmetry merely the absence of symmetry...

*Symmetry*

Bilateral Symmetry (p. 13)

Princeton University Press. Princeton, New Jersey, USA. 1960

**ASYMPTOTE****Frere, John Hookam** 1769–1846

British diplomat and man of letters

**Canning, George** 1770–1827

British statesman and prime minister

Where light Asymptotes o'er her bosom play,  
Nor touch her glowing skin, nor intercept the day.

In Charles Edmonds

*Poetry of the Anti-Jacobin*

The Loves of the Triangle, Canto II, l. 122–23

Printed for J. Wright, by W. Bulmer &amp; Company. London, England. 1801

**ATMOSPHERE****Baden-Powell, Robert Stephenson Smyth** 1857–1941

British army lieutenant-general

The atmosphere forms a vast ocean above us, an ocean but little explored. We crawl about the ground like crabs on the bottom of the sea. We make our meteorological observations down on the ground, ignorant of all that is going on in the midst of that great expanse of air above our heads, where the clouds hang about, where the rain and the hail are formed, where the lightning-flashes have their origin.

*Quarterly Journal of the Royal Meteorological Society*

1907 (p. 193)

**Fourcroy, Antoine-François** 1755–1809

French chemist

The atmosphere is a vast laboratory, in which nature operates immense analyses, solutions, precipitins, and combinations: it is a grand receiver, in which all the attenuated and volatilized productions of terrestrial bodies are received, mingled, agitated, combined, and separated.

*The Philosophy of Chemistry*

Chapter III (p. 15)

Printed for J. Johnson. London, England. 1795

**ATOM****Atkins, Peter William** 1940–

English physical chemist and writer

One of the wonders of this world is that objects so small can have such consequences: any visible lump of matter — even the merest speck — contains more atoms than there are stars in our galaxy.

*Molecules* (p. 4)

W.H. Freeman &amp; Company. New York, New York, USA. 1987

Each new atom brings something of the personality of its element to the molecule, and this conspiracy of atoms results in a molecule with properties that are richer than those of each atom alone.

*Molecules* (p. 13)

W.H. Freeman &amp; Company. New York, New York, USA. 1987

...one or two atoms can convert a fuel to a poison, change a color, render an inedible substance edible, or replace a pungent odor with a fragrant one. That changing a single atom can have such consequences is the wonder of the chemical world.

*Molecules* (p. 2)

W.H. Freeman &amp; Company. New York, New York, USA. 1987

**SCIENCE'S GREATEST DISCOVERY**  
**THE ATOM SPLIT AT 100,000 VOLTS**  
Secret of Cambridge Laboratory  
MAKING A NEW WORLD

A dream of scientists has been realised. The atom has been split, and the limitless energy thus released may transform civilisation. On the authority of Lord Rutherford, the world-famous scientist, Reynold's is able to announce exclusively that yeas of patient experiment at the Cavendish Laboratory at Cambridge have at last been successful. The effect of splitting the atom is that the electrical power now available to mankind may be multiplied 160 times. This is the greatest scientific discovery of the age.

*Reynold's Illustrated News (London edition)*

Sunday May 1, 1932

Nascent atoms are equipped with arms, with which they can combine with other atoms.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

I remember, I remember,  
When an atom was so small  
It really hardly paid you  
To think of one at all.  
It was so small that anywhere  
An atom safe could be  
And pass his time in molecules  
In elemental glee.

Past and Present

*Industrial and Engineering Chemistry: News Edition*, Volume 12, Number 3, April 20, 1934 (p. 161)

10 October 1929

Rostow na Donu

USSR

Dear Professor Rutherford,

We students of our university physics club elect you our honorary president because you proved that atoms have balls.

In George Gamow

*My World Line: An Informal Autobiography*



Chapter 3 (p. 76)  
The Viking Press. New York, New York, USA. 1979

**Baruch, Bernard M.** 1870–1965  
American presidential advisor

Science has taught us how to put the atom to work. But to make it work for good instead of evil lies in the domain dealing with the principles of human duty. We are now facing a problem more of ethics than physics.

The Baruch Plan for Banning the Atom Bomb  
*Life Magazine*, 24 June, 1946 (p. 35)

**Bednyi, Demian** 1883–1945  
Soviet Russian poet

The USSR has been labeled the land of the yokel and Khamov.

Quite right! And we have an example in this Soviet fellow

named Gamow.

Why, this working-class bumpkin, this dimwit, this Gyorgy Anton'ich called Geo.,

He went and caught up with the atom and kicked it about like a pro.

In George Gamow  
*My World Line: An Informal Autobiography*  
Chapter 3 (p. 74)  
The Viking Press. New York, New York, USA. 1979

**Benchley, Robert** 1889–1945  
American humorist and critic

...the atom is composed of little pieces of old pocket lint.

*Benchley Lost and Found*  
Atom Boy (p. 80)  
Dover Publications, Inc. New York, New York, USA. 1970

**Bentley, Richard** 1662–1742  
English critic and philologist

...the fortuitous or casual concurrence of atoms...

*The Works of Richard Bentley* (Volume 3)  
Sermon vii (p. 147)  
F. Macpherson. London, England. 1836–38

**Berthelot, Marcellin** 1827–1907  
French chemist

I do not want chemistry to degenerate into a religion; I do not want the chemist to believe in the existence of atoms as the Christian believes in the existence of Christ in the communion wafer.

In C. Graebe  
Marcellin Berthelot  
*Berichte der Deutschen Chemischen Gesellschaft*, Volume 41, 1908 (p. 485)

**Blake, William** 1757–1827  
English poet, painter, and engraver

The atoms of Democritus,  
And Newton's particles of light...

*The Complete Poetry and Prose of William Blake*  
Mock on Voltaire, Rousseau, l. 9–10  
University of California Press. Berkeley, California, USA. 1982

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

When it comes to atoms, language can be used only as in poetry.

In K.C. Cole  
On Imagining the Unseeable  
*Discovery*, Volume 3, Number 12, December 1982 (p. 70)

The study of atoms...not only has deepened our insight into a new domain of experience, but has thrown new light on general problems of knowledge.

In Robert K. Adair  
*The Great Design* (p. 194)  
Oxford University Press, Inc. New York, New York, USA. 1987

...the fuzzy and nebulous world of the atom only sharpens into concrete reality when an observation is made. In the absence of an observation the atom is a ghost. It only materializes when you look for it. Look for its location and you will get an atom at a place. Look for its motion and you get an atom with a speed. But you can't have both. The reality that the observation sharpens into focus cannot be separated from the observer and his choice of measurement strategy.

In P.C.W. Davies  
*God and the New Physics*  
Chapter 8 (p. 103)  
Simon & Schuster. New York, New York, USA. 1983

**Born, Max** 1882–1970  
German-born English physicist

The dance of atoms, electrons, and nuclei, which in all its fury is subject to God's eternal laws, has been entangled with another restless universe which may well be the Devil's: the human struggle for power and domination, which eventually becomes history.

*The Restless Universe*  
Postscript (p. 279)  
Dover Publications, Inc. New York, New York, USA. 1951

**Bradley, Omar** 1893–1981  
American Army officer

We have grasped the mystery of the atom and rejected the Sermon on the Mount.

*The Collected Writings of General Omar N. Bradley*  
Speeches, 1945–1949, Volume 1 (p. 588)  
Publisher undetermined

**Burton, Sir Richard Francis** 1821–90  
English explorer

Life, atom of that Infinite Space that stretcheth, 'twixt the Here and There.

*The Kasidah of Haji Abdu El-Yezdi*  
Chapter III  
Haldeman-Julius Company, Girard, Kansas, USA. 1924

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

When people talk of atoms obeying fixed laws, they are either ascribing some kind of intelligence and free will to atoms or they are talking nonsense.

*Samuel Butler's Notebooks* (p. 72)  
Jonathan Cape. London, England. 1951

We shall never get people whose time is money to take much interest in atoms.

*Samuel Butler's Notebooks*  
Atoms (p. 133)  
Jonathan Cape. London, England. 1951

The idea of an indivisible atom is inconceivable by the lay mind. If we can conceive an idea of the atom at all, we can conceive it as capable of being cut in half...

*Samuel Butler's Notebooks* (p. 84)  
Jonathan Cape. London, England. 1951

Some things can teach much to some things and little to others; some can be taught much by some things and little by others; some can neither be taught much nor teach much. All depends upon the kind of company into which an atom has got. If it has got into bad hands it will have to part with them before it can get into better. But all atoms being immortal go on learning and unlearning, combining and separating, appointing, disappointing, and being disappointed for ever and ever.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
Immortality of Atoms and Teaching (p. 126)  
Jonathan Cape. London, England. 1951

The puzzle which puzzles every atom is the same which puzzles ourselves — a conflict of duties — our duty towards ourselves, and our duty as members of a body of politic. It is swayed by its sense of being a separate thing — of having a life to itself which nothing can share; it is also swayed by the feeling that in spite of this it is only part of an individuality which is greater than itself and which absorbs it.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
Unity and Separateness (p. 143)  
Jonathan Cape. London, England. 1951

Atoms have a mind as much smaller and less complex than ours as their bodies are smaller and less complex.

*Samuel Butler's Notebooks* (p. 73)  
Jonathan Cape. London, England. 1951

**Capek, Milic** 1909–97  
Czechoslovakian philosopher and physicist

There can hardly be a sharper contrast than that between

the everlasting atoms of classical physics and the vanishing “particules” of modern physics.

In Richard F. Kitchener (ed.)  
*The World View of Contemporary Physics: Does It Need a New Metaphysics?*  
Chapter 6 (p. 99)  
State University of New York Press. Albany, New York, USA. 1988

**Cavendish, Margaret, Duchess of Newcastle** 1623–73

English poet, playwright, and biographer

Small Atomes of themselves a World may make,  
As being subtle, and of every shape:  
And as they dance about, fit places finde,  
Such Formes as best agree, make every kinde.

*Poems and Fancies*  
A World made by Atomes (p. 5)  
Printed by William Wilson. London, England. 1664

...nothing can be less than atoms.

*Poems and Fancies*  
The Bell in St Paul's Churchyard  
Printed by William Wilson. London, England. 1664

**Chu, Steven** 1948–

American physicist

The atoms become like a moth, seeking out the region of higher laser intensity.

In James Gleick  
Lasers Slow Atom for Scrutiny  
*New York Times*, Section 1, 13 July 1986 (p. 1)

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

The beginnings of all things are small.

In L.I. Ponomarev  
*The Quantum Dice* (p. 23)  
Institute of Physics Publishing. Bristol, England. 1993

...there are certain minute particles, some smooth, others rough, some round, some angular, some curved or hook-shaped, and others that heaven and earth were created from these, not by compulsion of any natural law but by a sort of accidental colliding...

Translated by H. Rackham  
*Cicero in Twenty Eight Volumes (XLX)*  
De Natura Deorum  
I, XXIV, 66 (p. 65)  
Harvard University Press. Cambridge, Massachusetts, USA. 1939

**Close, Frank**

English writer and physicist

**Martin, M.**

No biographical data available

Take a deep breath! You have just inhaled oxygen atoms that have already been breathed by every person who ever lived. At some time or other your body has contained atoms that were once part of Moses or Isaac Newton. The oxygen mixes with carbon atoms in your lungs and you

exhale carbon dioxide molecules. Chemistry is at work. Plants will rearrange these atoms, converting carbon dioxide back to oxygen, and at some future date our descendants will breathe some in.... If atoms could speak, what a tale they would tell.

*The Particle Explosion*

Chapter 1 (p. 7)

Oxford University Press, Inc. Oxford, England. 1987

Atoms are the complex end-products of creation. Their best constituents were created within the first seconds of the Big Bang. Several thousand years elapsed before these particles combined to make atoms. The cold conditions where atoms exist today are far removed from the intense heat of the Big Bang. So to learn about our origins we have to see within the atoms, and study the seeds of matter.

*The Particle Explosion*

Chapter 1 (p. 7)

Oxford University Press, Inc. Oxford, England. 1987

### **Cole, A. D.**

American physicist

...an atom is a world in itself.... How has the indivisible unit evolved into the complex microcosm we now imagine?

Recent Evidence for the Existence of the Nucleus Atom

*Science*, New Series, Volume 41, Number 1046, January 15, 1915

(p. 73)

### **Cudmore, Lorraine Lee**

American cell biologist

Have care of your atoms, for such is the stuff that dreams are made of — the yearning dreams of our immortality.

*The Center of Life: A Natural History of the Cell*

Death (p. 176)

New York Times Book Company. New York, New York, USA. 1977

### **Dalton, John** 1766–1844

English chemist and physicist

These observations have tacitly led to the conclusion which seems universally adopted, that all bodies of sensible magnitude, whether liquid or solid, are constituted of a vast number of extremely small particles, or atoms of matter...

*A New System of Chemical Philosophy* (Volume 1)

Part I, Chapter II (p. 141)

R. Bickerstaff. London, England. 1810

### **Darrow, Karl Kelchner** 1891–1982

American physicist

One of the things which distinguishes ours from all earlier generations is this, that WE HAVE SEEN OUR ATOMS.

*The Renaissance of Physics*

Chapter VI (p. 107)

The Macmillan Company. New York, New York, USA. 1936

### **Darwin, Erasmus** 1731–1802

English physician and poet

Dull atheist, could a giddy dance  
Of atoms lawlessly hurl'd

Construct so wonderful, so wise,  
So harmonised a world?

In Paul H. Barrett and R.B. Freeman (eds.)

*The Works of Charles Darwin* (Volume 29)

Erasmus Darwin

Preface (p. 44)

New York University Press. New York, New York, USA. 1989

### **Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Measure for measure, we are to an atom, what a star is to us.

*Superforce: The Search for a Grand Unified Theory of Nature*

Chapter 1 (p. 18)

Simon & Schuster. New York, New York, USA. 1984

...the rules of clockwork might apply to familiar objects such as snooker balls, but when it comes to atoms, the rules are those of roulette.

*God and the New Physics*

Chapter 8 (p. 102)

Simon & Schuster. New York, New York, USA. 1983

### **Democritus of Abdera** 460 BCE–370 BCE

Greek philosopher

The atoms are at war with one another as they move along in the void owing to their dissimilarity and their other differences, and as they move they collide and are interlaced in a manner which makes them touch and be near to one another, but they never really produce any single existence out of them: for it is quite absurd to suppose that two or more things could ever become one.

In Cyril Bailey

*The Greek Atomists and Epicurus*

Chapter III, Section 3 (p. 136)

Russell & Russell, Inc. New York, New York, USA. 1964

Nothing exists except atoms and empty space; everything else is opinion.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 1)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

By convention there is colour, by convention sweetness, by convention bitterness, but in reality there are atoms and space.

*Fragments of the Presocratics*

Fragment 125

Publication data not available

[Atoms] have all sorts of shapes and appearances and different sizes...Some are rough, some hook-shaped, some concave, some convex and some have other innumerable variations.

In Samuel Sambursky  
*The Physical World of the Greeks*  
Chapter V (pp. 110–111)

Routledge & Kegan Paul. London, England. 1956

**Douglas, A. Vibert** 1894–1988

Canadian astronomer

You cannot solve the riddles of the stars without invoking the aid of the atom, nor can you fully comprehend the atom without the aid of the stars. On the uplifting wings of imagination the astrophysicist roams the universe from atom to atom, from star to star, from star to atom, from atom to star. Impelled by curiosity regarding the natural universe, encouraged by the evidence for his faith in the reality of cosmic harmony, he presses on and on — a sweet and a fitting thing it is to toil for the Truth.

From *Atoms to Stars*

*The Atlantic Monthly*, Volume 144, August 1929 (p. 165)

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

To be the child of chance, and not of care,

No atoms casually together hurl'd.

*The Poetical Works of Dryden*

To my Honor'd Friend Sir Robert Howard, l. 31–32

The Riverside Press. Cambridge, Massachusetts, USA. 1949

The airy atoms did in plagues conspire...

*The Poetical Works of Dryden*

Britannia Rediviva, l. 154

The Riverside Press. Cambridge, Massachusetts, USA. 1949

So many huddled atoms make a play...

*The Poetical Works of Dryden*

Prologue and Epilogue to the University of Oxford, l. 31

The Riverside Press. Cambridge, Massachusetts, USA. 1949

From harmony, from heav'nly harmony This universal frame began: When Nature underneath a heap of jarring atoms lay, And could not heave her head...

*The Poetical Works of Dryden*

A Song for St Cecilia's Day, l. 4–8

The Riverside Press. Cambridge, Massachusetts, USA. 1949

For then our atoms, which in order lay,  
Are scatter'd from their heap, and puff'd away...

*The Poetical Works of Dryden*

Lucretius

The Riverside Press. Cambridge, Massachusetts, USA. 1949

May, tho' our atoms should resolve by chance...

*The Poetical Works of Dryden*

Lucretius

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Durack, J. J.**

No biographical data available

In the dusty lab'ratory

'Mid the coils and wax and twine,

There the atoms in their glory

Ionize and recombine.

Ions Mine

*The American Physics Teacher*, Volume 7, Number 3, June 1939 (p. 180)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The atom is as porous as the solar system.

*The Nature of the Physical World*

Chapter I (p. 1)

The Macmillan Company. New York, New York, USA. 1930

...now we realize that science has nothing to say as to the intrinsic nature of the atom. The physical atom is, like everything else in physics, a schedule of pointer readings.

*The Nature of the Physical World*

Chapter XII (p. 259)

The Macmillan Company. New York, New York, USA. 1930

Our method of making an atom work is to knock it about; and if it does not do what we want, knock it still harder.

*New Pathways in Science*

Chapter IX, Section V (p. 203)

The Macmillan Company. New York, New York, USA. 1935

Man is slightly nearer to the atom than to the star... From his central position he can survey the grandest works of Nature with the astronomer, or the minutest works with the physicist.

*Stars and Atoms*

Lecture I (p. 1)

Clarendon Press. Oxford, England. 1927

"A fortuitous concourse of atoms" — that bugbear of the theologian — has a very harmless place in orthodox physics.

*The Nature of the Physical World*

Chapter IV (p. 77)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-American physicist

The unleashed power of the atom has changed everything save our modes of thinking and we thus drift toward unparalleled catastrophe.

Atomic Education Urged by Einstein

*New York Times*, Section L+, May 1946

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

You cannot detach an atom from its holdings, or strip off from it the electricity, gravitation, chemic affinity, or the relation to light and heat, and leave the atom bare.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

Society and Solitude

Farming (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The atoms of the body were once nebulae...

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Chapter I (p. 24)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The intellect sees that every atom carries the whole of Nature...

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Illusions (p. 1111)

The Library of America. New York, New York, USA. 1983

For the world was built in order,  
And the atoms march in tune;  
Rhyme the pipe, and Time the warder,  
The sun obeys them and the moon.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

Monadnoc (p. 69)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Atom from atom yawns as far  
As moon from earth, or star from star.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

Nature (p. 339)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Faraday, Michael** 1791–1867

English physicist and chemist

But I must confess I am jealous of the term atom; for though it is very easy to talk of atoms, it is very difficult to form a clear idea of their nature, especially when compound bodies are under consideration.

*Experimental Researches In Electricity* (Volume 1)

Seventh Series, 869 (p. 256)

Richard & John Edward Taylor. London, England. 1839–1855

### **Feinberg, J. G.**

No biographical data available

The atom stands as a monument to the wisdom of the Human Race. One day it may stand a tombstone to its folly.

*The Atom Story, Being the Story of the Atom and the Human Race*

Chapter 1 (p. 1)

Philosophical Library. New York, New York, USA. 1953

The powerful weapon which first smashed the atom was not a massive machine in a physics laboratory but a puny pencil in the hands of a genius. The year was 1905 and the genius was Albert Einstein.

*The Atom Story, Being the Story of the Atom and the Human Race* (p. 91)

Philosophical Library. New York, New York, USA. 1953

### **Feynman, Richard P.** 1918–88

American theoretical physicist

The behavior of things on a very tiny scale is simply different. An atom does not behave like weight hanging on a spring and oscillating. An atom does not behave like a miniature representation of the solar system with little planets going around orbits. Nor does it appear to be somewhat like a cloud or fog of some sort surrounding the nucleus. It behaves like nothing you have ever seen before.

*The Character of Physical Law*

Chapter 6 (p. 128)

British Broadcasting Company. London, England. 1965

I,  
a universe of atoms,  
an atom of the universe.

*What Do You Care What Other People Think?*

The Value of Science (p. 243)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

If instead of arranging the atoms in some definite pattern, again and again repeated, on and on, or even forming little lumps of complexity like the odor of violets, we make an arrangement which is always different from place to place, with different kinds of atoms arranged in many ways, continually changing, not repeating, how much more marvelously is it possible that this thing might behave? Is it possible that that “thing” walking back and forth in front of you, talking to you, is a great glob of these atoms in a very complex arrangement, such that the sheer complexity of it staggers the imagination as to what it can do? When we say we are a pile of atoms, we do not mean we are merely a pile of atoms, because a pile of atoms which is not repeated from one to the other might well have the possibilities which you see before you in the mirror.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Atoms in Motion (p. 20)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generation of creatures, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis (or the atomic fact, if you wish to call it that) that all things are made of atoms — little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–1 (p. 1–2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...the atoms that are in the brain are being replaced: the ones that were there before have gone away.

So what is this mind of ours: what are these atoms with consciousness? Last week’s potatoes! They now can remember what was going on in my mind a year ago — a mind which has long ago been replaced.

To note that the thing I call my individuality is only a pattern or dance, that is what it means when one discovers how long it takes for the atoms of the brain to be replaced by other atoms. The atoms come into my brain, dance a dance, and then go out — there are always new atoms, but always doing the same dance, remembering what the dance was yesterday.

*What Do You Care What Other People Think?*

The Value of Science (p. 244)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

...if all of this, all the life of a stream of water, can be nothing but a pile of atoms, how much more is possible?

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–4 (p. 1–9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

Everything is made of atoms. That is the key hypothesis. The most important hypothesis in all of biology, for example, is that everything that animals do, atoms do. In other words, there is nothing that living things do that cannot be understood from the point of view that they are made of atoms acting according to the laws of physics. This was not known from the beginning: it took some experimenting and theorizing to suggest this hypothesis, but now it is accepted, and it is the most useful theory for producing new ideas in the field of biology.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–4 (p. (p. 1–8))

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

Atoms are completely impossible from the classical point of view...

*The Feynman Lectures on Physics* (Volume 3)

Chapter 2–4 (p. 2–6)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Freeman, Ira M.**

No biographical data available

O'er the atom's wondrous, useful pieces,

The physicist effuses;

Applauding too as Man releases

The atom's peaceful uses.

Nuclear Situation Unclear

*The Physics Teacher*, Volume 13, Number 5, May 1975 (p. 319)

**Frisch, Otto** 1904–79

Austrian-born English physicist

Today we no longer ask what really goes on in an atom; we ask what is likely to be observed — and with what likelihood — when we subject atoms to any specified influences such as light or heat, magnetic fields or electric currents.

*What Little I Remember*

Atoms (p. 20)

Cambridge University Press. Cambridge, England. 1979

**Gassendi, Pierre** 1592–1655

French logician and philosopher

As letters are the elements of writing and from letters are formed first syllables, and then successively words,

phrases, and speeches, so also atoms are the elements of all things. From the atoms the smallest molecules are joined together first, and then successively somewhat bigger ones, still bigger ones, the finest and the coarsest bodies, and finally the biggest bodies.

In Walter Charleton

*Physiologia Epicuro-Gassendo-Charltoniana; or, a fabric of science natural, upon the hypothesis of atoms founded by Epicurus, repaired by Petrus Gassendus, augmented by Walter Charleton*

Animadversions (p. 108)

**Goepfert-Mayer, Maria** 1906–72

German-American physicist

No one has ever seen, nor probably ever will see, an atom, but that does not deter the physicist from trying to draw a plan of it, with the aid of such clues to its structure as he has.

The Structure of the Nucleus

*Scientific American*, Volume 184, Number 3, March 1951 (p. 22)

**Hall, John**

No biographical data available

If that this thing we call the world

By chance on atoms was begot

Which through in ceaseless motion whirled

Yet weary not

How doth it prove

Thou art so fair and I in love.

In John D. Barrow

*The World Within the World* (p. 162)

Clarendon Press. Oxford, England. 1988

**Harrow, Benjamin** 1888–1970

American chemist

If the constituent atoms in a tumbler of water could all be labeled for later identification, and the water were then mixed with all the water in the world, and if, after thoroughly mixing, the tumbler were again filled, it would contain two thousand of the original atoms.

In Bernard Jaffe

*New World of Chemistry* (p. 56)

Silver, Burdett & Company. New York, New York, USA. 1935

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The atom of modern physics can be symbolized only through a partial differential equation in an abstract space of many dimensions. All its qualities are inferential; no material properties can be directly attributed to it. That is to say, any picture of the atom that our imagination is able to invent is for that very reason defective. An understanding of the atomic world in that primary sensuous fashion... is impossible.

In S.F. Mason

*A History of Science* (p. 502)

Collier Books. New York, New York, USA. 1962

All the qualities of the atom of modern physics are derived, it has no immediate and direct physical properties at all, i.e., every type of visual conception we might wish to design is *eo ipso*, faulty.

Translated by F.C. Hayes

*Philosophic Problems of Nuclear Science*

Chapter 2 (p. 38)

Faber & Faber Ltd. London, England. 1952

In the experiments about atomic events we have to do with things and facts, with phenomena that are just as real as any phenomena in daily life. But the atoms of the elementary particles are not as real; they form a world of potentialities or possibilities rather than one of things or facts.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter X (p. 186)

Harper & Row, Publishers. New York, New York, USA. 1958

It is important that we should understand the “handwriting” of atoms for it is something which has not been thought out by man; it has far deeper meaning. Even when we shall have mastered and understood it, let us not forget that is the content not the words which is important in a tragedy or comedy and that this also holds good for our world.

*Philosophic Problems of Nuclear Science*

Chapter 7 (p. 108)

Faber & Faber Ltd. London, England. 1952

It is not surprising that our language should be incapable of describing the processes occurring within the atoms, for, as has been remarked, it was invented to describe the experiences of daily life, and these consist only of processes involving exceedingly large numbers of atoms. Furthermore, it is very difficult to modify our language so that it will be able to describe these atomic processes, for words can only describe things of which we can form mental pictures, and this ability, too, is a result of daily experience.

*The Physical Principles of the Quantum Theory*

Translated by Carl Eckhart and Frank C. Hoyt (p. 11)

The University of Chicago Press. Chicago, Illinois, USA. 1930

...atoms are neither things nor objects...atoms are part of observational situations...

*Physics and Beyond: Encounters and Conversations*

Chapter 10 (p. 123)

Harper & Row, Publishers. New York, New York, USA. 1972

### **Higgins, Bryan** 1737–1820

Irish physicist

...the atoms of each element are globular or nearly so; and that the spiral, spicular and other figures ascribed to these atoms are fictitious, unnecessary, and are inconsistent with the uniformity of nature, and are repugnant to experience.

In D.S.L. Cardwell (ed.)

*John Dalton & the Progress of Science*

Quoted in B.B. Kelham

*Atomic Speculation in the Late Eighteenth Century* (p. 112)

Manchester University Press. Manchester, England. 1968

### **Huxley, Aldous** 1894–1963

English writer and critic

Atoms, or perhaps it would be more accurate to say those aspects of the atom which scientists chose to consider, are immeasurable less complicated than men.

*Proper Studies*

Introduction (p. vii)

Chatto & Windus. London, England. 1957

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The universe was a stage in which always the same actors — the atoms — played their parts, differing in disguises and groupings, but without change of identity. And these actors were endowed with immortality.

*The Mysterious Universe*

Chapter III (p. 56)

The Macmillan Company. New York, New York, USA. 1932

All the innumerable substances which occur on earth — shows, ships, sealing-wax, cabbages, kings, carpenters, walruses, oysters, everything we can think of — can be analyzed into their constituent atoms.... It might be thought that a quite incredible number of different kinds of atoms would emerge from the rich variety of substances we find on earth. Actually the number is quite small. The same atoms turn up again and again, and the great variety of substances we find on earth result, not from any great variety of atoms entering into their composition, but from the great variety of ways in which a few types of atoms can be combined.

*The Universe Around Us*

Chapter II (pp. 97–98)

The Macmillan Company. New York, New York, USA. 1929

### **Jeffers, Robinson** 1887–1962

American poet

...Useless intelligence of far stars, dim knowledge of the spinning demons that make an atom...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

Roan Stallion (p. 189)

Stanford University Press. Stanford, California. USA. 1988

### **Jenkin, Fleeming** 1833–85

English engineer

We are not wholly without hope that the real weight of each such atom may some day be known...; that the form and motion of the parts of each atom, and the distance by which they are separated, may be calculated; that the motions by which they produce heat, electricity, and light may be illustrated by exact geometrical diagrams.... Then the motion of the planets and music of the spheres

will be neglected for a while in admiration of the maze in which the tiny atoms turn.

In Sidney Colvin and J.A. Ewing (eds.)

*Papers, Literary, Scientific, & c., by the Late Fleeming Jenkin* (Volume 1)

Lucretius and the Atomic Theory

1868 (p. 213)

Longmans, Green & Company. London, England. 1887

### **Kekulé, Friedrich August** 1829–96

German chemist

The question of whether atoms exist or not has but little significance from a chemical point of view: its discussion belongs rather to metaphysics. In chemistry we have only to decide whether the assumption of atoms is an hypothesis adapted to the explanation of chemical phenomena. More especially have we to consider the question whether a further development of the atomic hypothesis promises to advance our knowledge of the mechanism of chemical phenomena...

Should the progress of science lead to a theory of the constitution of chemical atoms — important as such a knowledge might be for the general philosophy of matter — it would make but little alteration in chemistry itself. The chemical atoms will always remain the chemical unit...

In Ida Freund

*The Study of Chemical Composition*

Chapter XIX (p. 624)

At the University Press. Cambridge, England. 1904

### **Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

The idea of an atom has been so constantly associated with incredible assumptions of infinite strength, absolute rigidity, mystical actions at a distance and indivisibility, that chemists and many other reasonable naturalists of modern times, losing all patience with it, have dismissed it to the realms of metaphysics, and made it smaller than “anything we can conceive.”

On the Size of Atoms

*Nature*, Volume 1, March 31, 1870 (p. 551)

### **Kraus, Arthur Lawrence**

No biographical data available

Every atom in your body was once inside an exploding star...

*The Lee Rogers radio show*

KSFO Radio 560, San Francisco, 11/3/97

### **Krauss, Lawrence M.** 1954–

American theoretical physicist

Our atoms are vibrant messengers from the past, and harbingers of the future. They connect us in a definite way to everything we can see about us. Let us enjoy, with them, our moment in the sun.

*Atom: An Odyssey from the Big Bang to Life on Earth...and Beyond*

Chapter 19 (p. 283)

Little, Brown & Company. Boston, Massachusetts, USA. 2001

### **Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

The most important discoveries of the laws, methods and progress of Nature have nearly always sprung from the examination of the smaller objects which she contains.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 2)

Atomic Numbers (p. 842)

Simon & Schuster. New York, New York, USA. 1956

### **Leacock, Stephen** 1869–1944

Canadian humorist

When Rutherford was done with the atom all the solidity was pretty well knocked out of it.

*The Boy I Left Behind Me*

Chapter VI (p. 169)

The Bodely Head. London, England. 1947

### **Lederman, Leon** 1922–

American high-energy physicist

Although atoms are way more than 99.99 percent empty space, I have a real problem in walking through a wall.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 5 (p. 184)

Bantam Dell Doubleday Publishing Group. New York, New York, USA. 1993

### **Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

Atoms are the effect of the weakness of our imagination, for it likes to rest and therefore hurries to arrive at a conclusion in subdivisions or analyses; this is not the case in Nature, which comes from the infinite and goes to the infinite. Atoms satisfy only the imagination, but they shock the higher reason.

In John D. Barrow

*The World Within the World* (p. 166)

Clarendon Press. Oxford, England. 1988

### **Lemaître, Abbé Georges** 1894–1966

Belgian astronomer and cosmologist

The atom-world was broken into fragments, each fragment into still smaller pieces. To simplify matters, supposing that this fragmentation occurred in equal pieces, two hundred sixty generations would have been needed to reach the present pulverization of matter into our poor little atoms, almost too small to be broken again. The evolution of the world can be compared to a display of fireworks that has just ended: some few red wisps, ashes and smoke. Standing on a well-chilled cinder, we see the slow fading of the suns, and we try to recall the vanished brilliance of the origin of the worlds.

*The Primeval Atom*



Chapter II (p. 78)

Van Nostrand Company, Inc. New York, New York, USA. 1950

**Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

She wondered why the particles of a metal stick so close together. Lucretius had said it was because the atoms were hooked. It did rather look as if in some way they overlapped, but then it also looked as if the atoms themselves were compressed. She wondered what force could be so tremendous as to squeeze atoms into iron, nickel, ruthenium, rhodium, palladium, and osmium, each a little denser than the preceding.

*White Lightning*

Chapter 76 (p. 309)

Covici-McGee. Chicago, Illinois, USA. 1923

**Lloyd, Seth** 1960–

American professor of mechanical engineering

It's just hard to string a lot of atoms together. I mean, these things are wicked small.... They're sensitive little buggers too. But people are getting to the point where they can control these things. It's a big technological crapshoot. In the not-too-distant future people might be able to do full-blown quantum computation.

The Best Computer in All Possible Worlds

*Discover Magazine*, October 1995

**Locke, John** 1632–1704

English philosopher and political theorist

... a blind fortuitous concourse of atoms, not guided by an understanding agent...

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book IV, Chapter XX, Section 15 (p. 393)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lodge, Sir Oliver** 1851–1940

English physicist

We do not in the least know how to harness the energy locked up in the atoms of matter. If it could be liberated at will, we would experience a violence beside which the suddenness of high explosive is gentle and leisurely.

In Thomas Thorneley

*Collected Verse*

The Atom

Cambridge, England. 1939

**Macfie, Ronald Campbell** 1867–1931

Scottish poet and physician

The atoms and molecules, by their aggregation and arrangement, by their weddings and partnerships, make everything. We put a packet of molecules, known as a seed, into the ground, and they attract other molecules from the air and soil — molecules of carbonic acid, and lime, and potassium, and so on, and lo! a lily, or a pine

tree. Without mistake they carry out more machinery in each molecular brick than in a chronometer, and more molecular bricks in each leaflet than in a cathedral.

*Science, Matter and Immortality*

Chapter 4 (pp. 53–54)

William & Norgate. London, England. 1909

Let us consider even such a minor wonder as a hen's egg... these atoms in the egg have been gathered together in a few hours, and have come from all quarters of the earth. Not so long ago the oxygen may have come on the wings of the wind from the leaf of a lily, the hydrogen from the teardrop of a maiden, the carbon from a factory chimney, the nitrogen from the plains of Chili, the sulphur from Mount Pelée, and the iron from a meteorite. And behold, there they all are collected together by red rivers of blood into an eggshell, ready to make a chicken!

*Science, Matter and Immortality*

Chapter 17 (pp. 215–216)

William & Norgate. London, England. 1909

Atoms and molecules have been weighed; they have been proved to dance, they have been persuaded to wed, and yet their shape is still unknown.

*Science, Matter and Immortality*

Chapter IV (p. 58)

William & Norgate. London, England. 1909

... the most wonderful thing about atoms and molecules is not their power of destroying, but their powers of creating. They themselves choose their partners, and their partnerships have made the world as we know it.

*Science, Matter and Immortality*

Chapter 4 (p. 53)

William & Norgate. London, England. 1909

... the atoms and molecules are as real as the ice-crystals in the cirrus clouds that he cannot reach — as real as the unseen members of a meteoric swarm whose death-glow is lost in the sunshine, or which past us unentangled in the night" — that the atoms are in fact "not merely helps to puzzled mathematicians, but physical realities."

*Science, Matter and Immortality*

Chapter IV (p. 42)

William & Norgate. London, England. 1909

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The atomic theory plays a part in physics similar to that of certain auxiliary concepts in mathematics: it is a mathematical model for facilitating the mental reproduction of facts. Although we represent vibrations by the harmonic formula, the phenomena of cooling by exponentials, falls by squares of time, etc., no one would fancy that vibrations in themselves have anything to do with circular functions, or the motion of falling bodies with squares.

*The Science of Mechanics* (5<sup>th</sup> Edition)

Chapter IV, Part IV, Section 9 (p. 590)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

If belief in the reality of atoms is so important to you,  
I cut myself off from the physicist's mode of thinking.

In Timothy Ferris

*The Red Limit: The Search for the Edge of the Universe*

Letter to Max Planck (p. 65)

William Morrow & Company, Inc. New York, New York, USA. 1977

### **Mann, Thomas** 1875–1955

German-born American novelist

The atom was a cosmic system, laden with energy; in  
which heavenly bodies rioted rotating about a centre like  
a sun; through whose ethereal space comets drove with  
the speed of light years, kept in their eccentric orbits by  
the power of the central body.

*The Magic Mountain*

Chapter V

Research (p. 284)

Alfred A. Knopf. New York, New York, USA. 1966

### **Maxwell, James Clerk** 1831–79

Scottish physicist

At any rate the atoms are a very tough lot, and can stand  
a great deal of knocking about. . .

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

Correspondence (p. 391)

Macmillan & Company Ltd. London, England. 1882

At quite uncertain times and places,

The atoms left their heavenly path,

And by fortuitous embraces,

Engendered all that being hath.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

Molecular Evolution (p. 637)

Macmillan & Company Ltd. London, England. 1882

How freely he scatters his atoms before the beginning  
of years;

How he clothes them with force as a garment, those  
small incompressible spheres!

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

British Association, 1874 (p. 639)

Macmillan & Company Ltd. London, England. 1882

In the very beginning of science,  
the parsons, who managed things then,  
Being handy with hammer and chisel,  
made gods in the likeness o' men;  
Till Commerce arose and at length  
some men of exceptional power  
Supplanted both demons and gods by  
the atoms, which last to this hour.

In John D. Barrow

*The World Within the World* (p. 168)

Clarendon Press. Oxford, England. 1988

[Atoms]...the imperishable foundation-stones of the  
universe.

In James Jeans

*The Mysterious Universe*

Chapter III (p. 64)

The Macmillan Company. New York, New York, USA. 1932

An atom is a body which cannot be cut in two.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 361)

Dover Publications. New York, New York, USA. 1965

### **Nabokov, Vladimir** 1899–1977

Russian-born writer

But the individual atom is free: it pulsates as it wants,  
in high or low gear; it decides itself when to absorb and  
when to radiate energy.

*Bend Sinister* (p. 159)

Henry Holt & Company. New York, New York, USA. 1947

### **Ostwald, Friedrich Wilhelm** 1853–1932

Latvian-born German chemist

We must renounce the hope of representing the physical  
world by referring natural phenomena to a mechanics of  
atoms. "But" — I hear you say — "but what will we have  
left to give us a picture of reality if we abandon atoms?"  
To this I reply: "Thou shalt not take unto thee any graven  
images, or any likeness of anything." Our task is not to  
see the world through a dark and distorted mirror, but  
directly, so far as the nature of our minds permits. The  
task of science is to discern relations among realities. . .

In Nick Herbert

*Quantum Reality: Beyond the New Physics*

Chapter 1 (pp. 11–12)

Anchor Press. Garden City, New York, USA. 1985

### **Pallister, William Hales** 1877–1946

Canadian physician

Each atom is a tiny universe

In which electrons in orbit rehearse

The motions of the planets round the sun,

In miniature the actions there begun.

It's particles revolve so far apart

The solar system might have taught the art.

*Poems of Science*

Men and the Stars

Within the Atom

Playford Press. New York, New York, USA. 1931

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

...the long-standing mechanistic and atomistic hypoth-  
eses have recently taken on enough consistency to cease  
almost appearing to us as hypotheses; atoms are no lon-  
ger a useful fiction; things seem to us in favour of saying  
that we see them since we know how to count them. . .

The brilliant determination of the number of atoms made  
by M. Perrin has completed this triumph of atomism. ...  
The atom of the chemist is now a reality.

In Mary Jo Nye

*Molecular Reality: A Perspective on the Scientific Work of Jean Perrin*  
(p. 157)

MacDonald. London, England. 1972

**Pope, Alexander** 1688–1744

English poet

See plastic nature working to this end,  
The single atoms each to other tend,  
Attract, attracted to, the next place  
Form'd and impell'd its neighbor to embrace.

*The Complete Poetical Works*

An Essay on Man

Epistle III, l. 9–12

Houghton Mifflin Company. New York, New York, USA. 1903

Atoms or systems into ruin hurl'd,  
And now a bubble burst, and now a world.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, Of the Nature and State of Man, with  
Respect to the Universe, Argument, l. 89–90

Houghton Mifflin Company. New York, New York, USA. 1903

**Rees, Martin John** 1942–

15<sup>th</sup> Astronomer Royal of England

If we are to understand an everyday question like “Where  
did the atoms we are made of come from?” we must  
understand the stars.

Interview by Claudia Dreifus

*New York Times*, April 26, 1998

**Robb, Alfred Arthur** 1873–1936

English physicist

What's in an atom  
The innermost substratum?  
That's the problem he is working at today.  
He lately did discover  
How to shoot them down the player,  
And the poor little things can't get away.  
He uses as munitions

On his hunting expeditions

Alpha particles which out of Radium sprang.

In Ruth Moore

*Niels Bohr: The Man, His Science, and the World They Changed*

Chapter 7 (p. 113)

Alfred A. Knopf. New York, New York, USA. 1966

A Corpuscle once did oscillate so quickly to and fro,  
He always raised disturbances wherever he did go.  
He struggled hard for freedom against a powerful foe —  
An atom — who wouldn't let him go.

The Revolution of the Corpuscle

*The American Physics Teacher*, Volume 17, Number 3, June 1939 (p. 180)

All preconceived notions he sets at defiance  
By means of some neat and ingenious appliance  
By which he discovers a new law of science

Which no one had ever suspected before.

All the chemists went off into fits,

Some of them thought they were losing their wits,

When quite without warning

(Their theories scorning)

The atom one morning

He broke into bits.

In Cecilia Payne-Gaposchkin

*Introduction to Astronomy*

On J.J. Thomson (p. 341)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

**Roscoe, Henry E.** 1833–1915

English chemist

Atoms are round bits of wood invented by Mr. Dalton.

In William H. Brock

*The Norton History of Chemistry*

Chapter 4 (p. 128)

W.W. Norton & Company, Inc. New York, New York, USA. 1993

**Rothman, Tony** 1953–

American cosmologist

YOU MUST REMEMBER THIS: Atoms cannot be seen.

To show that the world was made of particles a million  
times smaller than objects visible to the naked eye was so  
difficult that their existence was not established beyond  
reasonable doubt until the end of the nineteenth century.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 2 (p. 47)

Ballentine Books. New York, New York, USA. 1995

**Rowland, Henry Augustus** 1848–1901

American physicist

The round hard atom of Newton which God alone could  
break into pieces has become a molecule composed of  
many atoms and each of these smaller atoms has become  
so elastic that after vibrating 100,000 times its amplitude  
of vibration is scarcely diminished. It has become so com-  
plicated that it can vibrate with as many thousand notes.  
We cover the atom with patches of electricity here and  
there and make of it a system compared with which the  
planetary system, nay the universe itself, is simplicity.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aim of the Physicist (p. 671)

Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Rukeyer, Muriel** 1930–80

American poet and activist

The universe is made of stories,  
not of atoms.

*The Speed of Darkness*

The Speed of Darkness

Stanza IX

Random House, Inc. New York, New York, USA. 1968

**Rutherford, Ernest** 1871–1937

English physicist

The atom will always be a sink of energy and never a reservoir.

In Ritchie Calder

*Profile of Science*

Chapter 1 (p. 23)

George Allen & Unwin Ltd. London, England. 1951

My work on the atom goes on in fine style. Several atoms succumb each week.

In Ruth Moore

*Niels Bohr: The Man, His Science, & the World They Changed*

Chapter 7 (p. 114)

Alfred A. Knopf. New York, New York, USA. 1966

[Atom] a nice, hard fellow, red or grey in color according to taste.

*From Quarks to Quasars: A Tour of the Universe*

Chapter 6 (p. 57)

Athenaeum. New York, New York, USA. 1987

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

Why must our bodies be so large compared with the atom?

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*

Chapter I, Section 4 (p. 6)

At the University Press. Cambridge, England. 1945

**Siegel, Eli** 1902–784

American philosopher, poet, critic, and founder of Aesthetic Realism

A pimple has atoms to it; and mucus has electrons.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #234 (p. 121)

Definition Press. New York, New York, USA. 1972

**Shapley, Harlow** 1885–1972

American astronomer

Splitting the atom has been going on for billions of years in the universe. It is an old, old story so far as the suns and stars are concerned. They do it easily, whereas man has toiled to accomplish it, and when he did he caused a world-wide headache and a crisis for humanity.

In S.J. Woolf

Dr. Harlow Shapley

*American Scientist*, Volume 34, Number 3, July 1946 (p. 468)

**Silver, Brian L.**

Israeli professor of physical chemistry

In solids, atoms or molecules generally occupy permanent sites from which they rarely stray, but they can be crudely envisaged as a gospel choir, each singer swaying, wobbling, and bobbing up and down, but remaining tethered to their places as a consequence of the close proximity of their neighbors.

*The Ascent of Science*

Part Five, Chapter 16 (p. 202)

Solomon Press Book. New York, New York, USA. 1998

**Smith, Robert Angus** 1817–84

Scottish chemist

We believe in atoms, because Nature seems to use them, and we break them up continuously because we do not know where to stop. There are various methods of spanning the distance from nothing to something.

In Ida Freund

*The Study of Chemical Composition*

Chapter XI (p. 301)

At the University Press. Cambridge, England. 1904

**Smith, Sydney** 1771–1845

English clergyman, writer, and wit

Let onion atoms lurk within the bowl...

*The Wit and Wisdom of Sydney Smith: A Selection of the Most Memorable Passages in His Writings and Conversations*

Recipe for a Salad (p. 429)

G.P. Putnam's Sons. New York, New York, USA. 19 — ?

**Snelson, Kenneth** 1927–

American artist

It seems clear that the mind hungers for pictures of everything — atoms, no less than trees, flowers and creatures.

*Kenneth Snelson Exhibition*

The Nature of Structure, The New York Academy of Sciences, January–April 1989, Portraying the Atom

**Soddy, Frederick** 1877–1956

English chemist

Yet the atom, for all that, is not Nature's unit, but ours.

*Matter and Energy*

Chapter V (p. 143)

Henry Holt & Company. New York, New York, USA. 1991

**Stedman, Edmund Clarence** 1833–1908

American banker, poet, and critic

White orbs like angels pass

Before the triple glass

That men may scan the record of each flame, —

Of spectral line and line

The legendary divine

Finding their mould the same, and aye the same,

The atoms that we knew before

Of which ourselves are made, — dust, and no more.

*The Poems of Edmund Clarence Stedman*

Poems of Occasion

Corda Concordia

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Stevenson, Adlai E.** 1900–65

American political leader and diplomat

There is no evil in the atom; only in men's souls.

Speech

30 April 1946, House of Commons

**Stoppard, Tom** 1937–

Czech-born English playwright

There is a straight ladder from the atom to the grain of sand, and the only real mystery in physics is the missing rung. Below it, particle physics; above it, classical physics; but in between, metaphysics. All the mystery in life turns out to be this same mystery, the join between things which are distinct and yet continuous, mind and body, free will and causality, living cells and life itself; the moment before the foetus. Who needed God when everything worked like billiard balls?

*Tom Stoppard: Plays*

Hapgood, Act I, Scene 5 (p. 545)

Faber & Faber Ltd. London, England. 1999

### **Tennyson, Alfred (Lord)** 1809–92

English poet

If all be atoms, how then should the Gods

Being atomic not be dissoluble,

Not follow the great law?

*Alfred Tennyson's Poetical Works*

Lucretius, I. 114–116

Oxford University Press, Inc. London, England. 1953

### **Tesla, Nikola** 1856–1943

Croatian-American electrical engineer

But now a mechanism consisting of a finite number of parts and few at that, cannot perform an infinite number of definite motions, hence the impulses which govern its movements must come from the environment. So the atom, the ulterior element of the universe's structure is tossed about in space eternally, a play of external influences, like a boat in a troubled sea. Were it to stop its motion it would die. Matter at rest, if such a thing could exist, would be matter dead. Death of matter! Never has a sentence of deeper philosophical meaning been uttered. . . . There is no death of matter, for throughout the infinite universe, all has to move to vibrate, that is, to live.

*Lectures, Patents, Articles*

On light and other high frequency phenomena, Delivered before the Franklin Institute, Philadelphia, February 1893. Tesla Museum, Beograd, Yugoslavia, 1956 (p. L–110)

### **Thompson, Hunter S.** 1937–2005

American journalist and writer

He seemed surprised. "You found a knife that can cut off an atom?" he said. "In this town?" I nodded. "We're sitting on the main nerve right now," I said.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 2 (p. 25)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### **Tillich, Paul** 1886–1965

German-born American theologian

Only the eternal can save us from the anxiety of being a meaningless bit of matter in a meaningless vortex of atoms and electrons.

*The Eternal Now* (p. 77)

Charles Scribner's Sons. New York, New York, USA. 1963

### **Tyndall, John** 1820–93

Irish-born English physicist

Take your dead hydrogen-atoms, your dead nitrogen-atoms, your dead phosphorus-atoms, and all the other atoms, dead as grains of shot, of which the brain is formed. Imagine them separate and sensationless, observe them running together and forming all imaginable combinations. This, as a purely mechanical process, is seeable by the mind. But can you see, or dream, or in any way imagine, how out of that mechanical act, and from these individually dead atoms, sensation, thought, and emotion are to arise?

Address Delivered Before the English Association Assembled at Belfast Report of the 44<sup>th</sup> Meeting

August 1874 (p. 37)

### **Vaihinger, Hans** 1852–1933

German philosopher

The opponents of the atom are generally content to point to its contradictions and reject it as unfruitful for science. A rash form of caution, for without the atom science falls.

*The Philosophy of "As If"*

Part I, Chapter XV (pp. 70–71)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1925

### **von Baeyer, Hans Christian** 1938–

German-born physicist and author

The atom is not a static structure but a dynamic mechanism in constant interaction with its equally dynamic environment. It is not a grain of sand but a wave-tossed buoy blinking from afar. If we want to understand it, we must look beyond still pictures and record the action in a movie.

*Taming the Atom*

Chapter 7 (p. 117)

Random House, Inc. New York, New York, USA. 1992

If atoms obey spooky rules, and we are made of atoms, why don't we follow the same rules? The answer to the quandary must lie on the theoretical ladder that leads from the laboratory down into the world of atoms, precisely at the missing rung between the two regimes, where classical physics loses its relevance and quantum mechanics takes over.

*Taming the Atom*

Chapter 11 (p. 164)

Random House, Inc. New York, New York, USA. 1992

### **von Lindemann, Louis Ferdinand** 1852–1939

German mathematician

...the oxygen atom has the shape of a ring, and the sulphur atom, the shape of a clot.

In L.I. Ponomarev  
*The Quantum Dice* (p. 40)  
 Institute of Physics Publishing, Bristol, England. 1993

**von Weizsäcker, Carl Friedrich (Baron)** 1912–2007  
 German theoretical physicist and philosopher

...only after the atom has lost the last sensible quality does its true meaning for the physical world view become clear; the unity — real, though remote from our immediate perception — of all that our perception knows only as a multitude of appearances is systematically held together and symbolically represented in it, but not mechanically explained.

Translated by Majorie Grene  
*The World View of Physics*  
 Chapter Two (pp. 55–56)  
 Routledge & Kegan Paul, London, England. 1952

**Wallace, Robert C.** 1881–1955  
 Scottish-Canadian geologist and educator

It is almost with a sense of shock that we realize that the essence of physics and chemistry alike lies in the arrangements within the atom.

Cooperation in the Natural and Human Sciences  
*Canadian Historical Review*, Volume XIV, Number 4, December 1933 (p. 374)

**Wells, H. G. (Herbert George)** 1866–1946  
 English novelist, historian, and sociologist

A little while ago we thought of the atoms as we thought of bricks, as solid building material, as substantial matter, as unit masses of lifeless stuff, and behold! these bricks are boxes, treasure boxes, boxes full of the intensest force.

*The World Set Free*  
 Prelude, Section 8  
 E.P. Dutton, & Company, New York, New York, USA. 1914

**Whitman, Walt** 1819–92  
 American poet, journalist, and essayist

For every atom belongs to me as good as belongs to you.  
*Complete Poetry and Collected Prose*  
 Song of Myself, I.  
 The Library of America, New York, New York, USA. 1982

**Wordsworth, William** 1770–1850  
 English poet

To let a creed, built in the heart of things,  
 Dissolve before a twinkling atom!  
*The Complete Poetical Works of William Wordsworth*  
 The Borderers, Act III, l. 1220–1221  
 Crowell, New York, New York, USA. 1888

**Wysong, R. L.**  
 American veterinary surgeon

A well known principle in physics is the Heisenberg principle of uncertainty. The principle basically argues

that the movement of electrons and atoms is a random process. If the atom is governed by random processes, how could there be biochemical bias? If the law of the atom is randomness how can we cite the atom as the source of order?

*The Creation-Evolution Controversy*  
 Chapter 7 (p. 126)  
 Inquiry Press, Midland, Texas, USA. 1976

## ATOMIC

**Macfie, Ronald Campbell** 1867–1931  
 Scottish poet and physician

It is often assumed that the atomic theory has divested nature of its mystery, and has reduced natural and evolutionary processes to the level of ordinary mechanics. But this is not so. The atomic theory doubles the mystery and the wonder of life. Any artist might mould a bird or beast of clay, but where is the artist who could make so much as a little finger-nail or a single eyelash out of the dancing molecules? And yet continually this miracle is wrought. The molecules I take for dinner, the molecules I unconsciously breathe, will find their way to the little finger-nail or eyelash, and will take there their appointed places.

*Science, Matter and Immortality*  
 Chapter 17 (p. 213)  
 William & Norgate, London, England. 1909

## ATOMIC BOMB

**Einstein, Albert** 1879–1955  
 German-born physicist

Often in evolutionary processes a species must adapt to new conditions in order to survive. Today the atomic bomb has altered profoundly the nature of the world as we know it, and the human race consequently finds itself in a new habitat to which it must adapt its thinking.  
*New York Times Magazine*, June 23, 1946

**Oppenheimer, J. Robert** 1904–67  
 American theoretical physicist

There is only one future of atomic explosives that I can regard with any enthusiasm: that they should never be used in war.

*The Open Mind*  
 Chapter I (p. 5)  
 Simon & Schuster, New York, New York, USA. 1955

## ATOMIC ENERGY

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

If indeed, the subatomic energy in the stars is being freely used to maintain their great furnaces, it seems to bring

a little nearer to fulfillment our dream of controlling this latent power for the well-being of the human race — or for its suicide.

The Internal Constitution of Stars

*Nature*, Volume 106, Number 2603, 2 September 1920 (p. 19)

### **Einstein, Albert** 1879–1955

German-American physicist

Since I do not foresee that atomic energy is to be a great boon for a long time, I have to say that for the present it is a menace. Perhaps it is well that it should be. It may intimidate the human race into bringing order into its international affairs, which, without the pressure of fear, it would not do.

Atomic War or Peace

*Atlantic Monthly*, November 1945

## ATOMIC LANDSCAPE

### **Church, Peggy Pond** 1903–86

American poet

We had thought the magicians were all dead, but this was the blackest of magic.

There was even the accompaniment of fire and brimstone,

The shape of evil, towering leagues high into the heaven  
In terrible, malevolent beauty, and, beneath, the bare trees

Made utterly leafless in one instant, and the streets  
where no one

Moved, and some wall still standing

Eyeless, and as silent as before Time.

*Ultimatum for Man*

The Nuclear Physicist

Stanford University Press. Stanford, California, USA. 1946

### **Laurence, William Leonard** 1888–1977

Lithuanian-American journalist

And just at that instant there rose as if from the bowels of the earth a light not of this world, the light of many suns in one.

It was a sunrise such as the world had never seen, a great green super-sun climbing in a fraction of a second to a height of more than 8,000 feet, rising ever higher until it touched the clouds, lighting up earth and sky all around with dazzling luminosity.

Up it went, a great wall of fire about a mile in diameter, changing colors as it kept shooting upward, from deep purple to orange, expanding, growing bigger, rising as it was expanding, an elemental force freed from its bonds after being chained for billions of years.

Drama of the Atomic Bomb Found Climax in New Mexico Test

*New York Times*, A16, column 5, September 26, 1945

## Narrator

But the end, when it came, was to be from the sky. Irresistible. Unimaginable. Mushroom shaped.

*The World at War*

Episode 22, Japan

Film documentary

### **Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

[W]hile man still struggles and dreams, his very substance will change and crumble from beneath him. . . . Suppose, indeed, that is to be the end of our planet; no splendid climax and finale, no towering accumulation of achievements, but just — atomic decay! I add that to the ideas of the suffocating comet, the dark body out of space, the burning out of the sun, the distorted orbit, as a new and far more possible end — as Science can see ends — to this strange by-play of matter that we call human life. I do not believe this can be the end; no human soul can believe in such an end and go on living, but to it science points as a possible thing, science and reason alike. If single human beings — if one single rickety infant — can be born as it were by accident and die futile, why not the whole race?

*Tono-Bungay*

Book the Third, Chapter the Fourth, V (p. 387)

Duffield & Company. New York, New York, USA. 1921

## ATOMIC WEIGHT

### **Richards, Theodore William** 1868–1928

American chemist

If our inconceivably ancient Universe even had any beginning, the conditions determining that beginning must even now be engraved in the atomic weights. They are the hieroglyphics which tell in a language of their own the story of the birth or evolution of all matter, and the Periodic Table containing the classification of the elements is the Rosetta Stone, which may enable us to interpret them. Until, however, these hieroglyphics are clearly visible in their true form, we cannot hope for an interpretation.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1914

Atomic Weights (p. 282)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

## ATOMISM

### **Democritus of Abdera** 460 BCE–370 BCE

Greek philosopher

By convention are sweet and bitter, hot and cold, by convention is color; in truth are atoms and the void. . . . In reality we apprehend nothing exactly, but only as it

changes according to the condition of our body and the things that impinge on or offer resistance to it.

In G.S Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 589 (p. 422)

At the University Press. Cambridge, England. 1963

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

Again after the revolution of many of the sun's years a ring on the finger is thinned on the under side by wearing, the dripping from the eaves hollows a stone, the bent ploughshare of iron imperceptibly decreases in the fields, and we behold the stone-paved streets worn down by the feet of the multitude.... These things then we see are lessened, after they are thus worn down; but what bodies depart at any given time nature has jealously shut out the means of seeing...

In *Great Books of the Western World* (Volume 12)

*Lucretius: On the Nature of Things*

Book One, l. 311–324 (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ATTRACTION

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

By the Table in the second Part of the second Book, wherein the thicknesses of colour'd Plates of Water between two Glasses are set down, the thickness of the Plate where it appears very black, is three eighths of the ten hundred thousandth part of an Inch. And where the Oil of Oranges between the Glasses is of this thickness, the Attraction collected by the foregoing Rule, seems to be so strong, as within a Circle of an Inch in diameter, to suffice to hold up a Weight equal to that of a Cylinder of Water of an Inch in diameter, and two or three Furlongs in length. And where it is of a less thickness the Attraction may be proportionally greater, and continue to increase, until the thickness[es] do not exceed that of a single Particle of the Oil. There are therefore Agents in Nature able to make the Particles of Bodies stick together by very strong Attractions. And it is the Business of experimental Philosophy to find them out.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book III: Part I, Query 31

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## AURORA BOREALIS

**Ackerman, Diane** 1948–

American writer

As we flew down across the Canadian Arctic, we were beneath an arc of northern lights, which were pure green

and bell-shaped. We and the plane were the clapper of this bell, with the green light over us. And for the first time in my life I felt that I was in the position of the whale that is singing to you when you're in the boat and just listening to it.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*

The Moon by Whale Light (p. 130)

Random House, Inc. New York, New York, USA. 1991

## Author undetermined

...those northern lights have this peculiar nature, that the darker the night is, the brighter they seem, and they always appear at night but never by day, most frequently in the densest darkness and rarely by moonlight. In appearance they resemble a vast flame of fire viewed from a great distance. It also looks as if sharp points were shot from this flame up into the sky, they are of uneven height and in constant motion, now one, now another darting highest; and the lights appears to blaze like a living flame...it seems to me not unlikely that the frost and the glaciers have become so powerful there that they are able to radiate forth these flames.

Translated by L.M. Larson

*Scandinavian Monograph* (Volume 3)

The King's Mirror

Chapter XIX (pp. 150,151)

The American-Scandinavian Foundation. New York, New York, USA. 1917

**Aytoun, William Edmondstone** 1813–65

Scottish poet and parodist

All night long the northern streamers

Shot across the trembling sky:

Fearful lights, that never beckon

Save when kings or heroes die.

Edinburgh after Flodden

*Harper's New Monthly Magazine*, Volume 28, Number 165, February 1864 (p. 337)

**Burns, Robert** 1759–96

English writer

The cauld blae North was streaming forth

Her lights, wi' hissing eerie din.

*The Complete Poetical Works of Robert Burns*

A Vision

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**Haliburton, Thomas C.** 1796–1865

Canadian jurist and writer

The sun has scarcely set behind the dark wavy outline of the western hills, ere the aurora borealis mimics its setting beams, and revels with wild delight in the heavens, which it claims as its own, now ascending with meteor speed to the zenith, then dissolving into a thousand rays of variegated light, that vie with each other which shall first reach the horizon; now flashing



bright, brilliant and glowing, as emanations of the sun, then slowly retreating from view pale and silvery white like wandering moonbeams.

*The Old Judge*

The Seasons (p. 210)

Clarke, Irwin & Company Ltd. Toronto, Ontario, Canada. 1968

**Kingsley, Charles** 1819–75

English clergyman and writer

Night's son was driving  
His golden-haired horses up;  
Over the eastern firths  
High flashed their manes.

*Poems*

The Longbeards' Saga

Ticknor & Fields. Boston, Massachusetts, USA. 1856

**Nansen, Fridtjof** 1861–1930

Norwegian explorer, oceanographer, and statesman

The glowing fire-masses had divided into glistening, many coloured bands, which were writhing and twisting across the sky both in the south and north. The rays sparkled with the purest, most crystalline rainbow colours, chiefly violet-red or carmine and the clearest green. Most frequently the rays of the arch were red at the ends, and changed higher up into sparkling green. . . . It was an endless phantasmagoria of sparkling colour, surpassing anything that one can dream. Sometimes the spectacle reached such a climax that one's breath was taken away; one felt that now something extraordinary must happen — at the very least the sky must fall.

*Fridtjof Nansen: The Fram Expedition – Nansen in the Frozen World*  
A.G. Holman. Philadelphia, Pennsylvania, USA. 1897

**Remek, Vladimir** 1948–

Czechoslovakian cosmonaut

Firefly meteorites blazed against a dark background, and sometimes the lightning was frighteningly brilliant. Like a boy, I gazed open-mouthed at the fireworks, and suddenly, before my eyes, something magical occurred. A greenish radiance poured from Earth directly up to the station, a radiance resembling gigantic phosphorescent organ pipes, whose ends were glowing crimson, and overlapped by waves of swirling green mist. Consider yourself very lucky, Vladimir, I said to myself, to have watched the northern lights.

The View from Out There: In Words and Pictures

*Life magazine*, Volume 11, Number 13, November 1988 (p. 195)

**Scott, Sir Walter** 1771–1832

Scottish novelist and poet

He knew, by streamers that shot so bright,  
That spirits were riding the northern light.

*The Complete Poetical Works of Sir Walter Scott*

The Lay of the Last Minstrel, Canto Second, VIII, l. 91–2

T.Y. Crowell. New York, New York, USA. 1894

**Service, Robert William** 1874–1958

Canadian poet and novelist

Some say that the Northern Lights are the glare of the Arctic ice and snow;

And some that it's electricity, and nobody seems to know.

*Collected Poems of Robert Service*

The Ballad of the Northern Lights

Dodd, Mead & Company New York, New York, USA. 1961

And the Northern Lights in the crystal nights came forth with a mystic gleam.

They danced and they danced the devil-dance over the naked snow;

And soft they rolled like a tide upshoaled with a ceaseless ebb and flow.

They rippled green with a wondrous sheen, they fluttered out like a fan;

They spread with a blaze of rose-pink rays never yet seen of man.

*Collected Poems of Robert Service*

The Ballad of the Northern Lights

Dodd, Mead & Company New York, New York, USA. 1961

**Taylor, Bayard** 1825–78

American journalist and writer

The amber midnight smiles in dreams of dawn.

*The Poetical Works of Bayard Taylor*

From the North

Houghton, Osgood. Boston, Massachusetts, USA. 1880

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

“What are fireworks like?” she asked. . . .

“They are like the Aurora Borealis,” said the King. . . .

“only much more natural. I prefer them to stars myself, as you always know when they are going to appear. . . .”

*Oscar Wilde Selected Writing*

The Remarkable Rocket (p. 196)

Oxford University Press, Inc. London, England. 1961

## AUTHORITY

**Andreski, Stanislaw** 1919–

Polish sociologist

So long as authority inspires awe, confusion and absurdity enhance conservative tendencies in society. Firstly, because clear and logical thinking leads to a cumulation of knowledge (of which the progress of the natural sciences provides the best example) and the advance of knowledge sooner or later undermines the traditional order. Confused thinking, on the other hand, leads nowhere in particular and can be indulged indefinitely without producing any impact upon the world.

*Social Sciences as Sorcery*

Chapter 7 (p. 90)

St. Martin's Press. New York, New York, USA. 1972

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Anyone who in discussion relies upon authority uses, not his understanding, but rather his memory.

*The Literary Works of Leonardo da Vinci* (Volume 2)  
1159 (p. 241)

University of California Press. Berkeley, California, USA. 1977

**Recorde, Robert** 1510?–58  
English mathematician and writer

No man can worthily praise Ptolemy, his travel being so great, his diligence so exact in observations, and conference with all nations, and all ages, and his reasonable examination of all opinions, with demonstrable confirmation of his owne assertion, yet muste you and all men take heed, that both in him and in all mennes workes, you be not abused by their authoritye, but evermore attend to their reasons, and examine them well, ever regarding more what is saide, and how it is proved, than who saieith it for authorite often times deceaveth many menne...

*The Castle of Knowledge*

The Fourth Treatise (p. 119)

Imprinted by R. Wolfe. London, England. 1556

**Wright, Thomas** 1711–86  
English cosmologist

...I am an Enemy to the taking of anything for granted, merely because a Person of reputed Judgment, has been heard to say, it absolutely is so...

*An Original Theory or New Hypothesis of the Universe*

Letter the Second (p. 9)

Printed for the Author. London, England. 1750

## AUTONOMIC NERVOUS SYSTEM

**Langley, John Newport** 1852–1925  
English physiologist

I propose to substitute the word “autonomic”. The word implies a certain degree of independent action, but exercised under control of a higher power. The “autonomic” nervous system means the nervous system of the glands and of the involuntary muscle; it governs the “organic” functions of the body.

On the Union of Cranial Autonomic Visceral Fibers with the Nerve Cells of the Superior Cervical Ganglion

*The Journal of Physiology*, Volume 23, 1898–1899 (p. 241)

## AUTONOMY

**Swartz, Norman**  
American philosopher

If the physical laws of this world are autonomous, we are not free; if we are free, then the physical laws are not autonomous.

*The Concept of Physical Law*

Chapter 10

Cambridge University Press. Cambridge, England. 1985

## AUTOPSY

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Mrs. Dollop became more and more convinced... Dr Lydgate meant to let the people die in the Hospital, if not to poison them, for the sake of cutting them up without saying by your leave or with your leave; for it was a known “fac” that he had wanted to cut up Mrs. Goby, as respectable a woman as any in Parley Street, who had money in trust before her marriage — a poor tale for a doctor, who if he was good for anything should know what was the matter with you before you died, and not want to pry into your inside after you were gone.

*Middlemarch*

Book V, Chapter XLV (p. 434)

Clarendon Press. Oxford, England. 1986

**Flexner, Abraham** 1866–1959  
American educator

The effective teaching of pathology is dependent on ease and frequency of access to the autopsy-room.... The post-mortem is in this country relatively rare and precarious.... [N]ot infrequently pathological courses are organized and given whose illustrative material is limited to models, to a small number of preserved specimens, or even to bits of material already cut into microscopic sections or just lacking that last touch.

*Medical Education in the United States and Canada: A Report to the*

*Carnegie Foundation for the Advancement of Teaching*

Bulletin 4 (p. 66)

The Carnegie Foundation. New York, New York, USA. 1910

The physician is constantly in contact with disease processes that he is unable to correlate with the accompanying structural modifications. Occasionally the surgeon throws a stream of light upon such a situation; too often all is dark until the autopsy reveals the truth.

*Medical Education in the United States and Canada: A Report to the*

*Carnegie Foundation for the Advancement of Teaching*

Bulletin 4 (p. 66)

The Carnegie Foundation. New York, New York, USA. 1910

**Giles, Roscoe C.**

No biographical data available

A check-up of one’s clinical findings at the autopsy table is indispensable to the progress of the art and science of medicine. The public is being aroused to the importance of autopsies as a matter of self-protection. I believe it is only a matter of time before physicians as well as hospitals will be rated by the percentage of autopsies they do or see in their practices.

Some Clinical Lessons from a Year's Observation in the Department of Pathology of the University of Vienna  
*Journal of the National Medical Association*, Volume 24, 1932

## AVALANCHE

**Heinlein, Robert A.** 1907–88

American science fiction writer

If a man pushes a rock, can he ignore an avalanche that follows?

*Time Enough for Love*

Chapter IX (p. 238)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Muir, John** 1838–1914

American naturalist

When the snow first gives way on the upper slopes of their basins a dull muffled rush and rumble is heard, which increasing with heavy deliberation, seems to draw rapidly near with appalling intensity of tone. Presently the white flood comes in sight bounding out over bosses and sheer places, leaping from bench to bench, spreading and narrowing and throwing off clouds of whirling diamond dust like a majestic foamy cataract.

*The Yosemite*

Chapter 3 (p. 46)

Sierra Club Books. San Francisco, California, USA. 1988

Compared with cascades and falls, avalanches are short-lived, few of them lasting more than a minute or two, and the sharp clashing sounds so common in dashing water are usually wanting; but in their low massy thunder-tones and purple-tinged whiteness, and in their dress, gait, gestures, and general behavior, they are much alike.

*The Yosemite*

Chapter 3 (pp. 46–47)

Sierra Club Books. San Francisco, California, USA. 1988

## AVERAGE

**Alderson, M. H.**

No biographical data available

If at first you don't succeed, you are running about average.

In Paul Dickson

*The Official Explanations* (p. A-4)

Delacorte Press. New York, New York, USA. 1980

**Atherton, Gertrude** 1857–1948

American novelist

The average intelligence is always shallow, and in electric climates very excitable.

*Senator North*

Book III, Chapter IX (p. 303)

John Lane: The Bodley Head. New York, New York, USA. 1900

...but they are more hysterical than the average because they have the opportunity their constituents lack, of shouting in public.

*Senator North*

Book II, VII (p. 172)

John Lane: The Bodley Head. New York, New York, USA. 1900

**Bailey, Thomas D.**

No biographical data available

There must be such a thing as a child with average ability, but you can't find a parent who will acknowledge that it is his child. ...

Notable and Quotable

*Wall Street Journal*, December 17, 1962 (p. 16)

**Bernard, Claude** 1813–78

French physiologist

Another very frequent application of mathematics to biology is the use of averages which, in medicine and physiology, leads, so to speak, necessarily to error. ... By destroying the biological character of phenomena, the use of averages in physiology and medicine usually give only apparent accuracy to the results.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section IX (p. 134)

Henry Schuman, Inc. New York, New York, USA. 1927

Chemical averages are also often used. If we collect a man's urine during twenty-four hours and mix all this urine to analyze the average, we get an analysis of a urine which simply does not exist; for urine, when fasting, is different from urine during digestion. A startling instance of this kind was invented by a physiologist who took urine from a railroad station urinal where people of all nations passed, and who believed he could thus present an analysis of average European urine!

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section ix (pp. 134–135)

Henry Schuman, Inc. New York, New York, USA. 1927

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

About the hardest thing a phellow kan do, iz tew spark two girls at onest, and preserve a good average.

*Old Probability: Perhaps Rain — Perhaps Not*

May 1870 (Green Section)

G.W. Carleton & Company, Publishers. New York, New York, USA. 1879

**Bowley, Arthur L.** 1869–1957

English statistician and economist

Of itself an arithmetic average is more likely to conceal than to disclose important facts; it is the nature of an abbreviation, and is often an excuse for laziness.

*The Mathematical Gazette*

Volume 12, Number 77, July 1925 #319 (p. 421)

**Brandeis, Louis D.** 1856–1941  
American lawyer, reformer, and associate justice

I abhor averages. I like the individual case. A man may have six meals one day and none the next, making an average of three meals per day, but that is not a good way to live.

In Alpheus T. Mason  
*Brandeis: A Free Man's Life*  
Chapter Ten (p. 145)  
The Viking Press. New York, New York, USA. 1956

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
English Romantic poet and satirist

Have shaving too entailed upon their chins, —  
A daily plague, which in the aggregate  
May average on the whole with parturition.

*The Complete Poetical Works of Byron*  
Don Juan  
Canto XIV, 23–24  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Carrel, Alexis** 1873–1944  
French surgeon and biologist

The best way of increasing the [average] intelligence of scientists would be to reduce their number.

*Man the Unknown*  
Chapter 2, Section 4 (p. 49)  
Harper & Brothers Publishers. New York, New York, USA. 1939

**Cohen, Morris Raphael** 1880–1947  
American philosopher

The concept of average was developed in the Rhodian laws as to the distribution of losses in maritime risks.

The Statistical View of Nature  
*Journal of the American Statistical Association*, Volume 31, Number 194, June 1936 (p. 328)

**Dickens, Charles** 1812–70  
English novelist

...the criminal intellect...its own professed students perpetually misread, because they persist in trying to reconcile it with the average intellect of average men instead of identifying it as a horrible wonder apart....

*The Mystery of Edwin Drood*  
Chapter XX (p. 225)  
Oxford University Press. Oxford, England. 1956

**Foss, Sam Walter** 1858–1911  
American librarian and poet

The plain man is the basic clod  
From which we grow the demigod;  
And in the average man is curled  
The hero stuff that rules the world.

*Back Country Poems*  
Memorial Day, Stanza 2  
Lee & Shepard. Boston, Massachusetts, USA. 1894

**Friedman, Milton** 1912–2006  
American laissez-faire economist

True, the average rate for the year as a whole, though on the high side, is not too bad, but that is like assuring the nonswimmer that he can safely walk across a river because its average depth is only 4 feet.

Irresponsible Monetary Policy  
*Newsweek*, January 10, 1972 (p. 57)

**Froude, James Anthony** 1818–94  
English historian and biographer

Unfortunately, the average of one generation need not be the average of the next.

*Short Studies on Great Subjects* (Volume 1)  
The Science of History (p. 26)  
Longmans, Green & Company. London, England. 1879

We have to consider the million, not the units; the average, not the exceptions.

*Short Studies on Great Subjects* (Volume 2)  
On Progress (p. 261)  
Charles Scribner's Sons. New York, New York, USA. 1890

My friends at Rhodes made me so. I cost as much as sixteen gold gods of average size.

*Short Studies on Great Subjects* (Volume 3)  
Lucian (p. 225)  
Charles Scribner's Sons. New York, New York, USA. 1890

**Grover Snood**  
Fictional character

“You can't fight the law of averages,” Grover said, “you can't fight the curve.”

In Thomas Pynchon  
*Slow Learner: Early Stories*  
The Secret Integration (p. 142)  
Little Brown Publishers. Boston, Massachusetts, USA. 1984

**Harte, Francis Bret** 1839–1902  
American writer and poet

Give me a man that is capable of a devotion to anything, rather than a cold, calculating average of all the virtues!

*Two Men of Sandy Bar*  
Act IV (p. 425)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1910

**Heller, Walter** 1915–87  
American economist

If a man stands with his left foot on a hot stove and his right foot in a refrigerator, the statistician would say that, on the average, he's comfortable.

In Harry Hopkins  
*The Numbers Game: The Bland Totalitarianism*  
Chapter 12, Faithful Partners, Counter Attack (p. 270)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

But an average, which was what I meant to speak about, is one of the most extraordinary subjects of observation and study.

*The Autocrat of the Breakfast-Table*

Chapter VI (p. 140)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1891

**Hooke, Robert** 1635–1703

English physicist

On the average, bunting with a man on first loses a lot of runs. On the average, it doesn't increase the probability of scoring at least one run in the inning.

*Statistics: A Guide to the Unknown*

Statistics, Sports, and Some Other Things (p. 192)

Wadsworth & Brooks. Pacific Grove, California, USA. 1989

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE

Roman philosopher and dramatic critic

There is a mean in things, fixed limits on either side of which right living cannot get a foothold.

In Casper J. Kraemer (ed.)

*The Complete Works of Horace*

The Golden Mean (p. 6)

The Modern Library. New York, New York, USA. 1936

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

The average man believes a thing first, and then searches for proof to bolster his opinion.

*The Philistine: A Periodical of Protest*

Volume XI, July 1900 (p. 36)

**Huxley, Aldous** 1894–1963

English writer and critic

Fertilize and boganovskify — in other words, multiply by seventy-two — and you get an average of nearly eleven thousand brothers and sisters in a hundred and fifty two batches of identical twins, all within two years of the same age.

*Brave New World*

Chapter One (p. 7)

Harper & Brothers. New York, New York, USA. 1950

**Inge, William Ralph** 1860–1954

English religious leader and writer

The average man is rich enough when he has a little more than he has got, and not till then.

*Outspoken Essays (First Series)*

Patriotism (pp. 38–39)

Longmans, Green & Company. New York, New York, USA. 1920

...public opinion [is] a vulgar, impertinent, anonymous tyrant who deliberately makes life unpleasant for anyone who is not content to be the average man.

*Outspoken Essays (First Series)*

Our Present Discontents (p. 9)

Longmans, Green & Company. New York, New York, USA. 1920

**Jacobs, Joseph** 1854–1916

Australian writer

Such is the past career, present condition, and certain future of the Middle American. There are as many above him as below him, and especially as many below him as above him.

The Middle American

*American Magazine*, Volume 63, March 1907

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

Myth is more individual and expresses life more precisely than does science. Science works with concepts of averages which are far too general to do justice to the subjective variety of an individual life.

*Memories, Dreams, Reflections*

Chapter I (p. 3)

Vintage Books. New York, New York, USA. 1963

**Juster, Norton** 1929–

American architect and writer

“Pardon me for staring,” said Milo, after he had been staring for some time, “but I’ve never seen half a child before.”

“It’s .58 to be precise,” replied the child from the left side of his mouth (which happened to be the only side of his mouth).

“I beg your pardon?” said Milo.

“It’s .58,” he repeated; “it’s a little bit more than a half

...we’re just the average family,” he said thoughtfully; “mother, father, and 2.58 children — and, as I explained, I’m the .58.”...

“But averages aren’t real,” objected Milo, “they’re just imaginary.”

“That may be so,” he agreed, “but they’re also very useful at times. For instance, if you didn’t have any money at all, but you happened to be with four other people who had ten dollars apiece, then you’d each have an average of eight dollars. Isn’t that right?”

*The Phantom Tollbooth*

Chapter 16 (p. 196)

Alfred A. Knopf. New York, New York, USA. 1989

**Keegan, John** 1934–

English military historian

“...hitting the target”, for centuries the principal military skill, is henceforth to be left to the law of averages.

*The Face of Battle* (p. 307)

The Viking Press. New York, New York, USA. 1979

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

One need not accept Shaw's own estimate of his intellectual equipment to see that the doctor's remark cut through a confusion in which psychologists and sociologists flounder. Frequently they make no distinction between what is "normal" and what is "usual", "average", or "statistically probable".

*Human Nature and the Human Condition*

Chapter V (p. 75)

Random House, Inc. New York, New York, USA. 1959

...the question "How many legs does a normal man have?" should be answered by finding a statistical average. And since some men have only one leg, or none, this would lead inevitably to the conclusion that a "normal" man is equipped with one and some fraction legs.

*Human Nature and the Human Condition*

Chapter V (p. 76)

Random House, Inc. New York, New York, USA. 1959

**Lao Tzu** fl. 6<sup>th</sup> century BCE

Chinese philosopher and father of Taoism

The wise student hears of the Tao and practices it diligently. The average student hears of the Tao and gives it thought now and again.

Translated by Gia-Fu Feng and Jane English

*Tao Te Ching*

Forty-one

Alfred A. Knopf. New York, New York, USA. 1974

**Leacock, Stephen** 1869–1944

Canadian humorist

Dear Sir, — We beg to acknowledge your letter of application and cheque for fifteen dollars. After careful comparison of your case with the average modern standard, we are pleased to accept you as a first-class risk.

*Literary Lapses*

Insurance up to Date (p. 158)

John Lane. London, England. 1911

All very old men have splendid educations; all men who apparently know nothing else have thorough classical educations; nobody has an average education.

*Literary Lapses*

A Manual of Education (p. 127)

John Lane. London, England. 1911

**Lieber, Lillian R.**

American mathematician

What does this mean for The Average Man?

*The Education of T.C. MITS*

Part I, Chapter VI (p. 71)

W.W. Norton & Company, Inc. New York, New York, USA. 1944

**Moroney, M. J.**

American statistician

In former times, when the hazards of sea voyages were much more serious than they are today, when ships buffeted by storms threw a portion of their cargo overboard,

it was recognized that those whose goods were sacrificed had a claim in equity to indemnification at the expense of those whose goods were safely delivered. The value of the lost goods was paid for by agreement between all of those whose merchandise had been in the same ship. This sea damage to cargo in transit was known as "*havararia*" and the word came naturally to be applied to the compensation money which each individual was called upon to pay. From this Latin word derives our modern word average.

*Facts from Figures*

On the Average (p. 34)

Penguin Books Ltd., Harmondsworth, England. 1951

**Nightingale, Florence** 1820–1910

English nursing pioneer and statistician

A want of the habit of observing and an inveterate habit of taking averages are each of them often equally misleading.

*Notes on Nursing: What It Is and What It Is Not*

Chapter XIII (p. 67)

Harrison. London, England. 1859

**Nixon, Richard M.** 1913–94

37<sup>th</sup> president of the United States

The average American is just like the child in the family.

Statement from Pre Election Interviews with Nixon Outlining 2<sup>nd</sup> Term Plans

*The New York Times*, November 10, 1972 (p. 20, column 8)

**O. Henry (William Sydney Porter)** 1862–1910

American short story writer and journalist

They had on average, about a quarter of a suit of clothes and one shoe apiece. One chap was sitting on the floor of the aisle, looking as if he were working a hard sum in arithmetic. He was trying very solemn, to pull a lady's number two shoe on a number nine foot.

*Tales of O. Henry*

Holding Up a Train (p. 834)

Doubleday & Company, Inc. Garden City, New York, USA. 1953

**Pynchon, Thomas** 1937–

American novelist

...it suggests Haverie — average, you know...

*Gravity's Rainbow*

Part 2 (p. 207)

The Viking Press. New York, New York, USA. 1973

**Quetelet, Adolphe** 1794–1874

Belgian mathematician, astronomer, and statistician

*l'homme moyen*

the average man

*A Treatise on Man and the Development of His Faculties* (p. 100)

Scholar's Facsimiles & Reprints. Gainesville, Florida, USA. 1969

**Redfield, Roy A.**

No biographical data available

Make sure that the real average is what you are dealing with.

*Factors of Growth in a Law Practice* (p. 170)  
Callaghan. Mundelein, Illinois, USA. 1962

**Rickover, Hyman G.** 1900–86

American naval nuclear engineer

Great minds discuss ideas, average minds discuss events, small minds discuss people.

*The World of the Uneducated*  
*The Saturday Evening Post*, November 28, 1959 (p. 59)

**Shaffer, Peter** 1926–

English playwright

The Normal is the good smile in a child's eyes — all right. It is also the dead stare in a million adults. It both sustains and kills — like a God. It is the Ordinary made beautiful; it is also the Average made lethal.

*Equus and Shrivings: Two Plays*  
*Equus*  
Act I, Scene 19  
Athenaeum. New York, New York, USA. 1974

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

NERISSA. They are as sick that surfeit with too much as they that starve with nothing. It is no mean happiness therefore, to be seated in the mean: superfluity comes sooner by white hairs, but competency lives longer.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The Merchant of Venice  
Act I, Scene ii, l. 5  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Slonim, Morris James** 1909–2004

American statistician

It is a well-known statistical paradox that the average age of women over forty is under forty....

*Sampling in a Nutshell* (p. 26)  
Simon & Schuster. New York, New York, USA. 1960

**Stamp, Josiah** 1880–1941

English economist and financier

Ask a ferryman or a toll-keeper how many visitors come through daily on an average, and with an appearance of great intellectual discomfort he assures you the number varies so much.

*Some Economic Factors in Modern Life*  
Chapter VII (p. 253)  
P.S. King & Son Ltd. London, England. 1929

**Stewart, Alan**

No biographical data available

Sir, — In your issue of December 31 you quoted Mr. B.S. Morris as saying that [among the] many people [that] are disturbed...about half the children in the country are below the average in reading ability. This is only one of many similarly disturbing facts. About half the church steeples in the country are below average height; about half our coal scuttles below average capacity, and about half our babies below average weight. The only remedy would seem to be to repeal the law of averages.

Averages  
*The Times*, Monday, January 4, 1954 (p. 7)

**Stoppard, Tom** 1937–

Czech-born English playwright

GUIL: The equanimity of your average tosser of coins depends upon a law, or rather a tendency, or let us say a probability, or at any rate a mathematically calculable chance, which ensures that he will not upset himself by losing too much nor upset his opponent by winning too often.

*Rosencrantz and Guildenstern Are Dead*  
Act One (p. 18)  
Grove Press, Inc. New York, New York, USA. 1967

Expectation in the general sense may be considered as a kind of average.

*The Encyclopædia Britannica*, 11<sup>th</sup> Edition  
Probability

GUIL: The law of averages, if I have got this right, means that if six monkeys were thrown up in the air for long enough they would land on their tails about as often as they would land on their —

*Rosencrantz and Guildenstern Are Dead*  
Act One (p. 13)  
Grove Press, Inc. New York, New York, USA. 1967

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

The average man's a coward.... The average man don't like trouble and danger.

*The Adventures of Huckleberry Finn*  
Chapter XXII (pp. 187–188)  
Grosset & Dunlap Publishers. New York, New York, USA. 1948

The only very marked difference between the average civilized man and the average savage is that the one is gilded and the other painted.

*Mark Twain Laughing: Humorous Anecdotes by and about Samuel Clemens*  
1904, #370 (p. 98)  
University of Tennessee Press. Knoxville, Tennessee, USA. 1985

**Venn, John** 1834–1923

English logician

Why do we resort to averages at all?

On the Nature and Uses of Averages  
*Journal of the Royal Statistical Society*, Volume 54, 1891 (p. 429)

How can a single introduction of our own [average], and that a fictitious one, possibly take the place of the many values which were actually given to us? And the answer surely is, that it can not possibly do so; the one thing cannot take the place of the other for purposes in general, but only for this or that specific purpose.

On the Nature and uses of Averages

*Journal of the Royal Statistical Society*, Volume 54, 1891 (p. 430)

If we start with the assumption, grounded on experience, that there is uniformity in this average, and so long as this is secured to us, we can afford to be perfectly indifferent to the fate, as regards causation, of the individuals which compose the average.

*The Logic of Chance: An Essay on the Foundation and Province of the Theory of Probability*

Chance, Causation, and Design, Section 4 (p. 239)

Macmillan & Company Ltd. London, England. 1888

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

CECILY: Mr. Mancreif and I are engaged to be married, Lady Brocknell.

LADY BROCKNELL [with a shiver, crossing to the sofa and sitting down]: I do not know whether there is anything peculiarly exciting in the air of this particular part of Hertfordshire, but the number of engagements that go on seems to me considerably above the proper average that statistics have laid down for our guidance.

*The Importance of Being Earnest: A Trivial Comedy for Serious People* Act III (p. 104)

Walter H. Baker Company. Boston, Massachusetts, USA. 19–?

## AWARENESS

**Gilkey, Langdon** 1919–2004

American protestant theologian

Surely one of the most important characteristics of a scientific, introverted, specialized, hence infinitely intellectual culture is its drive toward, and faith in, total “awareness”. Awareness of almost every conceivable factor influencing almost every conceivable situation is our characteristic panacea or cure-all. In this sense, gnosis, the total consciousness, and self-consciousness are the major goals of our secular culture. We really believe that if we know or are aware of everything, if we can understand all relevant causes and factors, we can control everything.

*Religion and the Scientific Future: Reflections on Myth, Science, and Theology*

Chapter III (p. 78)

Harper & Row, Publishers. New York, New York, USA. 1970

## AXIAL TILT

**Milton, John** 1608–74

English poet

Some say he bid his angels turne ascance  
The poles of Earth twice ten degrees and more  
From the suns axle; they with labour push'd  
Oblique the Centric Globe: Som say the Sun  
Was bid turn Reines from th' Equinoctial Rode  
Like distant breadth to Taurus with the sev'n  
Atlantic Sisters, and the Spartan Twins,  
Up to the Tropic Crab; thence down amain  
By Leo and the Virgin and the Scales,  
As deep as Capricorn, to bring in change  
Of Seasons to each Clime; else had the Spring  
Perpetual smil'd on Earth with vernant Flours,  
Equal in Days and Nights...

The sun, as from Thyestean Banquet, turn'd  
His course intended; else how had the World  
Inhabited, though sinless, more than now  
Avoided pitching cold and scorching heate?

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book X, l. 668–680, 688–691

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## AXIOM

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...though it be true that I am principally in pursuit of works and the active department of the sciences, yet I wait for harvest-time, and do not attempt to mow the moss or to reap the green corn. For I well know that axioms once rightly discovered will carry whole troops of works along with them, and produce them, not here and there one, but in clusters.

*Instauratio Magna*

The Plan of the Instauratio Magna

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

I once told an audience of school children that the world would never change if they did not contradict their elders. I was chagrined to find next morning that this axiom outraged their parents. Yet it is the basis of the scientific method. A man must see, do and think things for himself, in the face of those who are sure that they have already been over all that ground. In science, there is no substitute for independence.

*Science and Human Values*

The Sense of Human Dignity (pp. 60–61)

Harper & Row, Publishers. New York, New York, USA. 1965

**Chargaff, Erwin** 1905–2002

Austrian biochemist

...nowadays our sciences, quick and fickle, wear out dogmas in 10 years, and axioms take only a little longer. Bitter Fruits from the Tree of Knowledge



*Perspectives in Biology and Medicine*, Volume 16, Number 4, Summer 1973 (p. 496)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

It has long been an axiom of mine that the little things are infinitely the most important.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Case of Identity (p. 414)

Wings Books. New York, New York, USA. 1967

**Frayn, Michael** 1933–  
English dramatist

For hundreds of pages the closely-reasoned arguments unroll, axioms and theorems interlock. And what remains with us in the end? A general sense that the world can be expressed in closely-reasoned arguments, in interlocking axioms and theorems.

*Constructions*

No. 277

Wildwood House. London, England. 1974

**Planck, Max** 1858–1947  
German physicist

Axioms are instruments which are used in every department of science, and in every department there are purists who are inclined to oppose with all their might any expansion of the accepted axioms beyond the boundary of their logical application.

*Where Is Science Going?*

Chapter VI (p. 179)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Raju, Poolla Tirupati** 1904–  
Indian philosopher

We are driven to conclude that science, like mathematics, is a system of axioms, assumptions, and deductions; it may start from being, but later leaves it to itself, and ends in the formation of a hypothetical reality that has nothing to do with existence; or it is the discovery of an ideal being which is, of course, present in what we call actuality, and renders it an existence for us only by being present in it.

*Idealistic Thought of India*

Chapter II, Section VII (p. 84)

The Harvard University Press. Cambridge, Massachusetts, USA. 1953

**von Neumann, John** 1903–57  
Hungarian-American mathematician

**Morgenstern, Oskar** 1902–77  
German-born American economist

A choice of axioms is not purely a subjective task. It is usually expected to achieve some definite aim — some specific theorem or theorems are to be derivable from the axioms — and to this extent the problem is exact and objective. But beyond this there are always other important desiderata of a less exact nature: the axioms should not be too numerous, their system is to be as simple and transparent as possible, and each axiom should have an immediate intuitive meaning by which its appropriateness can be judged directly.

*Theory of Games and Economic Behavior*

Chapter 3.5.2 (p. 25)

Princeton University Press. Princeton, New Jersey, USA. 1947

## AXIOMIZE

**Weyl, Hermann** 1885–1955  
German mathematician

— I should not pass over in silence the fact that today the feeling among mathematicians is beginning to spread that the fertility of these abstracting methods is approaching exhaustion. The case is this: that all these nice general notions do not fall into our laps by themselves. But definite concrete problems were conquered in their undivided complexity, singlehanded by brute force, so to speak. Only afterwards the axiomaticians came along and stated: Instead of breaking in the door with all your might and bruising your hands, you should have constructed such and such a key of skill, and by it you would have been able to open the door quite smoothly. But they can construct the key only because they are able, after the breaking in was successful, to study the lock from within and without. Before you can generalize, formalize and axiomatize, there must be a mathematical substance. I think that the mathematical substance in the formalizing of which we have trained ourselves during the last decades, becomes gradually exhausted. And so I foresee that the generation now rising will have a hard time in mathematics.

Emmy Noether

*Scripta Mathematica*, Volume 3, 1935

## B

### BACK

**Hubbard, Elbert** 1856–1915  
American editor, publisher, and writer

BACK: 2. A smooth surface composed of skin and bones which stretches between Land's End and John O'Groat's. *The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 15)  
The Roycrofters. East Aurora, New York, USA. 1914

### BACKBONELESSNESS

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Backboneless marine animals are the creatures of the sea in which they live. Like the sea itself they are sluggish, if not entirely sedentary. Like the rest of us they are products of their environment.  
*Parade of the Living*  
Part I, Chapter V (p. 55)  
Coward-McCann, Inc. New York, New York, USA. 1930

### BACTERIA

**Cohn, Ferdinand Julius** 1828–98  
German botanist and bacteriologist

At last, in the most recent times, an unexpected knowledge of the secret life energies of bacteria has been revealed, through which they rule with demoniacal power over the weal and woe, and even over the life and death of man.  
*Bacteria: The Smallest of Living Organisms*  
Lüder. Berlin. 1872

If one could inspect a man under a similar lens-system he would appear as big as Mont Blanc or even as Mt. Chimborazo. But even under these colossal magnifications the smallest bacteria look no larger than the periods and commas of good print; little or nothing can be distinguished of their inner parts, and of them their very existence would have remained unsuspected if it had not been for their countless numbers.  
In Kenneth Thimann  
*The Life of Bacteria: Their Growth, Metabolism, and Relationships*  
Chapter II (p. 33)  
The Macmillan Company. New York, New York, USA. 1963

**Dyer, Betsey Dexter** 1954–  
American biologist

Before refrigeration, when seafood might be kept a few days in a chilly basement, this phenomenon of glowing decay [from bacteria] was observed and noted. Charles

Dickens, in *A Christmas Carol*, likens Marley's face in the knocker of Scrooge's door to a glowing lobster: "Marley's face...had a dismal light about it, like a bad lobster in a dark cellar." How many nonmicrobiologists have passed over that line, unable to decipher what image Dickens had in mind?

*A Field Guide to Bacteria*  
Chapter 8 (p. 131)  
Cornell University Press. Ithaca, New York, USA. 2003

**Feynman, Richard P.** 1918–88  
American theoretical physicist

The proteins of bacteria and the proteins of humans are the same. In fact it has recently been found that the protein-making machinery in the bacteria can be given orders from the red cells to produce red cell proteins. So close is life to life.  
*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 11)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Grassé, Pierre P.** 1895–1985  
French zoologist

Bacteria, the study of which has formed a great part of the foundation of genetics and molecular biology, are the organisms which, because of their huge numbers, produce the most mutants. This is why they gave rise to an infinite variety of species, called strains, which can be revealed by breeding or tests. Like *Erophila verna*, bacteria, despite their great production of intraspecific varieties, exhibit a great fidelity to their species. The bacillus *Escherichia coli*, whose mutants have been studied very carefully, is the best example. The reader will agree that it is surprising, to say the least, to want to prove evolution and to discover its mechanisms and then to choose as a material for this study a being which practically stabilized a billion years ago!  
*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 87)  
Academic Press. New York, New York, USA. 1977

**Helmuth, William Tod** 1833–1902  
American physician

Oh, powerful bacillus,  
With wonder how do you fill us,  
Every day!  
While medical detectives,  
With powerful objectives,  
Watch you play.  
"Scratches" of a Physician  
Ode to the Bacillus  
W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Paulos, John Allen** 1945–  
American mathematician

We are trying to measure bacteria with a yardstick.

*New York Times*, 22 November 2000 (p. A31)

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and writer

The bacteria are only the most primitive, and adaptable-to-the-primitive beings that are at present known. They may have had — may still have — antecedents even more hardy and fitted to digest the raw stuff of the universe, perhaps even the interstellar calcium that is one of the recent discoveries of the watchers of the skies.

*An Almanac for Moderns*

November Thirtieth (p. 278)

G.P. Putnam's Sons. New York, New York, USA. 1935

No picture of life today is even worth a glance that does not show the bacteria as the foundation of life itself, the broad base of the pyramid on which all the rest is erected.

*An Almanac for Moderns*

November Twenty-Seventh (p. 275)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Tyndall, John** 1820–93

Irish-born English physicist

We have been scourged by invisible throngs, attacked from impenetrable ambuscades, and it is only today that the light of science is being let in upon the murderous dominion of our foes.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

In Edwin O. Jordan

The Bacteria (p. 215)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Wallin, Ivan E.** 1883–1969

American biologist

It is a rather startling proposal that bacteria, the organisms which are popularly associated with the disease, may represent the fundamental causative factor in the origins of species.

*Symbioticism and the Origin of Species*

Chapter I (p. 8)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

## BACTERIOLOGIST

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Well, I'm a bacteriologist, you know. I live in a nine-hundred-diameter microscope. I can hardly claim to take serious notice of anything that I can see with my naked eye.

*The Lost World*

Chapter II (p. 25)

The Colonial Press. Clinton, Massachusetts, USA. 1959

## BALANCE

**Chargaff, Erwin** 1905–2002

Austrian biochemist

A balance that does not tremble cannot weigh.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part III

The Trembling of a Balance (p. 179)

Rockefeller University Press. New York, New York, USA. 1978

**Johnston, James Finlay Weir** 1796–1855

Scottish chemist

...the first object one notices is a glass case standing on a table. It is the balance. How much light this fragile, simple instrument has shed on the natural sciences! How many phenomena it has explained! How many hidden truths it has revealed! Who could enumerate the discussions it has ended, the hypotheses it has destroyed! Who, in former times, would have believed that the determination of abstract truths and the development of the laws of nature would depend on the oscillations of this moving beam!

In Mary Elvira Weeks

*The Discovery of the Elements* (pp. 533–534)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**von Liebig, Justus** 1803–73

German organic chemist

For all great discoveries chemists are indebted to the “balance” — that incomparable instrument which gives permanence to every observation, dispels all ambiguity, establishes truth, detects error, and guides us in the true path of inductive science.

*Familiar Letters in Chemistry*

Letter I (p. 6)

Taylor & Walton. London, England. 1843

## BAYESIAN

**Bartlett, Maurice Stevenson** 1910–2002

English statistician

I am not altogether facetious in suggesting that, while non-Bayesians should make it clear in their writings whether they are non-Bayesian Orthodox or non-Bayesian Fisherian, Bayesians should also take care to distinguish their various denominations of Bayesian Epistemologists, Bayesian Orthodox, and Bayesian Savage.

*Journal of the Royal Statistical Society*

Discussion on Professor Pratt's Paper (p. 197)

**Kadane, Joseph**

Statistician

I believe that assumptions are useful to state in statistical practice because they impose a discipline on the user. Once

a full set of assumptions is stated, the conclusion should follow. (Actually, only a Bayesian analysis can meet this standard, but that's another topic for another time.)

Comment

*Statistical Science*, Volume 1, Number 1, February 1986 (p. 12)

**Wang, Chamont** 1949–  
Statistician

...there are at least 46,656 varieties of Bayesians.

*Sense and Nonsense of Statistical Inference: Controversy, Misuse, and Subtlety*

Chapter 6 (p. 158)

Marcel Dekker. New York, New York, USA. 1993

## BEACH

**Jones, Thomas Rymer** 1810–80  
English surgeon and zoologist

And now, gentle reader, let us hasten to the beach: the tide is near its ebb, and yonder rocks, baring their shoulders to the sunshine, seem to rest themselves in grim repose.

This is the time for work. Come boy! The fishing basket and the muslin landing-net — a hammer and an iron chisel. Mind, too, you don't forget the large glass jar with handles made of rope, wherein to put what specimens we find.

*The Aquarian Naturalist: A Manual for the Sea-Side*

John Van Voorst. London, England. 1858

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Here about the beach I wandered, nourishing a youth sublime

With the fairy tales of science, and the long results of time.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 6

Oxford University Press, Inc. London, England. 1953

## BEAUTY

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

All we have, it seems to me, is the beauty of art and nature and life, and the love which that beauty inspires.

*The Journey Home: Some Words in Defense of the American West*

Chapter 4 (p. 57)

E.P. Dutton. New York, New York, USA. 1977

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Now since the good and the beautiful are different... those who assert that the mathematical sciences say nothing of the beautiful or the good are in error. For these sciences

say and prove a great deal about them; if they do not expressly mention them, but prove attributes which are their results or definitions, it is not true that they tell us nothing about them. The chief forms of beauty are order and symmetry and definiteness, which the mathematical sciences demonstrate in a special degree.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book XIII, Chapter 3, 1078a [30]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The mathematical sciences particularly exhibit order, symmetry, and limitation; and these are the greatest forms of the beautiful.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book XIII, Chapter 3 (p. 610)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Awiakta, Marilou** 1936–  
Native American writer

Beauty is no threat to the wary  
who treat the mountain in its way,  
the copperhead in its way,  
and the deer in its way,  
knowing that nature is the human heart  
made tangible.

*Selu: Seeking the Corn-Mother's Wisdom*

Trail Warning (p. 39)

Fulcrum Publishers. Golden, Colorado, USA. 1993

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

There is no excellent beauty that hath not some strangeness in the proportion.

In Brian Vickers (ed.)

*Francis Bacon*

Essays of Beauty (p. 425)

Published for the British Council by Longman. Harlow, England. 1978

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

Certain methods have frequently yielded the most beautiful results, and many persons have been tempted to believe that the development of science to the end of all time would consist in the systematic and unremitting application of them. But suddenly they begin to show indications of impotency, and all efforts are then bent upon discovering new and antagonistic methods. Then there usually arises a conflict between the adherents of the old method and those of the new. The point of view of the former is characterized by its opponents as antiquated and obsolete; whilst its upholders in their turn look down with scorn upon the innovators as perverters of true classical science.

The Recent Development of Method in Theoretical Physics

*The Monist*, Volume 11, 1901 (p. 229)

**Bridges, Robert Seymour** 1844–1930  
English poet

For beauty being the best of all we know  
Sums up the unsearchable and secret aims  
Of nature.

*Poetical Works of Robert Bridges* (Volume 1)  
The Growth of Love, 8 (p. 226)  
Smith, Elder & Company. London, England. 1898

**Bryan, J. Ingram**  
No biographical data available

Nature seems to exist only to satisfy man's thirst for beauty; it is her way of teaching him confidence in the integrity of the Universe...

*The Interpretation of Nature in English Poetry*  
Chapter I (p. 1)  
Kaitakusha. Tokyo, Japan. 1932

**Burke, Edmund** 1729–97  
British statesman and philosopher

The stomach, the lungs, the liver, as well as other parts, are incomparably well adapted to their purposes; yet they are far from having any beauty.

*On the Sublime and the Beautiful*  
Part III, Section VI (p. 196)  
Printed for F.C. & J Rivington & others. London, England. 1812

**Cayley, Arthur** 1821–95  
English mathematician

It is difficult to give an idea of the vast extent of modern mathematics. The word "extent" is not the right one: I mean extent crowded with beautiful detail — not an extent of mere uniformity such as an objectless plain, but of a tract of beautiful country seen at first in the distance, but which will bear to be rambled through and studied in every detail of hillside and valley, stream, rock, wood, and flower. But, as for every thing else, so for mathematical theory — beauty can be perceived but not explained.

*The Collected Mathematical Papers of Arthur Cayley* (Volume 11)  
Presidential Address, British Association, September 1883 (p. 449)  
The University Press. Cambridge, England. 1889–97

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

This "shuddering before the beautiful," this incredible fact that a discovery motivated by a search after the beautiful in mathematics should find its exact replica in Nature, persuades me to say that beauty is that to which the human mind responds at its deepest and most profound.

*Truth and Beauty: Aesthetics and Motivations in Science*  
Chapter 3, Section VI (p. 54)  
The University of Chicago Press. Chicago, Illinois, USA. 1987

All of us are sensitive to nature's beauty. It is not unreasonable that some aspects of this beauty are shared by the natural sciences.

Beauty and the Quest for Beauty in Science  
*Physics Today*, Volume 32, Number 7, July 1979 (p. 25)

**Collins, Wilkie** 1824–89  
English novelist

Admiration of those beauties of the inanimate world, which modern poetry so largely and so eloquently describes, is not, even in the best of us, one of the original instincts of our nature. As children, we none of us possess it. No uninstructed man or woman possesses it. Those whose lives are exclusively passed amidst the ever changing wonders of sea and land are also those who are most universally insensible to every aspect of Nature not directly associated with the human interest of their calling. Our capacity of appreciating the beauties of the earth we live on is, in truth, one of the civilized accomplishments which we all learn, as an art; and, more, that very capacity is rarely practiced by any of us except when our minds are most indolent and most unoccupied.

*The Woman in White*  
The Story Begun by Walter Hartright  
Chapter VIII (p. 43)  
Everyman's Library. London, England. No date

**Copernicus, Nicolaus** 1473–1543  
Polish astronomer

Among the many and varied literary and artistic studies upon which the natural talents of man are nourished, I think that those above all should be embraced and pursued with the most loving care which have to do with things that are very beautiful and very worthy of knowledge.

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
Book One (p. 510)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Curie, Marie Skłodowska-** 1867–1934  
Polish-born French physicist and chemist

I am among those who think that science has great beauty. ... A scientist in his laboratory is not only a technician but also a child placed in front of natural phenomena which impresses him like a fairy tale.

In *Eve Curie*  
*Madame Curie*  
Chapter XXIV (p. 341)  
The Literary Guild of America, Inc. New York, New York, USA. 1937

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Even though the genius of man might make various inventions, attaining the same end by various means, it will not invent anything more beautiful, or more economical, or more direct than nature, for in nature's inventions nothing is wanting and nothing is superfluous.  
In Theodosius Dobzhansky

Evolution of Genes and Genes in Evolution  
*Cold Spring Harbor Symposia on Quantitative Biology*  
 Volume XXIV, 1959 (p. 15)  
 Cold Spring Harbor Laboratory, Cold Spring Harbor, New York, USA.

**Davy, Sir Humphry** 1778–1829  
 English chemist

Amidst the various infinitely diversified changes of things, nothing can be said to be accidental or without design. Even the most terrible of the ministrations of nature in their ultimate operation are pregnant with blessings and with benefits. Beauty and harmony are made to result from apparent confusion, and all the laws of the material world are ultimately made subservient to the preservation of life and the promotion of happiness.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*  
 Lecture Ten (p. 139)  
 The University of Wisconsin Press, Madison, Wisconsin, USA. 1980

**Dickinson, Emily** 1830–86  
 American lyric poet

Beauty — be not caused — It is...

*The Complete Poems of Emily Dickinson*  
 No. 516 (p. 252)  
 Little, Brown, Boston & Company, Boston, Massachusetts, USA. 1960

**Dirac, Paul Adrian Maurice** 1902–84  
 English theoretical physicist

We may try to make progress by following in Hamilton's footsteps, taking mathematical beauty as our guiding beacon, and setting up theories which are of interest, in the first place, only because of the beauty of their mathematics. We may then hope that such equations will ultimately prove their value in physics, basing this hope on the belief that Nature demands mathematical beauty in her laws.

Hamiltonian Methods and Quantum Mechanics  
*Proceedings of the Royal Irish Academy*, Volume 63, Section A, Number 3, January 1964 (p. 59)

The researcher worker, in his efforts to express the fundamental laws of Nature in mathematical form, should strive mainly for mathematical beauty. He should still take simplicity into consideration in a subordinate way to beauty.... It often happens that the requirements of simplicity and beauty are the same, but where they clash the latter must take precedence.

The Relation Between Mathematics and Physics  
*Proceedings of the Royal Society (Edinburgh)*  
 Volume LIX, February 25, 1939 (p. 124)

It is quite clear that beauty does depend on one's culture and upbringing for certain kinds of beauty, pictures, literature, poetry and so on .... But mathematical beauty is of a rather different kind. I should say perhaps it is of a completely different kind and transcends these personal factors. It is the same in all countries and at all periods of time.

In Helge Kragh  
*Dirac: A Scientific Biography*  
 Chapter 14 (p. 288)  
 Cambridge University Press, Cambridge, England. 1990

**Dretske, Fred I.** 1932–  
 American philosopher

Beauty is in the eye of the beholder, and information is in the head of the receiver.

*Knowledge and the Flow of Information*  
 Preface (p. vii)  
 Center for the Study of Language and Information, Leland Stanford Junior College, USA. 1999

**Duhem, Pierre-Maurice-Marie** 1861–1916  
 French physicist and mathematician

It is impossible to follow the march of one of the greatest theories of physics, to see it unroll majestically its regular deductions starting from initial hypotheses, to see its consequences represent a multitude of experimental laws down to the smallest detail, without being charmed by the beauty of such a construction, without feeling keenly that such a creation of the human mind is truly a work of art.

*The Aim and Structure of Physical Theory*  
 Part I, Chapter II (p. 24)  
 Princeton University Press, Princeton, New Jersey, USA. 1954

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

We ascribe beauty to that which is simple; which has no superfluous parts; which exactly answers its end.

*Ralph Waldo Emerson: Essays and Lectures*  
 The Conduct of Life  
 Beauty (p. 1093)  
 The Library of America, New York, New York, USA. 1983

For the world is not painted, or adorned, but is from the beginning beautiful; and God has not made some beautiful things, but Beauty is the creator of the Universe.

*Ralph Waldo Emerson: Essays and Lectures*  
 Essays: Second Series  
 The Poet (p. 449)  
 The Library of America, New York, New York, USA. 1983

Beauty rests on necessities. The line of beauty is the line of perfect economy.

*Ralph Waldo Emerson: Essays and Lectures*  
 The Conduct of Life  
 Beauty (p. 1097)  
 The Library of America, New York, New York, USA. 1983

**Gross, David** 1941–  
 American physicist and string theorist

At the fundamental level nature, for whatever reason, prefers beauty and is marvelously inventive in inventing new forms of beauty.

The Role of Symmetry in Fundamental Physics  
*Proceedings of the National Academy of Science USA*, Volume 93, Number 25, December 10, 1996

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

If nature leads to mathematical forms of great simplicity and beauty — to forms that no one has previously encountered — we cannot help thinking that they are true and that they revealed genuine features of Nature.

*Selected Papers S. Chandrasekhar* (Volume 7)

The Series Paintings of Claude Monet and the Landscape of General Relativity (p. 138)

The University of Chicago Press. Chicago, Illinois, USA. 1997

...beauty in exact science, no less than in the arts is the most important source of illumination and clarity.

*Across the Frontiers*

Chapter XIII (p. 183)

Harper & Row, Publishers. New York, New York, USA. 1974

**Hilbert, David** 1862–1943  
German mathematician

Our Science, which we loved above everything, had brought us together. It appeared to us as a flowering garden. In this garden there were well-worn paths where one might look around at leisure and enjoy oneself without effort, especially at the side of a congenial companion. But we also liked to seek out hidden trails and discovered many an unexpected view which was pleasing to our eyes; and when the one pointed it out to the other, and we admired it together, our joy was complete.

In Constance Reid

*Hilbert — Courant*

Hilbert

Chapter XV (p. 121)

Springer-Verlag. New York, New York, USA. 1986

**Huntley, Henry Edwards**

No biographical data available

Nature's beauty dies. The day dawns when the nautilus is no more. The rainbow passes, the flower fades away, the mountain crumbles, the star grows cold. But the beauty in mathematics — the divine proportion, the golden rectangle, spira mirabilis — endures for evermore.

*The Divine Proportion: A Study in Mathematical Beauty*

Chapter XIII (p. 176)

Dover Publications. New York, New York, USA. 1970

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

The scientific man sees and feels beauty as much as any mere observer — as much as any artist or painter. But he also sees something underlying that beauty; he wishes to learn something of the actions and forces producing those beautiful results.

*Popular Lectures and Addresses* (Volume 2)

The Bangor Laboratories

Address

Physical and Chemical Laboratories in University College

Bangor, North Wales, February 2, 1885 (p. 477)

Macmillan & Company Ltd. London, England. 1894

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

To those who say Newton removed the hand of God from the heavens, I say he replaced a toilsome hand of brute force with a sublime hand of beauty.

*Blind Watchers of the Sky*

Chapter Five (p. 135)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Kragh, Helge** 1944–  
Science historian

The main problem is that beauty is essentially subjective and hence cannot serve as a commonly defined tool for guiding or evaluating science. It is, to say the least, difficult to justify aesthetic judgment by rational arguments. ... The sense of aesthetic standards is part of the socialization that scientists acquire; but scientists, as well as scientific communities, may have widely different ideas of how to judge the aesthetic merit of a particular theory. No wonder that eminent physicists do not agree on which theories are beautiful and which are ugly.

*Dirac: A Scientific Biography*

Chapter 14 (pp. 287–288)

Cambridge University Press. Cambridge, England. 1990

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

The beauty of nature is so great and its contemplation so sweet...whoever tastes it can't help but view all other amusements as inferior.

Translated by Elizabeth Oehlkers

In Ernest Peter Fischer

*Beauty and the Beast*

Chapter 2 (p. 47)

Plenum Trade. New York, New York, USA. 1999

**Misner, Charles W.**  
American physicist

**Thorne, Kip S.** 1940–

American theoretical physicist

Some day a door will surely open and expose the glittering central mechanism of the world in all its beauty and simplicity.

In Charles W. Misner et al

*Gravitation*

Part X, Chapter 44 (p. 1197)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Muir, John** 1838–1914  
American naturalist

Everybody needs beauty as well as bread, places to play in and pray in, where nature may heal and give strength to body and soul alike.

*The Yosemite*

Chapter 15 (p. 192)

Sierra Club Books. San Francisco, California, USA. 1988

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Science is not everything. But science is very beautiful.

With Oppenheimer on an Autumn Day

*Look*, Volume 30, Number 26, December 27, 1966 (p. 63)

The profession I'm part of has, as its whole purpose, the rendering of the physical world understandable and beautiful. Without this you have only tables and statistics.

With Oppenheimer on an Autumn Day

*Look*, Volume 30, Number 26, December 27, 1966 (p. 63)

**Penrose, Roger** 1931–

English mathematical physicist

A beautiful idea has a much greater chance of being a correct idea than an ugly one.

*The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*

Chapter 10 (p. 421)

Oxford University Press, Inc. Oxford, England. 1989

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

...what are the mathematical entities to which we attribute this character of beauty and elegance, and which are capable of developing in us a kind of aesthetic emotion? They are those whose elements are harmoniously disposed so that the mind without effort can embrace their totality while realizing the details. This harmony is at once a satisfaction of our aesthetic needs and an aid to the mind, sustaining and guiding.

*The Foundations of Science*

Science and Method, Book I

Chapter III, Section I (p. 391)

The Science Press. New York, New York, USA. 1913

**Proust, Marcel** 1871–1922

French novelist

...beauty is a sequence of hypotheses which ugliness cuts short when it bars the way that we could already see opening into the unknown.

Translated by C.K. Scott Moncrief

*Within a Budding Grove*

Part Two, Place-Names: The Place (p. 14)

The Modern Library. New York, New York, USA. 1951

**Raman, Chandrasekhar Venkata** 1888–1970

Indian physicist

The concept of beauty defies abstract analysis.

*The New Physics: Talks on Aspects of Science*

Chapter IV (p. 23)

Philosophical Library, New York. 1951

**Reddy, Francis**

Science writer

**Walz-Chojnacki, Grey**

Science writer

We live in an age when the complex and forbidding explanations of science often masks the simple beauty of nature.

*Celestial Delights*

Introduction (p. ix)

Celestialarts. Berkeley. 1992

**Robbins, R. Robert**

American Archaeoastronomer

**Jefferys, William H.** 1940–

American astronomer

The beauty of the night sky can be overwhelming.

*Discovering Astronomy* (3<sup>rd</sup> edition)

Preface (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Sartre, Jean-Paul** 1905–80

French existentialist philosopher and novelist

The real is never beautiful. Beauty is a value which applies only to the imaginary and which entails the negation of the world in its essential structure.

In Theodosius Dobzhansky

*The Biology of Ultimate Concern*

Chapter 5 (p. 102)

The New American Library, Inc. New York, New York, USA. 1967

**Shaftesbury, Anthony Ashley Cooper**

1671–1713

English philosopher

There is no one who, by the least progress of science or learning, has come to know barely the principles of mathematics, but has found, that in the exercise of his mind on the discoveries he there makes, though merely of speculative truths, he receives a pleasure and delight superior to that of sense. When we have thoroughly searched into the nature of this contemplative delight, we shall find it of a kind which relates not in the least to any private interest of the creature, nor has for its object any self-good or advantage of the private system.

*Characteristics of Men, Manners, Opinions, Times, etc.* (Volume 1)

Treatise IV, Book II, Part II, Section I (p. 296)

G. Richards. London, England. 1900

**Steensen, Niels** 1638–86

Danish anatomist and naturalist

Beautiful are the things we see

More beautiful those we understand

Much the most beautiful those we no not comprehend.

Introductory Lecture

Copenhagen Anatomical Theater 1673



**Wallace, Lew** 1827–1905  
American statesman and writer

... beauty is altogether in the eye of the beholder: ...  
*The Prince of India: or, Why Constantinople Fell* (Volume 1)  
Book III, Chapter VI (p. 178)  
Harper & Brothers Publishers. New York, New York, USA. 1893

**Weil, Simone** 1909–43  
French philosopher and mystic

The true subject of science is the beauty of the world.  
Translated by Elizabeth Oehlkers  
In Ernest Peter Fischer  
*Beauty and the Beast*  
Chapter 5 (p. 91)  
Plenum Trade. New York, New York, USA. 1999

**Wheeler, John Archibald** 1911–  
American physicist and educator

The beauty in the laws of physics is the fantastic simplicity that they have.  
In Paul Buckley and F. David Peat (eds.)  
*Glimpsing Reality: Ideas in Physics and the Link to Biology*  
John Archibald Wheeler (p. 96)  
University of Toronto Press. Toronto, Ontario, Canada. 1996

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Beauty is a form of Genius — is higher, indeed, than Genius, as it needs no explanation.  
*The Picture of Dorian Gray*  
Chapter 2 (pp. 24–25)  
The Modern Library. New York, New York, USA. 1992

## BEGINNING

**Ramsay, Sir William** 1852–1916  
English chemist

Like every other endeavor, the beginning is in small things. Any one who tries to look into anything with sufficient care will find something new. A drop of water; a grain of sand; an insect; a blade of grass; we know indeed little about them when all is told.  
*Essays Biographical and Chemical*  
Chemical Essays  
How Discoveries Are Made (p. 116)  
Archibald Constable & Company Ltd. London, England. 1908

## BELIEF

**Darwin, Charles Robert** 1809–82  
English naturalist

Thus disbelief crept over me at a very slow rate, but was at last complete. The rate was so slow that I felt no distress, and have never since doubted even for a second that my conclusion was correct. I can indeed hardly see

how anyone ought to wish Christianity to be true; for if so the plain language of the text seems to show that the men who do not believe, and this would include my Father, Brother and almost all of my friends, will be everlasting punished.

And this is a damnable doctrine.  
*The Autobiography of Charles Darwin, 1809–1882: With Original Omissions Restored*  
Religious Belief (p. 87)  
Harcourt, Brace. New York, New York, USA. 1959

At some future period, not very distant as measured by centuries, the civilised races of man will almost certainly exterminate, and replace, the savage races throughout the world. At the same time the anthropomorphous apes, as Professor Schaaffhausen has remarked, will no doubt be exterminated. The break between man and his nearest allies will then be wider, for it will intervene between man in a more civilised state, as we may hope — [more civilized] than the Caucasian, and some ape as low as a baboon, instead of as now between the negro or Australian and the gorilla.  
In *Great Books of the Western World* (Volume 49)  
*The Descent of Man*  
Part I, Chapter VI (p. 336)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Heinlein, Robert A.** 1907–88  
American science fiction writer

I don't "believe" in anything. I know certain things — little things, not the Nine Billion Names of God — from experience. But I have no beliefs. Belief gets in the way of learning.  
*Time Enough for Love*  
Prelude, Chapter II (p. 41)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Huxley, Thomas Henry** 1825–95  
English biologist

Every belief is the product of two factors: the first is the state of mind to which the evidence in favor of that belief is presented; and the second is the logical cogency of the evidence itself.  
*Collected Essays* (Volume 2)  
*Darwiniana*  
The Coming of Age of "The Origin of Species" (p. 230)  
Macmillan & Company Ltd. London, England. 1904

**Redi, Francesco** 1626–78  
Italian physician

Belief [that worms in meat were derived from the droppings of flies] would be vain without the confirmation of experiment, hence in the middle of July, I put a snake, some fish, some eels of the Arno, and a slice of milk-fed veal in four large, wide-mouthed flasks;

having well closed and sealed them, I then filled the same number of flasks in the same way, only leaving these open.

Translated by Mab Bigeflow

*Experiments on the Generation of Insects*

Meat in Sealed Flasks (p. 33)

The Open Court Publishing Company, Chicago, Illinois, USA. 1909

**Sayers, Dorothy L.** 1893–1957

English novelist and essayist

But you see, I can believe a thing without understanding it. It's all a matter of training.

*Strong Poison and Have His Carcase*

Have His Carcase

Chapter XXII (p. 301)

Harcourt, Brace & Company, New York, New York, USA. No date

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

There is no harder scientific fact in the world than the fact that belief can be produced in practically unlimited quantity and intensity, without observation or reasoning, and even in defiance of both, by the simple desire to believe founded on a strong interest in believing.

*The Doctor's Dilemma*

Preface on Doctors

Credulity and Chloroform (p. xviii)

Brentano's. New York, New York, USA. 1920

## BESSEL FUNCTION

**Feynman, Richard P.** 1918–88

American theoretical physicist

When I see equations, I see the letters in colors — I don't know why. As I'm talking, I see vague pictures of Bessel functions from Jahnke and Ernde's book, with light-tan j's, slightly violet-bluish n's, and dark brown x's flying around. And I wonder what the hell it must look like to the students.

*What Do You Care What Other People Think?*

It's as Simple as One, Two, Three... (p. 59)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

## BETA DECAY

**Wu, Chien-Shiung** 1912–97

Chinese-American physicist

Beta decay was...like a dear old friend. There would always be a special place in my heart reserved especially for it.

In H. B. Newman and T. Ypsilantis (eds.)

*History of Original Ideas and Basic Discoveries in Particle Physics*

Parity Violation (pp. 390–391)

Plenum Press. New York, New York, USA. 1996

## BIBLIOGRAPHY

**de Cervantes, Miguel** 1547–1616

Spanish novelist, playwright, and poet

Now let us come to those references to authors which other books have, and you want for yours. The remedy for this is very simple; You have only to look out for some book that quotes them all, from A to Z as you say yourself, and then insert the very same alphabet in your book, and though the imposition may be plain to see, because you have so little need to borrow from then, that is no matter; there will probably be some simple enough to believe that you have made use of them all in this plain, artless story of yours. At any rate, if it answers no other purpose this long catalogue of authors will serve to give a surprising look of authority to your book.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Preface (p. xiii)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## BIG BANG

**Alphonsus X** 1221–84

Castilian monarch and patron of the sciences

...a certain King of Castile, a great mathematician, (but not much troubled with religion) said, that, "had God consulted him when he made the world, he would have told him how to have framed it better."

In Bernard de Fontenelle

*Conversations on the Plurality of Worlds*

The First Evening (pp. 13–14)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Ball, Philip** 1962–

English science writer

Origins are seldom uncontentious. Current fashion sometimes has it that the idea of a cosmic Big Bang is best regarded as our latest cultural myth, as much a social construct as the slaying of Ymir. On the one hand, it can only be arrogant to suggest otherwise; on the other, it's this particular kind of confidence that makes science possible.

*Life's Matrix: A Biography of Water*

Part One, Chapter 1 (p. 5)

Farrar, Straus & Giroux. New York, New York, USA. 2000

**Capek, Milic** 1909–97

Czechoslovakian philosopher and physicist

World history thus began by a "super-radioactive explosion" of the original single quantum, and the development of the universe is a continuation of this process of fragmentation of energy into the increasing number of smaller and smaller quanta. The enormous energy of the cosmic rays is merely a "fossil remnant"

of the high-frequency radiation from the original phase of cosmic history.

*The Philosophical Impact of Contemporary Physics*

Chapter XVII (p. 352)

D. van Nostrand Company, Inc. Toronto, Ontario, Canada. 1961

### **Cardenal, Ernesto** 1925–

Nicaraguan poet and Roman Catholic priest

And that was Big Bang.

The Great Explosion.

The universe subjected to relations of uncertainty,

its radius of curvature undefined,

its geometry imprecise

with the uncertainty principle of Quantum Mechanics.

Translated by John Lyons

*Cosmic Canticle*

Cantigua 1, Big Bang (p. 11)

Curbstone Press. Willimantic, Connecticut, USA. 1993

### **Ehrenreich, Barbara** 1941–

American social critic and essayist

If that's how it all started, then we might as well face the fact that what's left out there is a great deal of shrapnel and a whole bunch of cinders (one of which is, fortunately, still hot enough and close enough to be good for tanning).

*The Worst Years of Our Lives*

Blocking the Gates to Heaven (p. 267)

Pantheon Books. New York, New York, USA. 1981

### **Ferris, Timothy** 1944–

American science writer

We have at present only two kinds of physics to choose from, classical and quantum; and classical physics, as Alex Vilenkin notes, “fails to describe the beginning of the universe.” Its breakdown is clearly signaled by the fact that general relativity invokes a singularity at time zero, which is to say that its equations yield infinities and can produce no meaningful result. Roger Penrose and a youthful Stephen Hawking proved this in 1970, in theorems demonstrating that if gravitation is always attractive and if the universe has anything like the matter density we observe to have, then there must have been a singularity at the outset of time. So we are left with quantum cosmology — the attempt to apply quantum precepts, previously employed in studying subatomic particles and fields, to the universe as a whole.

*The Whole Shebang: A State-of-the Universe's Report*

The Origin of the Universe (p. 249)

Simon & Schuster. New York, New York, USA. 1996

The term “big bang” was coined with derisive intent by Fred Hoyle, and its endurance testifies to Sir Fred's creativity and wit. Indeed, the term survived an international competition in which three judges — the television science reporter Hugh Downs, the astronomer Carl Sagan, and myself — sifted through 13,099 entries from

41 countries and concluded that none was apt enough to replace it. No winner was declared, and like it or not, we are stuck with “big bang.”

*The Whole Shebang: A State-of-the Universe's Report*

Notes, 10 (p. 323)

Simon & Schuster. New York, New York, USA. 1996

### **Gamow, George** 1904–68

Russian-born American physicist

God was very much disappointed, and wanted first to contract the Universe again, and to start all over from the beginning. But it would be much too simple. Thus, being almighty, God decided to correct His mistake in a most impossible way.

And God said: “Let there be Hoyle.” And there was Hoyle. And God looked at Hoyle...and told him to make heavy elements in any way he pleased.

And Hoyle decided to make heavy elements in stars, and to spread them around by supernova explosions.

*My World Line: An Informal Autobiography*

Chapter 6 (p. 127)

The Viking Press. New York, New York, USA. 1979

### **Guth, Alan** 1947–

American physicist

...the big bang theory is not really a theory of a bang at all. It is only a theory of the aftermath of a bang...the standard big bang theory says nothing about what banged, why it banged, or what happened before it banged.

*The Inflationary Universe: The Quest For a New Theory of Cosmic Origins*

Preface (p. xiii)

Addison-Wesley Publishing Company, Inc. Reading, Massachusetts, USA. 1997

### **Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

The big bang theory requires a recent origin of the Universe that openly invites the concept of creation.

*The Intelligent Universe*

Chapter 9 (p. 237)

Holt, Rinehart & Winston. New York, New York, USA. 1983

On scientific grounds this big bang assumption is much the less palatable of the two [steady state theory or point source origin theory]. For it is an irrational process that cannot be described in scientific terms.

*The Nature of the Universe*

Chapter 6 (p. 124)

The University Press. Cambridge. 1933

Big-bang cosmology is a form of religious fundamentalism, as is the furor over black holes, and this is why these peculiar states of mind have flourished so strongly over the past quarter century. It is in the nature of fundamentalism that it should contain a powerful streak of irrationality and that it should not relate, in a verifiable,

practical way, to the everyday world. It is also necessary for a fundamentalist belief that it should permit the emergence of gurus, whose pronouncements can be widely reported and pondered on endlessly-endlessly for the reason that they contain nothing of substance, so that it would take an eternity of time to distill even one drop of sense from them. Big-bang cosmology refers to an epoch that cannot be reached by any form of astronomy, and, in more than three decades, it has not produced a single successful prediction.

*Home Is Where the Wind Blows: Chapters from a Cosmologist's Life*  
Part Three, Chapter 28 (pp. 413–414)  
University Science Books, Mill Valley, California, USA. 1994

An ultimate theory, like the Holy Grail, is something the physicist must always seek but will never find.

*Ten Faces of the Universe*

The Physicist's Universe (p. 34)

W.H. Freeman & Company, San Francisco, California, USA. 1977

It is a suspicious feature of the explosion theory that no obvious relics of a superdense state of the Universe can be found.

*Frontiers of Astronomy* (p. 322)

Harper & Row, Publishers, New York, New York, USA. 1955

A major reason for the popularity of big-bang theory is undoubtedly that it is simple enough to place no burden on the mind. Undoubtedly, too, there are many who are attracted by its retreat into metaphysics. For myself, I find the retreat into nonexplanation unsatisfactory, contrasting so markedly with the exquisite subtlety of all science outside cosmology. Can the Universe really be so crude while the rest is so refined?

*Home Is Where the Wind Blows: Chapters from a Cosmologist's Life*  
Part Three, Chapter 24 (p. 354)

University Science Books, Mill Valley, California, USA. 1994

**Jeffers, Robinson** 1887–1962

American poet

...there is no way to express that explosion; all that exists

Roars into flame, the tortured fragments rush away from each other into all the sky, new universes

Jewel the black breast of night; and far off the outer nebulae like charging spearmen again

Invade emptiness.

No wonder we are so fascinated with fire-works.

*The Beginning and the End and Other Poems*

The Great Explosion (p. 3)

Random House, Inc. New York, New York, USA. 1963

**Levi, Primo** 1919–87

Italian writer and chemist

Twenty billion years before now,

Brilliant, soaring in space and time

There was a ball of flame, solitary, eternal,

Our common father and our executioner.

It exploded, and every change began.

Even now the thin echo of this one reverse catastrophe

Resounds from the furthest reaches.

Translated by Ruth Feldman and Brian Swann

*Collected Poems*

In the Beginning

Faber & Faber, Boston, Massachusetts, USA. 1988

**MacRobert, Alan**

Editor

The idea of an oscillating universe, in which the Big Bang resulted from the recollapse of a previous phase of the universe, gained currency merely because it avoided the issue of creation — not because there was the slightest evidence in favor of it.

Beyond the Big Bang

*Sky & Telescope*, Vols. 65–66, March 1983 (p. 211)

**Maddox, John Royden** 1925–

Welsh chemist and physicist

The microwave background radiation, which fills even the corners of the universe, would psychologically have been more compelling evidence for the Big Bang if it had been predicted before its discovery in 1965. That it was not is something of a surprise, which is nevertheless now irrelevant.

The Best Cosmology There Is

*Nature*, Volume 372, Number 6501, 3 November 1994 (p. 15)

**Mather, John C.** 1946–

American astrophysicist

“The Big Bang Theory comes out a winner. This is the ultimate in tracing one’s cosmic roots.” He added, “We are seeing the cold glow still remaining from the initially very hot Big Bang.... The closer we examine the Big Bang the simpler the picture gets.”

In P. Cleggett-Halein

Big Bang Theory Passes Toughest Test

*NASA Press Release*, Washington, D.C., January 7, 1993

**Parker, Barry**

Canadian physicist

If we accept the big bang theory, and most cosmologists now do, then a “creation” of some sort is forced upon us.

*Creation: The Story of the Origin and Evolution of the Universe*

Chapter 11 (p. 202)

Plenum Press, New York, New York, USA. 1998

**Poe, Edgar Allan** 1809–49

American short story writer

I am fully warranted in announcing that the Law which we have been in the habit of calling Gravity exists on account of Matter’s having being irradiated, at its origin, atomically, into a limited sphere of Space, from one, individual, unconditional, irrelative,

and absolute Particle Proper, by the sole process in which it is possible to satisfy, at the same time, the two conditions, irradiation and generally-equable distribution throughout the sphere, that is to say, by a force varying in direct proportion with the squares of the distances between the irradiated atoms, respectively, and the Particular centre of Irradiation.

*Eureka*

Line 8 (p. 67)

Geo. P. Putnam. New York, New York, USA. 1848

### **Silk, Joseph** 1942–

American astronomer and physicist

It's impossible that the Big Bang is wrong.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 11)

Random House, Inc. New York, New York, USA. 1991

### **Smoot, George** 1945–

American astrophysicist

What we have found is evidence for the birth of the universe .... It's like looking at God.

In T.H. Maugh

Relics of "Big Bang" Seen for First Time

*Los Angeles Times*, April 24, 1992:A1

### **Turner, Michael S.**

American astrophysicist

The significance of this cannot be overstated. They have found the Holy Grail of cosmology.

American Scientists Find a "Holy Grail"

*International Herald Tribune*, London, April 24, 1992:1

### **Updike, John** 1932–

American novelist, short story writer, and poet

Space-time. Three spatial dimensions, plus time. It knots. It freezes. The seed of the universe has come into being. Out of nothing. Out of nothing and brute geometry, laws that can't be otherwise, nobody handed them to Moses, nobody had to. Once you've got that little seed, that little itty-bitty mustard seed — ka-boom! Big Bang is right around the corner.

*Roger's Version*

Chapter V (p. 303)

Alfred A. Knopf. New York, New York, USA. 1986

### **Weinberg, Steven** 1933–

American nuclear physicist

In the beginning there was an explosion. Not an explosion like those familiar on earth, starting from a definite center and spreading out to engulf more and more of the circumambient air, but an explosion which occurred simultaneously everywhere, filling all space from the beginning, with every particle of matter rushing apart from every other particle.

*The First Three Minutes*

Chapter 1 (p. 5)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

### **Weldon, Fay** 1931–

English novelist

Who cares about half a second after the big bang; what about the half second before?

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 129)

Simon & Schuster. New York, New York, USA. 1995

### **Wheeler, John Archibald** 1911–

American physicist and educator

Not only particles and the fields of force had to come into being at the big bang, but the laws of physics themselves, and this by a process as higgledy-piggledy as genetic mutation or the second law of thermodynamics.

The Computer and the Universe

*International Journal of Theoretical Physics*, Volume 21, Numbers 6/7,

June 1982 (p. 565)

### **Zeldovich, Yakov Borisovich** 1914–87

Russian physicist

The point of view of a sinner is that the church promises him hell in the future, but cosmology proves that the glowing hell was in the past.

In Joseph Silk

*The Big Bang* (p. 101)

W.H. Freeman. New York, New York, USA. 1989

## **BINOMIAL EXPANSION**

### **Kaminsky, Kenneth**

American mathematics professor, writer, and editor

...yeah, our apartment was small. It was so small, we had to go out in the hall just to use the binomial expansion.

Professor Fogelfro

*Mathematical Magazine*, Volume 69, Number 2, April 1996 (p. 142)

## **BIOCHEMISTRY**

### **Chantrenne, H.**

No biographical data available

Biochemistry is no longer the chemistry of death and decay; it is the chemistry of the living cell, with its essential irreversible, oriented processes admirably organized and controlled.

In Nathan O. Kaplan and Eugene P. Kennedy (eds.)

*Current Aspects of Biochemical Energetics: Fritz Lipmann Dedicatory Volume*

For the 25<sup>th</sup> Anniversary of ~ P (p. 37)

Academic Press. New York, New York, USA. 1966

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

...biochemistry is helpless before life, having to kill the organism before investigating it. Biochemistry is, in fact, much more successful in practicing the second part of its composite name than in following the prefix.

Triviality in Science: A Brief Meditation on Fashions  
*Perspectives in Biology and Medicine*, Volume 19, Number 3, Spring 1976 (p. 333)

**Darling, David** 1953–  
Freelance science writer

Every human being, and every human mind, has roots that extend indefinitely far back through time. The genes that regulate all aspects of our physical development, including the prenatal fabrication of our brains, were in existence long before we or our parents were born. Those genes, in turn, evolved, step by step, from more primitive genetic material that can trace its ancestry back to the first biochemical reactions on Earth. And we do not have to stop there. We can carry the search for the ultimate origin of ourselves back still further-back to the very beginning of the universe.

*Equations of Eternity: Speculations on Consciousness, Meaning, and the Mathematical Rules That Orchestrate the Cosmos*  
Chapter 2 (p. 22)  
Hyperion. New York, New York, USA. 1993

**Deutscher, Murray**  
No biographical data available

To dialyze, or not to dialyze — that is the question: —  
Whether 'tis better for the protein to suffer

The wear and tear of defective Visking

Or to take the chances against a sea of buffers

By chromatography instead?

Biochemist's Soliloquy  
*Perspectives in Biology and Medicine*, Volume VIII, Number 2, Winter 1965 (p. 277)

**Fruton, Joseph S.** 1912–  
Polish-born American biochemist

**Simmonds, Sophia**  
No biographical data available

The ultimate goal of biochemistry is to describe the phenomena that distinguish the “living” from the “non-living” in the language of chemistry and physics.

*General Biochemistry* (2<sup>nd</sup> Edition)  
Chapter 1 (p. 1)  
John Wiley & Sons, Inc. New York, New York, USA. 1958

**Hopkins, Frederick Gowland** 1844–89  
English biochemist

The task of the biochemist wishing to get to the heart of his problem is exceptional in that he must study systems in which the organization of chemical events counts for

more, and is carried far beyond, such simpler coordinations as may be found in non-living systems. He would be overbold were he to claim at present that such high organization can depend alone upon adjusted concentrations and ordered structural distributions among specialized colloidal catalysts, but he is justified, I think, in feeling sure that such factors contribute to that organization in a significant sense. The biochemist, when he aims at describing living systems in his own language, comes in contact with philosophical thought.... His may not be the last word in the description of life, but without his help the last word will never be said.

In Joseph Needham and Ernest Baldwin (eds.)  
*Hopkins & Biochemistry*  
Problems of Specificity in Biochemical Catalysis  
33<sup>rd</sup> Robert Boyle Lecture, 1931 (p. 223)  
W. Heffer & Sons Ltd. Cambridge, England. 1949

**Ochoa, Severo** 1905–93  
Spanish biochemist and molecular biologist

In recent years biochemistry — the chemistry of life — has come more and more into the foreground of biological research. This is natural since chemical reactions are at the bottom of all life.

*Les Prix Nobel. The Nobel Prizes in 1959*  
Nobel banquet speech for award received in 1959  
Nobel Foundation. Stockholm, Sweden. 1960

**Rose, Steven Peter Russell** 1938–  
No biographical data available

Biochemists are different from organic and natural-product chemists in a number of important ways. First, for us the structure, sequence and molecular properties of substances derived from living organisms are not of great interest in their own right, but only insofar as they may be seen as providing information which casts light on the biological role of the substance .... Second...we are likely to be less interested in the properties of “pure” molecules in isolation, and more concerned with the ways in which they are involved in complex interactions with other molecules.

Reflections on Reductionism  
*Trends in Biochemical Sciences*, Volume 13, 1988 (p. 161)

**van Bergeijk, W. A.**  
No biographical data available

Biology implies biochemistry, but not the other way around.

In George Gaylord Simpson  
*Biology and Man*  
Chapter Two (p. 19)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1969

## BIODIVERSITY

**Terborgh, John** 1936–  
Tropical biologist

...to save biodiversity, we must act before the virgin forest disappears, because no effort at ecosystem rehabilitation, however sophisticated, will ever recreate nature in its primeval state.

*Diversity and the Tropical Rain Forest*

Chapter 9 (p. 232)

Scientific American Library. New York, New York, USA. 1992

**Wilson, Edward O.** 1929–

American biologist and writer

Biological diversity — “biodiversity” in the new parlance — is the key to the maintenance of the world as we know it. Life in a local site struck down by a passing storm springs back quickly because enough diversity still exists. Opportunistic species evolved for just such an occasion rush in to fill the spaces. They entrain the succession that circles back to something resembling the original state of the environment.

*The Diversity of Life*

Chapter One (p. 15)

W.W. Norton & Company, Inc. New York, New York, USA. 1992

## BIOGENESIS

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

A law of nature of the sort we know and love will not create biological information, or indeed any information at all .... The secret of life lies, not in its chemical basis, but in the logical and informational rules it exploits .... Real progress with the mystery of biogenesis will be made, I believe, not through exotic chemistry, but from something conceptually new.

*The Fifth Miracle: The Search for the Origin and Meaning of Life*

Chapter 18 (pp. 210, 216)

Simon & Schuster. New York, New York, USA. 1999

## BIOGEOGRAPHY

**Darwin, Charles Robert** 1809–82

English naturalist

In considering the distribution of organic beings over the face of the globe, the first great fact which strikes us is, that neither the similarity nor the dissimilarity of the inhabitants of various regions can be wholly accounted for by climatal and other physical conditions.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XII (p. 181)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A third great fact... is the affinity of the productions of the same continent or sea, though the species themselves are distinct at different points and stations. It is a law of the widest generality, and every continent offers innumerable

instances. Nevertheless the naturalist in traveling, for instance, from north to south never fails to be struck by the manner in which successive groups of beings, specifically distinct, yet clearly related, replace each other.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XII (p. 182)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## BIOINFORMATICS

**Spengler, Sylvia J.**

American researcher in genetics

Perhaps bioinformatics — the shotgun marriage between biology and mathematics, computer science, and engineering — is like an elephant that occupies a large chair in the scientific living room.... There are probably many biologists who feel that a major product of this bioinformatics elephant is large piles of waste material.

Bioinformatics in the Information Age

*Science*, Volume 287, Number 5456, 18 February 2000 (p. 1221)

## BIOLOGICAL

**Arber, Agnes Robertson** 1879–1960

English botanist

Since the first step in biological research involves the decision as the question on which to concentrate, the researcher is at once put upon his mettle, for the full recognition and appreciation of a problem may task him even more severely than its solution.

*The Mind and the Eye: A Study of the Biologist's Standpoint*

Chapter I (p. 6)

At the University Press. Cambridge, England, USA. 1954

**Bernard, Claude** 1813–78

French physiologist

If we mean to build up the biological sciences, and to study fruitfully the complex phenomena which occur in living beings, whether in the physiological or the pathological state, we must first of all lay down principles of experimentation, and then apply them to physiology, pathology and therapeutics.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (p. 2)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bird, J. M.**

No biographical data available

...we shall have to have a philosophy of biological life which gives the human animal something to survive with, a universe which gives us a place to survive into, and a covering of cosmic philosophy which recognizes all this as an aspect of reality. If the necessity arises it will be

met and in that event we shall be able to say with obvious truth that science and religion have come together.

In Edward H. Cotton  
*Has Science Discovered God?*  
Chapter XVI (p. 293)  
Thomas Y. Crowell Company, Publishers. New York, New York, USA.  
1931

**Brower, David** 1912–2000  
American environmentalist

A fallen tree supports a biological community that may be essential to the existence of the forest itself.

In Jonathan White  
*Talking on the Water: Conversations About Nature and Creativity*  
The Archdruid Himself (p. 41)  
The Sierra Club. San Francisco, California, USA. 1994

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

An observer of our biological sciences today sees dark figures moving over a bridge of glass. We are faced with an ever expanding universe of light and darkness. The greater the circle of understanding becomes, the greater is the circumference of surrounding ignorance.

*Essays on Nucleic Acids*  
Chapter 8 (p. 109)  
Elsevier Publishing Company. Amsterdam. 1963

**Dayton, P. K.**  
No biographical data available

**Mordida, B. J.**  
No biographical data available

Geological history and oceanographic processes are the warp and woof of the biological understanding of any marine habitat.

Polar Marine Communities  
*American Zoologist*, Volume 34, 1994 (p. 90)

**Dunn, R. A.**  
No biographical data available

**Davidson, R. A.**  
No biographical data available

Biologic categorization is one of the most conspicuous aspects of successful behavior, not only of man, but of all animals, in meeting the requirements for survival in a complex environment.

Pattern Recognition in Biological Classification  
*Pattern Recognition*, Volume 1, 1968 (p. 75)

**Durant, William James** 1885–1981  
American historian and essayist

So the first biological lesson of history is that life is competition. Competition is not only the life of trade, it is the trade of life — peaceful when food abounds, violent when the mouths outrun the food. Animals eat

one another without qualm; civilized men consume one another by due process of law.

*The Lessons of History*  
Chapter III (p. 19)  
Simon & Schuster. New York, New York, USA. 1968

**Handler, Philip** 1917–81  
American biochemist

Biology has become a mature science as it has become precise and quantifiable. The biologist is no less dependent upon his apparatus than the physicist.

*Biology and the Future of Man*  
Chapter 1 (p. 6)  
Oxford University Press, Inc. London, England. 1970

**Loewy, A. G.**  
No biographical data available

**Siekevitz, P.**  
No biographical data available

A dramatic demonstration of the importance of biological structure was provided by the experiments of Skoultchi and Morowitz, who cooled the eggs of the brine shrimp *Artemia* to temperatures below 2 degrees K (–271 C) and showed that upon rewarming their hatch rate was the same as that of control eggs held at room temperature. Since at that temperature we have structure but presumably no process, it is reasonable to conclude that structure is not only a necessary condition, but even a sufficient condition for initiating biological function. It would thus appear that living processes could be generated by putting together the proper structures, the synthesis of life becoming “merely” a very complicated exercise in organic chemistry.

*Cell Structure and Function*  
Chapter 4 (p. 33)  
Holt, Rinehart & Wilson, Inc. New York, New York, USA. 1969

**Pittendrigh, Colin S.** 1918–96  
English biologist

The study of adaptation is not an optional preoccupation with fascinating fragments of natural history, it is the core of biological study.

In A. Roe and G.G. Simpson (eds.)  
*Behavior and Evolution*  
Adaptation, Natural Selection, and Behavior (p. 395)  
Yale University Press. New Haven, Connecticut, USA. 1958

**Snyder, Gary** 1930–  
American poet, essayist, and environmental activist

We’re so impressed by our civilization and what it’s done, with our machines, that we have a difficult time recognizing that the biological world is infinitely more complex.

*The Real Work*  
Tracking Down the Natural Man (p. 87)  
New Directions Publishing Corporation, New York, New York, USA.  
1980



**Trivers, Robert** 1943–  
American biologist

I want to change the way people think about their everyday lives. How you think is going to affect who you marry, what kind of relationship you establish, whether and in what manner you reproduce. That's day—today thinking, right? But they don't even teach courses on that stuff . . . Life is intrinsically biological. It's absurd not to use our best biological concept.

In Roger Bingham

*A Passion to Know: 20 Profiles in Science*

Robert Trivers: Biologist of Behavior (p. 75)

Charles Scribner's Sons. New York, New York, USA. 1984

**Wheeler, William Morton** 1865–1937  
American entomologist

And so far as the actual, fundamental, biological structure of our society is concerned and notwithstanding its stupendous growth in size and all the tinkering to which it has been subjected, we are still in much the same infantile stage. But if the ants are not despondent because they have failed to produce a new social invention or convention in 65 million years, why should we be discouraged because some of our institutions and castes have not been able to evolve a new idea in the past fifty centuries?

*Social Life Among the Insects: Being a Series of Lectures Delivered at the Lowell Institute in Boston in March 1922*

Lecture I (pp. 8–9)

Harcourt, Brace & Company. New York, New York, USA. 1923

**Woodger, Joseph Henry** 1894–1981  
English biologist

If we make a general survey of biological science we find that it suffers from cleavages of a kind and to a degree which is unknown in such a well unified science as, for example, chemistry. Long ago it has undergone that inevitable process of subdivision into special branches which we find in other sciences, but in biology this has been accompanied by a characteristic divergence of method and outlook between the exponents of the several branches which has tended to exaggerate their differences and has even led to certain traditional feuds between them. This process of fragmentation continues, and with it increases the time and labour requisite for obtaining a proper acquaintance with any particular branch.

*Biological Principles: A Critical Study*

General Introduction (p. 11)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1929

**Young, Michael Dunlop** 1915–  
English lawyer

Every bodily process is pulsing to its own beat within the overall beat of the solar system.

*The Metronomic Society: Natural Rhythms and Human Timetables*

Chapter Two (p. 20)

Harvard University Press. Cambridge, Massachusetts, USA. 1988

## BIOLOGIST

**Allee, Warder C.** 1885–1955  
American zoologist

Our tasks as biologists, and as citizens of a civilized country, is a practical engineering job. We need to help arrange so that the existing trend toward a workable world organization will be guided along practical lines which accord with sound biological theory. And we must remember always that in such matters the idealist with the long-range view is frequently the true realist.

Where Angels Fear to Tread: A Contribution from General Sociology to Human Ethics

*Science*, Volume 97, 1943 (p. 517?)

**Allen, Durward L.** 1910–87  
Wildlife biologist

The biologist has a term for the progress of the seasons; he calls it phenology. It becomes a matter of habit to interpret almost any observation in terms of what has happened and what is going to happen. The present is a moment in a sequence of changes. The basis of phenology is, of course, the climatic cycle through the year.

*Wolves of Minong: Their Vital Role in a Wild Community*

Chapter 7 (p. 142)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1979

**Connolly, Cyril** 1903–74  
English critic and editor

The answer seems to rest with three categories of thinkers; the physicists, who incline to believe in God, but are now all busy making explosives; the biologists and chemists who can produce almost everything except life, and who, if they could create life, would prove that it might have arisen accidentally; and the psychologists and physiologists, who are struggling to discover the relation of mind to brain, the nature of consciousness.

*The Unquiet Grave*

Part III (p. 80)

Hamish Hamilton. London, England. 1945

**Cudmore, Lorraine Lee**  
American cell biologist

We are a sad lot, the cell biologist. Like the furtive collectors of stolen art, we are forced to be lonely admitters of spectacular architecture, exquisite symmetry, dramas of violence and death, nobility, self-sacrifice and yes, rococo sex.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 6)

New York Times Book Company. New York, New York, USA. 1977

All cell biologists are condemned to suffer an incurable secret sorrow: the size of the objects of their passion.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 5)

New York Times Book Company. New York, New York, USA. 1977

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

The physicist's problem is the problem of ultimate origins and ultimate natural laws. The biologist's problem is the problem of complexity.

*The Blind Watchmaker*

Chapter 1 (p. 15)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Eve, A. S.**

No biographical data available

Biologists are divided into three camps, vitalists, mechanists, and those who sit on the boundary fence.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1914*

Modern Views on the Constitution of the Atom (p. 183)

Government Printing Office. Washington, D.C. 1915

**Flannery, Maura C.**

American biologist

The patterns and rhythms of nature, science as a search for order, form as a central problem in biology, are themes that are rarely emphasized in research reports and in texts, they are nevertheless powerful concepts that direct and inform biologists' work.

Biology Is Beautiful

*Perspectives in Biology and Medicine*, Volume 35, Number 3, Spring 1992 (p. 427)

**Hull, David L.** 1935–

American philosopher of biology

Evolutionary biologists are currently confronted by a... dilemma: If they insist on formulating evolutionary theory in terms of commonsense entities, the resulting laws are likely to remain extremely variable and complicated; if they want simple laws, equally applicable to all entities of a particular sort, they must abandon their traditional ontology. This reconceptualization of the evolutionary processes is certainly counter-intuitive; its only justification is the increased scope, consistency, and power of the theory that results.

Individuality and Selection

*Annual Review of Ecology and Systematics*, Volume 11, 1980 (pp. 316–317)

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

“Know me, know my frog” — that is, I think, a legitimate adaptation of the old proverb for the biologist.

*Essays in Popular Science*

The Frog and Biology (p. 189)

Chatto & Windus. London, England. 1926

**Huxley, Thomas Henry** 1825–95

English biologist

I do not question for a moment, that while the Mathematician is busied with deductions from general propositions, the Biologist is more especially occupied with observations, comparisons, and those processes which lead to general propositions.

*Lay Sermons, Addresses, and Views*

On the Educational Value of the Natural History Sciences (p. 87)

New York, New York, USA. 1872

**Kellogg, Vernon** 1867–1937

American zoologist

...the biologist seems unable to escape from the use of a terminology that is to be found in the larger dictionaries — and these dictionaries are at home, while the public is in the lecture-hall.

The Biologist Speaks of Death

*The Atlantic Monthly*, June 1921 (p. 778)

**Loeb, Jacques** 1859–1924

German physiologist

...the investigations of the biologist differ from those of the chemist and physicist in that the biologist deals with the analysis of the mechanism of a special class of machines. Living organisms are chemical machines, made of essentially colloidal material which possess the peculiarity of developing, preserving and reproducing themselves automatically. The machines ...have thus far been reproducing themselves, though no one can say with certainty that such machines might not one day be constructed artificially.

The Recent Development of Biology, I

*Science*, Volume 20, Number 519, December 9, 1904 (p. 778)

**Martin, Charles-Noël** 1923–

French physicist

Despite the vast number of facts he has at his fingertips, the modern biologist still knows next to nothing about life itself, its origins, or its workings.

Translated by A.J. Pomerans

*The Role of Perception in Science*

Chapter 4 (p. 76)

Hutchinson of London. London, England. 1963

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Biologists work very close to the frontier between bewilderment and understanding. Biology is complex, messy and richly various, like real life; it travels faster nowadays than physics or chemistry (which is just as well, because it has so much farther to go), and it travels nearer to the ground.

*Pluto's Republic*

Induction and Intuition in Scientific Thought (p. 73)

Oxford University Press, Inc. Oxford, England. 1982

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

Biologists seldom have the mathematical view that is required to spot problems in the mathematics of biology that are staring at them. A biologist will never see anything deeper than binomial coefficients. It is not that the problems aren't there; rather, biologists don't have the view that comes with a solid education in mathematics.

*Indiscrete Thoughts*

Chapter XX (p. 213)

Birkhäuser. Boston, Massachusetts, USA. 1997

### **Salter, William T.**

No biographical data available

As he picks up his beautiful new tool...it is well for the modern biologist to remind himself how subtly and completely a fascination for gadgets can betray sound sense.

A Background for Biological Studies with Radioiodine

*Science*, Volume 109, Number 2836, May 6, 1949 (p. 454)

### **Salthe, Stanley N.**

American biologist

...we are, as evolutionary biologists, indirectly working on nothing less than an important part of our culture's very own creation myth. Is the combination of the pointlessness of chance with the tyranny of necessity, competitive exclusion, expedience, and obedience to material forces what we really want to think of as the sources of our origins.

In Max K. Hecht (ed.)

*Evolutionary Biology at the Crossroads*

Commentaries (p. 175)

Queens College Press. Flushing, New York, USA. 1989

### **Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

I have no powder, no bottle, no tabloid. I am not a quack:

I am a biologist.

*Back to Methuselah*

Part II, XXXIII (p. 84)

Constable & Company Ltd. London, England. 1921

### **Simpson, George Gaylord** 1902–84

American paleontologist

When bright young biologists speak of genetics without genes and wise old biologists of life without organisms it is evident that something peculiar is going on in the science of biology, so peculiar that "crisis" is not too strong a word. I would diagnose this as combining monomania and schizophrenia.

*Biology and Man*

Chapter One (p. 3)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

### **Steinbeck, John** 1902–68

American novelist

We sat on crates of oranges and thought what good men most biologists are, the tenors of the scientific world

— temperamental, moody, lecherous, loud laughing and healthy .... Your true biologist will sing you a song as loud and off-key as will a blacksmith, for he knows that morals are too often diagnostic of prostatitis and stomach ulcers. Sometimes he may proliferate a little too much in all directions, but he is as easy to kill as any other organism, and meanwhile he is very good company, and at least he does not confuse a low hormone productivity with moral ethics.

*Sea of Cortez*

Chapter 4 (p. 28–29)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

### **Stockbridge, Frank B.**

No biographical data available

A little bit of this, a little more of that, a pinch of something else, boil blank minutes, and set aside in the same vessel — thus might read the biologists' formula for creating life...

*Creating Life in the Laboratory*

*Cosmopolitan*, Volume 52, May 1912 (p. 775)

### **Vogel, Steven** 1940–

American biologist

With the ratification of long tradition, the biologist goes forth, thermometer in hand, and measures the effects of temperature on every parameter of life. Lack of sophistication poses no barrier; heat storage and exchange may be ignored or Arrhenius abused; but temperature is, after time, our favorite abscissa. One doesn't have to be a card-carrying thermodynamicist to wield a thermometer.

*Life in Moving Fluids: The Physical Biology of Flow*

Chapter 1 (p. 1)

W. Grant Press. Boston, Massachusetts, USA. 1981

### **Weisz, Paul B.** 1919–

German-born American chemical engineer and biomedical researcher

Man probably was a biologist before he was anything else. His own body in health and disease; the phenomenon of birth, growth and death; and the plants and other animals which gave him food, shelter, and clothing undoubtedly were matters of serious concern to even the first of his kind.

*Elements of Biology* (p. 13)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1981

### **Wilson, Edward O.** 1929–

American biologist and writer

The role of science, like that of art, is to blend proximate imagery with more distant meaning, the parts we already understand with those given as new into larger patterns that are coherent enough to be acceptable as truth. Biologists know this relation by intuition during the course of fieldwork, as they struggle to make order out of the infinitely varying patterns of nature.

*In Search of Nature*

The Bird of Paradise: The Hunter and the Poet (p. 129)  
Island Press. Washington, D.C. 1996

## BIOLOGY

**Abbey, Edward** 1927–89

American environmentalist and nature writer

The basic science is not physics or mathematics but biology — the study of life. We must learn to think both logically and bio-logically.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
Chapter 10 (p. 94)

St. Martin's Press. New York, New York, USA. 1989

**Bartlett, Elisha** 1804–55

American physician

With certain limited exceptions, the laws of physical science are positive and absolute, both in their aggregate, and in their elements, — in their sum, and in their details; but the ascertainable laws of the science of life are approximative only, and not absolute.

*An Essay on the Philosophy of Medical Science*  
Part II, Chapter 11

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1844

**Capra, Fritjof** 1939–

Austrian-born American physicist

The exploration of the atom has forced physicists to revise their basic concepts about the nature of physical reality in a radical way. The result of the revision is a coherent dynamic theory, quantum mechanics, which transcends the principal concepts of Cartesian-Newtonian science. In biology, on the other hand, the exploration of the gene has not led to a comparable revision of basic concepts, nor has it resulted in a universal dynamic theory.

*The Turning Point: Science, Society, and the Rising Culture*  
Chapter 4 (p. 121)

Simon & Schuster. New York, New York, USA. 1982

**Carson, Rachel** 1907–64

American marine biologist and author

I like to define biology as the history of the earth and all its life — past, present, and future. To understand biology is to understand that all life is linked to the earth from which it came; it is to understand that the stream of life, flowing out of the dim past into the uncertain future, is in reality a unified force, though composed of an infinite number and variety of separate lives ....

*Humane Biology Projects*

Introduction

Animal Welfare Institute. Washington, D.C. 1977

Any concept of biology is not only sterile and profitless, it is distorted and untrue, if it puts its primary focus on unnatural conditions rather than on those vast forces not

of man's making that shape and channel the nature and direction of life.

*Humane Biology Projects*

Introduction

Animal Welfare Institute. Washington, D.C. 1977

**Chargaff, Erwin** 1905–2002

Austrian biochemist

In the old times, the knowledge of biology was perhaps similar to what could be made out in a very large, very dark house. Many objects could be more felt than seen with equal dimness, once the eyes got used to the darkness; and scientists were conscious of the limiting conditions under which they worked. In our time, however, a few very powerful and very narrow beams of light have been thrown into a few corners of this dark house, and several things can be seen in clarity and illumination that almost distort their significance. But at the same time we have lost our dark-adaptation; and since we all have a tendency to follow the light, we have moved into these cozy corners, to the detriment of the rest, which still is, by far, the major part of nature. In pointing this out one runs the risk of being accused of trying to spread the darkness.

*Essays on Nucleic Acids*

Chapter 3 (pp. 39–40)

Elsevier Publishing Company. Amsterdam, Netherlands. 1963

**Cohen, Joel**

No biographical data available

Physics-envy is the curse of biology.

Mathematics as Metaphor

*Science*, Volume 172, May 1971 (p. 675)

**Crick, Francis Harry Compton** 1916–2004

English biochemist

The development of biology is going to destroy to some extent our traditional grounds for ethical belief, and it is not easy to see what to put in their place.

Thinking About the Brain

*Scientific American*, Volume 241, Number 3, September 1979 (p. 185)

The ultimate aim of the modern movement in biology is in fact to explain all biology in terms of physics and chemistry.

*Of Molecules and Men*

The Nature of Vitalism (p. 10)

University of Washington Press. Seattle, Washington, USA. 1966

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

What lies at the heart of every living thing is not a fire, not warm breath, not a “spark of life.” It is information, words, instructions. If you want a metaphor, don't think of fires and sparks and breath. Think, instead, of a billion discrete, digital characters carved in tablets of

crystal. If you want to understand life, don't think about vibrant, throbbing gels and oozes, think about information technology.

*The Blind Watchmaker*

Chapter 5 (p. 112)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

Biology is the study of the complex things in the Universe. Physics is the study of the simple ones.

The Necessity of Darwinism

*New Scientist*, Volume 94, Number 1301, 15 April 1982 (p. 130)

But, however many ways there may be of being alive, it is certain that there are vastly more ways of being dead, or rather not alive.

*The Blind Watchmaker*

Chapter 1 (p. 9)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

### **Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Seen in the light of evolution, biology is, perhaps, intellectually the most satisfying and inspiring science. Without that light it becomes a pile of sundry facts — some of them interesting or curious but making no meaningful picture as a whole.

In J. Peter Zetterberg (ed.)

*Evolution versus Creationism: The Public Education Controversy*

Nothing in Biology Make Sense Except in the Light of Evolution (p. 18)

Oryx Press, Phoenix, Arizona, USA. 1983

### **Driesch, Hans** 1867–41

German biologist and philosopher

The analysis of the Aristotelian theory of life must therefore be one of the corner-stones of any historical works on biology.

*The History & Theory of Vitalism*

Chapter 1 (p. 11)

Macmillan & Company. London, England. 1914

### **Dwyer, Herbert A.**

No biographical data available

If biology is the science of life and all its manifestations then some coordinating principle should have been derived, long ago, between the existing facts so that they would be helpful to the youth of the nation.

*The American Biology Teacher*, Volume 1, Number 1, October 1938 (p. 22)

### **Emmeche, Claus** 1956–

Danish theoretical biologist

Biology belongs to one of the surprising sciences, where each rule must always be supplemented with several exceptions (except this rule, of course).

Translated by Steven Sampson

*The Garden in the Machine: The Emerging Science of Artificial Life*

Chapter Six (p. 144)

Princeton University Press. Princeton, New Jersey, USA. 1994

### **Fauset, Jessie Redmon** 1884–1961

American writer

Biology transcends society!

*The Chinaberry Tree: A Novel of American Life*

Chapter XIX (p. 121)

Negro University Press. New York, New York, USA. 1931

### **Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

Biology is truly a land of unlimited possibilities; we may have the most surprising revelations to expect from it, and cannot conjecture what answers it will offer in some decades to the questions we have put to it. Perhaps they may be such as to overthrow the whole artificial structure of hypotheses.

Translated by James Strachey

*Beyond the Pleasure Principle*

Chapter VI (p. 54)

W.W. Norton & Company, Inc. New York, New York, USA. 1961

### **Goodwin, Brian Carey** 1931–

Canadian mathematician and biologist

The discovery of appropriate variables for biology is itself an act of creation.

In C.H. Waddington (ed.)

*Towards a Theoretical Biology: An IUBS Symposium* (Volume 2)

Appendix notes on the second symposium (p. 337)

Aldine Publishing Company. Chicago, Illinois, USA. 1968

### **Gore, Rick**

American science and nature journalist

If anything illustrates what has happened in biology, it is this profound new ability to take the very stuff of life out of a cell, to isolate it in a test tube, to dissect it, and to probe the deep mysteries borne in its fragments.

The Awesome Worlds Within a Cell

*National Geographic*, Volume 150, Number 3, September 1976 (p. 355)

### **Grassé, Pierre P.** 1895–1985

French zoologist

Biology, despite the brilliance of its appearance, stammers in the presence of the essentials. We know neither all the properties of living matter, nor all of its astonishing possibilities.

In Joseph Wood Krutch

*The Great Chain of Life*

Chapter 11 (p. 192)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1957

### **Haldane, John Burdon Sanderson** 1892–1964

English biologist

If physics and biology one day meet, and one of the two is swallowed up, that one will not be biology.

In J. Needham

*Time: The Refreshing River*

A Biologist's View of Whitehead's Philosophy (p. 204)

The Macmillan Company. New York, New York, USA. 1943

**Hoyle, Sir Fred** 1915–2001  
English mathematician, astronomer and writer

From the standpoint of biology, our presence on the Earth depends on a remarkable and even fantastic sequence of chemical processes. From the standpoint of physics, the very material of which we are constituted has experienced an evolution scarcely less remarkable.

*Ten Faces of the Universe*

The Astrophysicist's Universe (p. 79)

W.H. Freeman & Company. San Francisco, California, USA. 1977

I wouldn't go into biology if I were starting again now. In twenty years' time it is the biologists who will be working behind barbed wire.

In G. Rattray Taylor

*The Biological Time Bomb*

Chapter I (p. 17)

The World Publishing Company. New York, New York, USA. 1968

**Huxley, Aldous** 1894–1963  
English writer and critic

Solved by standard Gammas, unvarying Deltas, uniform Epsilons. Millions of identical twins. The principle of mass production at last applied to biology.

*Brave New World*

Chapter One (pp. 6–7)

Harper & Brothers. New York, New York, USA. 1950

**Huxley, Thomas Henry** 1825–95  
English biologist

In the first place it is said — and I take this point first, because the imputation is too frequently admitted by Physiologists themselves — that Biology differs from the Physico-chemical and Mathematical sciences in being “inexact”.

*Lay Sermons, Addresses, and Reviews*

On the Educational Value of the Natural History Sciences (pp. 78–79)

New York, New York, USA. 1872

**Judson, Horace**  
Science historian

Biology has proceeded not by great set-piece battles, but by multiple small-scale encounters — guerrilla actions — across the landscape. In biology, no large-scale, closely interlocking, fully worked out, ruling set of ideas has ever been overthrown .... Revolution in biology, from the beginnings of biochemistry and the study of cells, and surely in the rise of molecular biology and on to the present day, has taken place not by overturnings but by openings-up.

*The Eighth Day of Creation: Makers of the Revolution in Biology*

Afterword (p. 612)

Simon & Schuster. New York, New York, USA. 1979

**Kauffman, Stuart A.** 1939–  
Theoretical biologist

If biologists have ignored self-organization, it is not because self-ordering is not pervasive and profound. It is because we biologists have yet to understand how to think about systems governed simultaneously by two sources of order. Yet who seeing the snowflake, who seeing simple lipid molecules cast adrift in water forming themselves into cell-like hollow lipid vesicles, who seeing the potential for the crystallization of life in swarms of reacting molecules, who seeing the stunning order for free in networks linking tens upon tens of thousands of variables, can fail to entertain a central thought: if ever we are to attain a final theory in biology, we will surely, surely have to understand the commingling of self-organization and selection. We will have to see that we are the natural expressions of a deeper order. Ultimately, we will discover in our creation myth that we are expected after all.

*At Home in the Universe: The Search for Laws of Complexity*

Chapter 5 (p. 112)

Oxford University Press, Inc. New York, New York, USA. 1995

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

A sound Physics of the Earth should include all the primary considerations of the earth's atmosphere, of the characteristics and continual changes of the earth's external crust, and finally of the origin and development of living organisms. These considerations naturally divide the physics of the earth into three essential parts, the first being a theory of the atmosphere, or Meteorology, the second a theory of the earth's external crust, or Hydrogeology, and the third a theory of living organisms, or Biology.

Translated by Albert V. Carozzi

*Hydrogeology*

Forward (p. 18)

University of Illinois Press. Urbana, Illinois, USA. 1964

**Lapworth, Charles** 1842–1920  
English geologist

Biology is pre-eminent today among the natural sciences, because its younger sister, Geology, gave it the means.

*Report of the British Association for the Advancement of Science (1892)*

Presidential Address to the Geology Section (p. 696)

**Lorenz, Konrad** 1903–89  
Austrian zoologist

There are no good biologists whose vocation was not born of deep joy in the beauties of living nature.

In Jean Rostand

Translated by Lowell Bair

*Humanly Possible: A Biologist's Note on the Future of Mankind*

A Biologist's Mail (p. 20)

Saturday Review Press. New York, New York, USA. 1970

**Lovelock, James Ephraim** 1919–  
English scientist

The successes of molecular biology are so beguiling that we forget the organism and its physiology. Schrödinger's disciples, who founded the church of molecular biology, have turned his wisdom into the dogma that life is self-replicating and corrects its errors by natural selection. There is much more to life than this naïve truth, just as there is more to the Universe than atoms alone — grandmothers live and enjoy the shade of Lombardy poplar trees not knowing that they and the trees are deemed by this dogma to be dead.

Living Alternatives

*Nature*, Volume 320, Number 6063, 17 April, 1986 (p. 646)

**Mayr, Ernst** 1904–2005

German-born American biologist

There is more to biology than rats, *Drosophila*, *Caenorhabditis*, and *E. coli*.

In Lynn Margulis and Dorion Sagan

*Acquiring Genomes: A Theory of the Origins of Species*

Forward (p. xiv)

Basic Books, Inc. New York, New York, USA. 2002

Biology was referred to as a “dirty science,” an activity, according to the physicist Ernest Rutherford, not much better than “postage stamp collecting.” At best it was a second-class, “provincial” science.

*Toward a New Philosophy of Biology: Observations of an Evolutionist*

Is Biology an Autonomous Science? (p. 9)

Harvard University Press. Cambridge, Massachusetts, USA. 1988

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

If the task of scientific methodology is to piece together an account of what scientists actually do, the testimony of biologists should be heard with specially close attention. Biologists work very close to the frontier between bewilderment and understanding. Biology is complex, messy and richly various, like real life; it travels faster nowadays than physics or chemistry (which is just as well, since it has so much farther to go) and it travels nearer to the ground. It should therefore give us a specially direct and immediate insight into science in the making.

*Induction and Intuition in Scientific Thought*

Chapter I, Section 1 (p. 1)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

**Monod, Jacques** 1910–76

French biochemist

Biology occupies a position among the sciences at once marginal and central. Marginal because — the living world constituting but a tiny and very “special” part of the universe — it does not seem likely that the study of living beings will ever uncover general laws applicable outside the biosphere. But if the ultimate aim of the whole of science is indeed, as I believe, to clarify man's relationship to the universe, then biology must be accorded a central

position since of all disciplines it is the one that endeavors to go most directly to the heart of the problems that must be resolved before that of “human nature” can be framed in other than metaphysical terms.

Translated by Austryn Wainhouse

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*

Preface (p. xi)

Vintage Books. New York, New York, USA. 1972

**Needham, James G.** 1868–1957

American entomologist

It is a monstrous abuse of the science of biology to teach it only in the laboratory.... Life belongs in the fields, in the ponds, on the mountains and by the seashore.

In Allen H. Benton and William E. Werner

*Field Biology and Ecology* (p. 3)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

**Olson, Steve** 1956–

American science writer

Biology is not just the science of what we are and how we came to be — it is also the science of what we can become.

*Shaping the Future: Biology and Human Values*

Afterword (p. 110)

National Academy Press. Washington, D.C. 1989

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Biology touches the problems of life at every point, and may claim, as no other science, completeness of view and a comprehensiveness which pertains to it alone. To all those whose daily work lies in her manifestations the value of a deep insight into her relations cannot be overestimated. The study of biology trains the mind in accurate methods of observation and correct methods of reasoning, and gives to a man clearer points of view, and an attitude of mind serviceable in the working-day-world than that given by other sciences, or even by the humanities.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (pp. 91–92)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and writer

I say that it touches a man that his blood is sea water and his tears are salt, that the seed of his loins is scarcely different from the same cells in a seaweed, and that of stuff life his bones are coral made. I say that a physical and biologic law lies down with him, and wakes when a child stirs in the womb, and that sap in the smell of the loam, where the bacteria bestir themselves in darkness and the path of the sun in the heaven, these are facts of first importance to his mental conclusions, and that a man

who goes in no consciousness of them is a drifter and a dreamer, without a home or any contact with reality.

*An Almanac for Moderns*

April First (p. 14)

G.P. Putnam's Sons. New York, New York, USA. 1935

...grant but a single teleological explanation in biology, and you have left the path of scientific thinking. Plan there may be, but only a working plan, a vast experimentation still in course.

*An Almanac for Moderns*

May Nineteenth (p. 64)

G.P. Putnam's Sons. New York, New York, USA. 1935

### **Pycraft, W. P.**

Nature documentary filmmaker

So long as we insist on regarding biology as a crystallized creed, requiring no more than a possible rectification of some of its tenets, so long shall we continue groping in the dark to get an insight into the mysteries we are professedly trying to solve.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1936*

Some New Aspects of Evolution (p. 241)

Government Printing Office. Washington, D.C. 1937

### **Rashevsky, Nicolas** 1899–1972

Mathematical biophysicist

When we observe the phenomena of biological integration we notice, however, not quantities, varying continuously or discontinuously, but certain rather complex relations .... Topological analogies go much deeper in the realm of the living when we observe not merely structural but functional (in a biological sense) relations. The unity of the organism and the unity of all life is expressed by just that kind of relation.

*Mathematical Biophysics: Physico-Mathematical Foundations of Biology* (Volume 2)

Chapter XXVIII (p. 308)

The University of Chicago Press. Chicago, Illinois, USA. 1948

Let us, however, appraise the problem [of dealing with forces] realistically. In celestial mechanics, where we deal with forces varying as simply as the inverse square of the distance and acting on rigid masses, the three-body problem, let alone the n-body problem, still defies in its generality the ingenuity of mathematicians. The forces between cells are much more complex; they are non-conservative, and the cells themselves are not merely displaced but also changed externally and internally by these forces. What are the chances within a foreseeable number of generations to even approximately master the problem of an organism as an aggregate of cells, considering that this organism consists of some  $10^{14}$  of cells, hundreds of different tissues, and thousands of complex interrelated structures. Pessimism is not a healthy thing in science, but neither is unrealistic optimism.

*Mathematical Biophysics: Physico-Mathematical Foundations of Biology* (Volume 2)

Chapter XXVIII (p. 307)

The University of Chicago Press. Chicago, Illinois, USA. 1948

There is no successful mathematical theory which would treat the integrated activities of the organism as a whole.... The fundamental manifestation of life drops out from all our theories in mathematical biology.

*Mathematical Biophysics: Physico-Mathematical Foundations of Biology* (Volume 2)

Chapter XXVIII (p. 306)

The University of Chicago Press. Chicago, Illinois, USA. 1948

### **Roberts, Catherine**

No biographical data available

The driving force of biology and medical science is not unalloyed idealism but a complex of factors including prestige, publication, professional advancement, grants and business interests.

*The Use of Animals in Medical Research — Some Ethical Considerations*

*Perspectives in Biology and Medicine*, Volume VIII, Number 1, Autumn 1964 (p. 116, fn 4)

### **Root, R. K.**

No biographical data available

I can hear my good friend, the Professor of Biology, rather impatiently reporting that his science asks assent only to what it can demonstrate. "Come with me to my laboratory, and I will give you proofs ...." But how am I, quite untrained in his science, to weigh his arguments or interpret what his microscopes may show?

*The Age of Faith*

*The Atlantic Monthly*, Volume cx, July 1912 (p. 114)

### **Rostand, Jean** 1894–1977

French historian and biologist

[Biology] is the least self-centered, the least narcissistic of the sciences — the one that, by taking us out of ourselves, leads us to re-establish a link with nature and to shake ourselves free from our spiritual isolation.

Translated by Jonathan Griffin

*Can Man Be Modified?*

Victories and the Hopes of Biology (p. 31)

Basic Books, Inc. New York, New York, USA. 1959

### **Sears, Paul Bigelow** 1891–1990

American plant ecologist and conservationist

Biology is the link — still too largely a missing link — between the physical and social sciences. Through it, and it alone, can the student come to understand the natural communities of plants and animals which, during the centuries, have shaped his own region for its present human utility.

*The Importance of Biology Teaching for Secondary School Pupils*

*The American Biology Teacher*, Volume 1, Number 4, January 1939 (p. 67)



**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

There is nothing like biology. “The cloud-capped towers, the solemn binnacles, the gorgeous temples, the great globe itself: yea, all that it inherit shall dissolve, and, like this influential parent faded, leave not a rack behind.” That’s biology, you know. Good sound biology.

*Back to Methuselah*

Part II, XXXIII (p. 48)

Constable &amp; Company Ltd. London, England. 1921

**Simpson, George Gaylord** 1902–84

American paleontologist

Experimental biology...may reveal what happens to a hundred rats in the course of ten years under fixed and simple conditions, but not what happened to a billion rats in the course of ten million years under the fluctuating conditions of earth history. Obviously, the latter problem is more important.

*Tempo and Mode in Evolution*

Introduction (p. xvii)

Columbia University Press. New York, New York, USA. 1944

Biology, then, is the science that stands at the centre of all science. It is the science most directly aimed at science’s major goal and most definitive of that goal. And it is here, in the field where all the principles of all the sciences are embodied, that science can truly become unified.

*This View of Life: The World of an Evolutionist*

Chapter Five (p. 107)

Harcourt, Brace &amp; World, Inc. New York, New York, USA. 1964

**Standen, Anthony**

Anglo-American science writer

In its central content, biology is not accurate thinking, but accurate observation and imaginative thinking, with great sweeping generalizations.

*Science Is a Sacred Cow*

Chapter IV (pp. 99–100)

Dutton. New York, New York, USA. 1950

**Sullivan, John William Navin** 1886–1937

Irish mathematician

It is possible, nevertheless, that our outlook on the physical universe will again undergo a profound change. This change will come about through the development of biology. If biology finds it absolutely necessary, for the description of living things, to develop new concepts of its own, then the present outlook on “inorganic nature” will also be profoundly affected .... The notions of physics will have to be enriched, and this enrichment will come from biology.

*The Limitations of Science*

Chapter 7, Section 8 (pp. 188, 189)

New American Library. New York, New York, USA. 1956

**Tiffany, Lewis**

No biographical data available

We believe that there is a unified science of life, a general biology that is distinct from a shotgun marriage of botany and zoology, or any others of the special life sciences. We believe that this science has a body of established and working principles. We believe that literally nothing on earth is more important to a rational living than basic acquaintance with those principles.

*Life: An Introduction to Biology* (2<sup>nd</sup> Edition)

Preface from First Edition (p. v)

Harcourt, Brace &amp; World, Inc. New York, New York, USA. 1965

**Ulam, Stanislaw** 1909–84

Polish-born mathematician

After reading about [the biological developments] which were coming fast, I became curious about a conceptual role which mathematical ideas could play in biology. If I may paraphrase one of President Kennedy’s famous statements, I was interested in “not what mathematics can do for biology but what biology can do for mathematics”. I believe that new mathematical schemata, new systems of axioms, certainly new systems of mathematical structures will be suggested by the study of the living world.

Some ideas and prospects in biomathematics

*Annual Review of Biophysics and Bioengineering* 1, 1972 (p. 285)**Weaver, Warren** 1894–1978

American mathematician

The century of biology upon which we are now well embarked is no matter of trivialities. It is a movement of really heroic dimensions, one of the great episodes in man’s intellectual history. The scientists who are carrying the movement forward talk in terms of nucleoproteins, of ultra-centrifuges, of biochemical genetics, of electrophoresis, of the electron microscope, or molecular morphology, of radioactive isotopes. But do not be fooled into thinking this is more gadgetry. This is the dependable way to seek a solution of the cancer and polio problems, the problem of rheumatism and of the heart. This is the knowledge on which we must base our solution of the population and food problems. This is the understanding of life.

In R.B. Fosdick

*The Story of the Rockefeller Foundation*

Letter to H.M.H. Carson, 17 June 1949 (p. 166)

Harper &amp; Brothers Publishers. New York, New York, USA. 1952

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Unfortunately in this book of nature the biologists fare badly. Every expression of life takes time. Nothing that is characteristic of life can manifest itself at an instant. Murder is a prerequisite for the absorption of biology into physics as expressed in these traditional concepts.

Supplementary

*Aristotelian Society*, Volume II, Time, Space and Material (p. 45)

The living cell is to biology what the electron and the proton are to physics.

*Science and the Modern World*

Chapter VI (p. 146)

The Macmillan Company. New York, New York, USA. 1929

Science is taking on a new aspect that is neither purely physical nor purely biological. It is becoming the study of the larger organisms; whereas physics is the study of the smaller organisms.

*Science and the Modern World*

Chapter VI (p. 150)

The Macmillan Company. New York, New York, USA. 1929

Accordingly, biology apes the manners of physics. It is orthodox to hold that there is nothing in biology but what is physical mechanism under somewhat complex circumstances.

*Science and the Modern World*

Chapter VI (p. 150)

The Macmillan Company. New York, New York, USA. 1929

### **Wilson, Edward O.** 1929–

American biologist and writer

Society increasingly has neglected the substructure of biology to its own peril.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Genetic Destiny (p. 221)

Ticknor & Fields. New York, New York, USA. 1984

### **Woodger, Joseph Henry** 1894–1981

English biologist

Biology is being forced in spite of itself to become biological.

In Herbert J. Muller

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*

Chapter V (p. 110)

G. Braziller. New York, New York, USA. 1943

## **BIONIC ORGANS**

### **Television Introduction**

We can make him better than he was. We have the technology.

*Bionic Man*

Preamble to the television series

## **BIOSTRATIGRAPHY**

### **Darwin, Charles Robert** 1809–82

English naturalist

...every year tends to fill up the blanks between the stages, and to make the proportion between the lost and

existing forms more gradual. In some of the most recent beds...only one or two species are extinct, and only one or two are new .... Yet if we compare any but the most closely related formations, all the species will be found to have undergone some change.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XI (p. 167)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Shaw, Alan**

No biographical data available

Each objectively definable extinct fossil taxon divides geologic time into three segments — the time before it appeared, the time during which it existed, and the time since its disappearance.

*Time in Stratigraphy*

Chapter 17 (p. 102)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1964

## **BIRTH CONTROL**

### **Dickens, Charles** 1812–70

English novelist

...accidents will occur in the best-regulated families...

*David Copperfield* (Volume 1)

Chapter 28 (p. 454)

P.F. Collier & Son Company. New York, New York, USA. 1917

### **Farris, Jean**

No biographical data available

Birth control: Banned parenthood.

Quote, *the Weekly Digest*, February 18, 1968 (p. 137)

### **Gäbor, Dennis** 1900–79

Hungarian-English physicist

The technique of birth control can be suppressed only if one abolishes also the technique of death control: medicine and hygiene.

*Inventing the Future*

Overpopulation (p. 82)

Secker & Warburg. London, England. 1963

### **Sanger, Margaret** 1879–1966

American pioneer birth control advocate

“Yes, yes — I know, Doctor,” said the patient with trembling voice, “but,” and she hesitated as if it took all of her courage to say it, “what can I do to prevent getting that way again?”

“Oh, ho! laughed the doctor good naturedly. You want your cake while you eat it too, do you? Well, it can’t be done .... I’ll tell you the only sure thing to do. Tell Jake to sleep on the roof!”

*My Fight for Birth Control*

Awaking and Revolt (pp. 52–53)

Farrar & Rinehart, Inc. New York, New York, USA. 1931

The menace of another pregnancy hung like a sword over the head of every poor woman...

*My Fight for Birth Control*

Awaking and Revolt (p. 49)

Farrar & Rinehart, Incorporated. New York, New York, USA. 1931

## BLACK HOLE

**Asimov, Isaac** 1920–92

American author and biochemist

Since 1960 the universe has taken on a wholly new face. It has become more exciting, more mysterious, more violent, and more extreme as our knowledge concerning it has suddenly expanded. And the most exciting, most mysterious, most violent, most extreme phenomena of all has the simplest, plainest, calmest, and mildest name — nothing more than a “black hole.”

*The Collapsing Universe*

Chapter 1 (p. 1)

Walker. New York, New York, USA. 1977

**Cardenal, Ernesto** 1925–

Nicaraguan poet and Roman Catholic priest

But a star a little heavier than a neutron star  
is a black hole.

The forces of a black hole.

Like a cosmic vacuum cleaner.

Where gravitation is so great, the curvature so great,  
that light is swallowed up.

Translated by John Lyons

*Cosmic Canticle*

Cantigua 3, Autumn Fugue (p. 32)

Curbstone Press. Willimantic, Connecticut, USA. 1993

**Chandrasekhar, Subrahmanyan** 1910–95

Indian-born American astrophysicist

The black holes of nature are the most perfect macroscopic objects there are in the universe: the only elements in their construction are our concepts of space and time. And since the general theory of relativity provides only a single unique family of solutions for their descriptions, they are the simplest objects as well.

*The Mathematical Theory of Black Holes*

Prologue (p. 1)

Oxford University Press, Inc. Oxford, England. 1992

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I think there should be a law of Nature to prevent a star  
from behaving in this absurd way!

Relativistic Degeneracy

*Observatory*, Volume 58, Number 729, 1935 (p. 37)

**Gardner, Martin** 1914–

American writer and mathematics games editor

The healthy side of the black-hole craze is that it reminds us of how little science knows, and how vast is the realm about which science knows nothing.

*Science: Good, Bad, and Bogus*

Chapter 32 (p. 343)

Prometheus Books. Buffalo, New York, USA. 1981

Our entire universe may slowly stop expanding, go into a contracting phase, and finally disappear into a black hole, like an acrobatic elephant jumping into its anus.

*Science: Good, Bad, and Bogus*

Chapter 32 (p. 336)

Prometheus Books. Buffalo, New York, USA. 1981

**Hawking, Stephen William** 1942–

English theoretical physicist

Although Bekenstein’s hypothesis that black holes have a finite entropy requires for its consistency that black holes should radiate thermally, at first it seems a complete miracle that the detailed quantum-mechanical calculations of particle creation should give rise to emission with a thermal spectrum. The explanation is that the emitted particles tunnel out of the black hole from a region of which an external observer has no knowledge other than its mass, angular momentum and electric charge. This means that all combinations or configurations of emitted particles that have the same energy, angular momentum and electric charge are equally probable. Indeed, it is possible that the black hole could emit a television set or the works of Proust in 10 leather-bound volumes...

*The Quantum Mechanics of Black Holes*

*Scientific American*, Volume 236, Number 1, January 1977 (p. 40)

**Israel, Werner** 1931–

Canadian physicist

It is one of the little ironies of our times that while the layman was being indoctrinated with the stereotype of black holes as the ultimate cookie monsters, the professionals have been swinging round to the almost directly opposing view that black holes, like growing old, are really not so bad when you consider the alternative.

In John D. Barrow

*The World Within the World* (p. 312)

Clarendon Press. Oxford, England. 1988

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Young Archie, the intrepid mole,  
Went down to explore a Black Hole.

A stark singularity,

Devoid of all charity,

Devoured the mole as a whole.

In Bernard Dixon (ed.)

*From Creation to Chaos: Classic Writings in Science*

Cosmic Limerick (p. 108)

Basil Blackwell Ltd. Oxford, England. 1989

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

There exist in the heavens therefore dark bodies, as large as and perhaps as numerous as the stars themselves. Rays from a luminous star having the same density as the Earth and a diameter 250 times that of the Sun would not reach us because of its gravitational attraction; it is therefore possible that the largest luminous bodies in the Universe may be invisible for this reason.

In Jean-Pierre Luminet  
*Black Holes* (p. 6)  
Cambridge University Press. New York, New York, USA. 1992

**Lasota, Jean-Pierre**  
No biographical data available

Black holes may still be black, but they can no longer hide in disguise. We are learning how to unmask them.  
Unmasking Black Holes  
*Scientific American*, Volume 280, Number 5, May 1999 (p. 47)

**Levi, Primo** 1919–87  
Italian writer and chemist

The sky is strewn with horrible dead suns,  
Dense sediments of mangled atoms.  
Only desperate heaviness emanates from them,  
Not energy, not messages, not particles, not light.  
Light itself falls back down, broken by its own weight.  
Translated by Ruth Feldman and Brian Swann  
*Collected Poems*  
The Black Stars  
Faber & Faber Ltd. Boston, Massachusetts, USA. 1988

**Longair, Malcolm** 1941–  
Scottish physicist

“Just keep away from the black hole garbage bin by the door as you leave,” said the Caterpillar. “It’s very useful for getting rid of theoretical papers and weak students!”  
*Alice and the Space Telescope*  
Chapter 7 (p. 68)  
The Johns Hopkins University Press. Baltimore, Maryland, USA. 1989

**Michell, John** 1724–93  
English geologist and astronomer

If the semi-diameter of a sphere of the same density as the Sun in the proportion of five hundred to one, and by supposing light to be attracted by the same force in proportion to its [mass] with other bodies, all light emitted from such a body would be made to return towards it, by its own proper gravity.  
On the Means of discovering the Distance, Magnitude, etc. of the Fixed Stars  
*Philosophical Transactions of the Royal Society of London*, 1784

**Milne, A. A. (Alan Alexander)** 1882–1956  
English playwright, poet, and story writer

A great enormous thing, like — like nothing. A huge big — well, like a — I don’t know — like an enormous big nothing.

*The Complete Tales & Poems of Winnie-the-Pooh*  
Winnie-the-Pooh. Piglet Meets a Heffalump (p. 68)  
Dutton Children’s Books. New York, New York, USA. 2001

**Ruffini, Remo** 1940–  
American theoretical physicist

What was once the core of a star no longer visible. The core like a Cheshire cat fades from view. One leaves behind only its grin, the other, only its gravitational attraction. Gravitational attraction, yes; light, no. No more than light do any particles emerge. Moreover, light and particles incident from outside emerge and go down the black hole only to add to its mass and increase its gravitational attraction.  
Our Universe: The Known and the Unknown  
*American Scientist*, Volume 56, Number 1, Spring 1968 (p. 9)

**Sagan, Carl** 1934–96  
American astronomer and author

Black holes may be apertures to elsewhere. Were we to plunge down a black hole, we would re-emerge, it is conjectured, in a different part of the universe and in another epoch of time.... Black holes may be the entrances to Wonderland. But are there Alices or white rabbits?  
*Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 36 (p. 248)  
Anchor Press/Doubleday. Garden City, New York, USA. 1973

**Smolin, Lee** 1940–  
American theoretical physicist

...each black hole is a bud that leads to a new universe of moments.  
*The Life of the Cosmos*  
Part Two, Chapter Seven (p. 94)  
Oxford University Press, Inc. New York, New York, USA. 1997

**Thorne, Kip S.** 1940–  
American theoretical physicist

Of all the conceptions of the human mind from unicorns to gargoyles to the hydrogen bomb the most fantastic is the black hole: a hole in space with a definite edge over which anything perhaps can fall and nothing can escape; a hole with a gravitational field so strong that even light is caught and held in its grip; a hole that curves space and warps time.  
*Cosmology + 1*  
Chapter 8 (p. 63)  
W.H. Freeman & Company. San Francisco, California, USA. 1977

**Wheeler, John Archibald** 1911–  
American theoretical physicist and educator

Every black hole brings an end to time and space and the laws of physics.

*Geons, Black Holes, and Quantum Foam: A Life in Physics*  
Chapter 16 (p. 350)  
W.W. Norton & Company, Inc. New York, New York, USA. 1998

## BLINDNESS

**Keats, John** 1795–1821  
English Romantic lyric poet

There is a budding morrow in midnight;  
There is a triple sight in blindness keen.  
*The Complete Poetical Works and Letters of John Keats*  
To Homer  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Sophocles** 496 BCE–406 BCE  
Greek playwright

Oedipus: ...in sound is my sight...  
In *Great Books of the Western World* (Volume 5)  
*The Plays of Sophocles*  
Oedipus at Colonus, l. 135  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wordsworth, William** 1770–1850  
English poet

It is not now as it hath been of yore —  
Turn wheresoe'er I may,  
By night or day,  
The things which I have seen I can now see no more.  
*The Complete Poetical Works of William Wordsworth*  
Recollections of Early Childhood  
Ode: Intimations of Immortality  
Crowell. New York, New York, USA. 1888

## BLOOD

**Armstrong, John** 1709–79  
American civil engineer and soldier

The blood, the fountain whence the spirits flow,  
The generous stream that waters every part,  
And motion, vigor, and warm life conveys  
To every particle that moves or lives...  
*The Art of Preserving Health*  
Book II, l. 12–15 (p. 26)  
Printed by Hosea Sprague. Boston, Massachusetts, USA. 1802

**du Bartas, Guillaume de Salluste** 1544–90  
French poet

Even so the Blood (bred of good nourishment)  
By divers Pipes to all the body sent,  
Turns here to Bones there changes into Nerves;  
Here is made Marrow, there for Muscles serves.  
*Du Bartas: His Divine Weekes and Workes*  
First Week, Sixth Day (p. 55)  
Printed by Robert Young. London, England. 1641

## Editor of the Louisville Journal

Doctor, what do you think is the cause of this frequent  
rush of blood to my head?

Oh, it is nothing but an effort of nature. Nature, you  
know, abhors a vacuum.  
In George Denison Prentice  
*Prenticeana* (p. 22)  
Penguin Books. Baltimore 1957

**Harvey, William** 1578–1657  
English physician

But what remains to be said upon the quantity and source  
of the blood which thus passes is of so novel and unheard-  
of character, that I do not only fear injury to myself from  
the envy of a few, but I tremble lest I have mankind at  
large for my enemies, so much doth wont and custom, that  
become as another nature, and doctrine once sown and that  
hath struck deep root, and respect for antiquity influence  
all men; still the die is cast, and my trust is in my love of  
truth, and the candor that inheres in cultivated minds.  
In *Great Books of the Western World* (Volume 28)  
*An Anatomical Disquisition on the Motion of the Heart and Blood in*  
*Animals*  
Chapter 8 (p. 285)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

With purple fountains issuing from your veins.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume One)  
Romeo and Juliet  
Act I, Scene i, l. 92  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Blood is a quite peculiar juice.  
In *Great Books of the Western World* (Volume 47)  
*Faust*  
The First Part  
The Study (2), l. 1740  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## BLOOD PRESSURE

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

A man's life may be said to be a gift of his blood pressure,  
just as Egypt is a gift of the Nile.  
In Harvey Cushing  
*The Life of Sir William Osler* (Volume 2) (p. 297)  
Clarendon Press. Oxford, England. 1925

## BLUEPRINT

**Ridley, Matt** 1958–  
English science writer

Incidentally, you will not find the tired word “blueprint”  
in this book, after this paragraph, for three reasons. First,

only architects and engineers use blueprints and even they are giving them up in the computer age, whereas we all use books. Second, blueprints are very bad analogies for genes. Blueprints are two-dimensional maps, not one-dimensional digital codes. Third, blueprints are too literal for genetics, because each part of a blueprint makes an equivalent part of the machine or building; each sentence of a recipe book does not make a different mouthful of cake.

*Genome: The Autobiography of a Species in 23 Chapters*

Introduction (p. 8)

HarperCollins Publishers, Inc. New York, New York, USA. 2000

## BODY

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English writer

The trouble about always trying to preserve the health of the body is that it is so difficult to do without destroying the health of the mind.

*Come to Think of It*

On the Classics (p. 47)

Methuen & Company Ltd. London, England. 1932

**Flaubert, Gustave** 1821–90

French novelist

Body. If we knew how our body is made, we wouldn't dare move.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Heaney, Robert P.**

American physician

It's just like remodeling an office.... The body tears out partitions, puts up dry walls and paints.

The Calcium Craze

*Newsweek*, January 27, 1986 (p. 50)

**Heschel, Abraham J.** 1907–72

Jewish theologian

The body is a sanctuary, the doctor is a priest.

*The Insecurity of Freedom*

The Patient as a Person (p. 33)

Farrar, Straus & Giroux. New York, New York, USA. 1966

**Huxley, Thomas Henry** 1825–95

English biologist

The body is a machine of the nature of an army .... Of this army each cell is a soldier, an organ a brigade, the central nervous system headquarters and field telegraph, the alimentary and circulatory system the commissariat. Losses are made good by recruits born in camp, and the life of the individual is a campaign, conducted successfully for a number of years, but with certain defeat in the long run.

*Collected Essays* (Volume 3)

*Science and Education*

The Connection of the Biological Sciences with Medicine (p. 369)

Macmillan & Company Ltd. London, England. 1904

It is because the body is a machine that education is possible. Education is the formation of habits, a superinducing of an artificial organisation upon the natural organisation of the body: so that acts, which at first required a conscious effort, eventually became unconscious and mechanical.

*Collected Essays* (Volume 1)

*Method and Result*

Descartes' Discourse on Method (p. 188)

Macmillan & Company Ltd. London, England. 1904

**Novalis (Friederich von Hardenberg)** 1772–1801

German poet

We touch heaven when we lay our hand on a human body.

In Robert Coope

*The Quiet Art* (p. 117)

E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Plato** 428 BCE–347 BCE

Greek philosopher

...we are imprisoned in the body, like an oyster to his shell.

In *Great Books of the Western World* (Volume 7)

*Phaedrus*

Section 250 (p. 126)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

To man the human body is most sacred.

*Encyclopedia of Thoughts*

Aphorisms 1538

Ithaca Heritage Books. Ithaca, New York, USA. 1975

## BONE

**Cuvier, Georges** 1769–1832

French zoologist and statesman

By thus employing the method of observation, where theory is no longer able to direct our views, we procure astonishing results. The smallest fragment of bone, even the most apparently insignificant apophysis, possesses a fixed and determinate character, relative to the class, order, genus, and species of the animal to which it belonged; insomuch, that, when we find merely the extremity of a well-preserved bone, we are able, by careful examination, assisted by analogy and exact comparison, to determine the species to which it once belonged, as certainly as if we had the entire animal before us.

*An Essay on the Theory of the Earth*

Section 27 (p. 103)

Kirk & Mercein. New York, New York, USA. 1818

**BOOK**

**Alvarez, Luis Walter** 1911–88  
American experimental physicist

*Ex libro lapidum historia mundi* — from the book of rocks comes the history of the Earth.

*T. Rex and the Crater of Doom*

Chapter 2 (p. 19)

Princeton University Press. Princeton, New Jersey, USA. 1997

**Bernstein, Jeremy** 1929–  
American physicist, educator, and writer

...a physics book, unlike a novel, not only has no happy ending, but has no real ending at all.

*Elementary Particles and Their Currents*

Chapter 15 (p. 318)

W.H. Freeman. San Francisco, California, USA. 1968

**Brown, Hugh Auchincloss** 1878–1975  
American electrical engineer

For the earth is a great stone book

With strata of stone for pages;

In which we'll find if we look

The living record of ancient ages.

*Cataclysms of the Earth*

The Earth Is a Great Stone Book (p. 275)

Twayne Publishers. New York, New York, USA. 1967

**Cloos, Hans** 1885–1951  
German geologist

By far the most important books for geology students were the quarries and clay pits, the cliffs and creek beds, the road and railroad cuts in woods and fields. Our words and letters were the imprints of plants and animals in stone, the minerals and crystals, and our vast inexhaustible, incorruptible, and infallible library was nature itself.

*Conversation with the Earth*

Chapter II (p. 28)

Alfred A. Knopf. New York, New York, USA. 1953

**Cushing, Harvey** 1869–1939  
American neurosurgeon

Books are the most important tools of our craft when assembled in mass in our great medical libraries.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter VII (p. 72)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

**Darwin, Charles Robert** 1809–82  
English naturalist

I have heard, by roundabout channel, that Herschel says my book [*The Origin of the Species*] “is the law of higgledy-piggledy.” What this exactly means I do not know, but it is evidently very contemptuous. If true this is a great blow and discouragement.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin*

Letter to C. Lyell

December 12, 1859 (p. 37)

D. Appleton & Company. New York, New York, USA. 1896

**de Bury, Richard** 1287–1345  
English bibliophile

...all the glory of the world would be buried in oblivion, unless God had provided mortals with the remedy of books.

Translated by E.C. Thomas

*The Love of Books Being the Philobiblon of Richard De Bury*

Chapter I (p. 9)

Chatto & Windus. London, England. 1925

**French, John** 1616–57  
English physician

There is a glut of chemical books, but a scarcity of chemical truths.

*Art of Distillation*

To the Reader

By E. Cotes for Thomas Williams. London, England. 1653

**Gutenberg, Beno** 1889–1960  
German-American seismologist

Books and papers dealing with hypotheses on the development of the earth's crust are as the sands of the sea.

*Internal Constitution of the Earth*

Hypotheses on the Development of the Earth (p. 178)

Dover. New York, New York, USA. 1951

**Huxley, Thomas Henry** 1825–95  
English biologist

You may read any quantity of books, and you may be almost as ignorant as you were at starting, if you don't have, at the back of your minds, the change for words in definite images which can only be acquired through the operation of your observing faculties on the phenomena of nature.

*Collected Essays* (Volume 3)

*Science and Education*

On the Study of Biology (p. 283)

Macmillan & Company Ltd. London, England. 1904

Books are the money of Literature, but only the counters of Science.

*Collected Essays* (Volume 3)

*Science and Education*

Universities: Actual and Ideal (p. 213)

Macmillan & Company Ltd. London, England. 1904

**Lemery, Nicolas** 1645–1715  
French chemist

My Lord, the Treatise I now offer you, is not writ after the usual way of ordinary Chymists, it has none of the bombastick Expressions nor ridiculous Pretences, none of the Melancholick dreams and wretched Enthusiasms,

none of the palpable Falsities, and even Impossibilities, wherewith the common rate of Chymical Books has been stuff'd hitherto.

*Course of Chemistry* (English edition)  
Dedication  
London. 1677

**Mitchell, Maria** 1818–89

American astronomer and educator

Newton rolled up the cover of a book; he put a small glass at one end, and a large brain at the other — it was enough.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter IX (p. 180)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

I am firmly convinced that the best book in medicine is the book of Nature, as written large in the bodies of men.

The Natural Method of Teaching the Subject of Medicine  
*Journal of the American Medical Association*, Volume 36, 1901

**Pascal, Blaise** 1623–62

French mathematician and physicist

The last thing one settles in writing a book is what one should put in first.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section I, 19  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

We may learn a great deal from books, but we learn much more from the contemplation of nature — the reason and occasion for all books.

*Advice for a Young Investigator*  
Chapter 4 (p. 62)  
The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rota, Gian-Carlo** 1932–

Italian-born American mathematician

When too many books are written on a subject, one of two suspicions arises: either the subject is understood and the book is easy to write — as is the case with books on real variables, convexity, projective geometry in the plane, or compact orientable surfaces. Or the subject is important, but nobody understands what is going on; such is the case with quantum field theory, the distribution of primes, pattern recognition, and cluster analysis.

*Indiscrete Thoughts*  
Chapter XX (p. 216)  
Birkhäuser. Boston, Massachusetts, USA. 1997

**Slosson, Edwin E.** 1865–1929

American chemist and journalist

The Book of Nature is issued only in uncut editions, and the scientist has to open its pages one by one as he reads.

*Keeping Up with Science*  
Introduction (p. vi)  
Jonathan Cape. London, England. 1924

One obstacle in the way of spreading science, that is, of inculcating the scientific habit of mind, is that people have learned to read too well. Books may become an impediment to learning. Our students are taught how to learn to read but not always how to read to learn.

*Digest of the Proceedings of the Second Annual Meeting of the American Association for Adult Education*  
Adult Education in Science, 1927 (p. 53)

**Thompson, Silvanus P.** 1851–1916

English physics professor and author

One other thing will the professed mathematicians say about this thoroughly bad and vicious book: that the reason why it is so easy is because the author has left out all the things that are really difficult. And the ghastly fact about this accusation is that — it is true!

*Calculus Made Easy: Being a Very-Simplest Introduction to Those Beautiful Methods of Reckoning Which Are Generally Called by the Terrifying Names of the Differential Calculus and the Integral Calculus* (Second Edition)

Epilogue and Apologue (p. 284)  
The Macmillan Company. New York, New York, USA. 1929

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Our books of science, as they improve in accuracy, are in danger of losing the freshness and vigor and readiness to appreciate the real laws of Nature, which is a marked merit in the oftentimes false theories of the ancients.

*The Writings of Henry David Thoreau* (Volume 1)  
A Week on the Concord and Merrimack Rivers  
Friday (pp. 479–480)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

The popular scientific books by our scientists aren't the outcome of hard work, but are written when they are resting on their laurels.

Translated by Peter Winch  
*Culture and Value* (p. 42e)  
The University of Chicago Press. Chicago, Illinois, USA. 1980

**BOTANIST**

**Author undetermined**

We botanists cannot be so mathematically exact as geographers, and where an isthmus is very narrow, [the



geographers] must class the peninsula with the island. How often does it happen that two large orders, say of five hundred to two thousand or three thousand species, totally distinct from each other in all these species by a series of constant characters, are yet connected by some small isolated genus of a dozen, half a dozen, nay a single species in which these characters are so inconstant, uncertain or variously combined as to leave no room for the strait, through which we ought to navigate between the two islands.

De Candolle's Prodrômus

*London Journal of Botany*, Volume IX, 1845 (p. 232)

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Why should the botanist, geologist or other-ist give himself such airs.... Is it because he names his plants or specimens with Latin names, and divides them into genre and species...

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Botanists and Draper's Shopman (p. 264)

Jonathan Cape. London, England. 1951

**Croll, Oswald** 1560–1609

German chemist and physician

Oh that the Botanists of our time, who being ignorant of the internal Form of plants, know only their matter, substance, and body, would devote as much care to the discernment of the Signatures of Plants as they do to their manifold and frequently frivolous disputes about the accurate naming of them, it would render a much richer and more beneficial service to medicine.

*Basilica Chymica*

Tractatus de Signaturis (p. 1)

Printed for John Starkey. London, England. 1670

**Crothers, Samuel McChord** 1857–1927

American geoglyman and writer

Here are botanists who love the growing things in the fields and woods better than the specimens in their herbariums. They love to describe better than to analyze. Now and then one may meet a renegade who carries a geologist's hammer. It is a sheer hypocrisy, like a fishing rod in the hands of a contemplative rambler. It is merely an excuse for being out of doors and among the mountains.

*The Gentle Reader*

The Hinter-Land of Science (pp. 236–237)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Darwin, Charles Robert** 1809–82

English naturalist

But there is a growing pleasure in comparing the character of the scenery in different countries, which to a certain degree is distinct from merely admiring its beauty. It

depends chiefly on an acquaintance with the individual parts of each view. I am strongly induced to believe that as in music, the person who understands every note will, if he also possesses a proper taste, more thoroughly enjoy the whole, so he who examines each part of a fine view, may also thoroughly comprehend the full and combined effect. Hence, a traveler should be a botanist, for in all views plants form the chief embellishment.

*The Voyage of the Beagle*

Chapter XXI (pp. 502–503)

Heron Books. Sheridan, Oregon, USA. 1968

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

“Are you a botanist, Dr. Johnson?”

“No, Sir, (answered Johnson,) I am not a botanist; and, (alluding no doubt, to his near sightedness) should I wish to become a botanist, I must first turn myself into a reptile.”

*Boswell's "Life of Samuel Johnson"*

Summer 1762 (p. 267)

Oxford University Press, Inc. Oxford, England. 1965

**Kington, Miles** 1941–

English journalist, jazz musician and broadcaster

The way botanists divide up flowers reminds me of the way Africa was divided into countries by politicians.

*Nature Made Ridiculously Simple, or, How to Identify Absolutely Everything*

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

To you, my dearly-beloved botanists, I submit my rules, the rules which I have laid down for myself, and in accordance with which I intend to walk. If they seem to you worthy, let them be used by you also; if not, please propound something better!

*Critica Botanica*

Preface (pp. xxiii–xxiv)

The Ray Society. London, England. 1938

**Sayre, G. Armington**

No biographical data available

A fundamental principle in the higher education of botanists is embodied in the simple lines — “To love the flower and leave it on its stalk.” To do this requires more heroism than the majority of collectors possess.

Devastation of Nature

*The American Botanist*, Volume I, Number 1, July 1901 (p. 2)

**Teale, Edwin Way** 1899–1980

American naturalist

Today I had lunch in the city with two scientists, a botanist and an ichthyologist. The botanist said he never kept a garden and the ichthyologist said he never went fishing.

*Circle of the Seasons*

December 8 (p. 282)  
Dodd, Mead & Company. New York, New York, USA. 1953

## BOTANY

**Abbot, Charles** 1761–1817  
Grammar school teacher

The fair daughters of Albion have evinced a zeal and ardor in Botanical researches which have not only done the highest honor to themselves, but have eminently contributed to rescue these pursuits from unmerited reproach, to elevate them into reputation, and to impart to them, if not a superior value, at least a superior currency and fashion. — That such excellence should have been attained in this branch of science by so many of the female sex, notwithstanding the disadvantages they labour under from the want of scholastic and technical instruction, is a convincing proof of the liberality with which Nature has endowed the female mind.

*Flora Bedfordiensis*  
Printed by W. Smith. London, England. 1798

**Burroughs, John** 1837–1921  
American naturalist and writer

We study botany so hard that we miss the charm of the flower entirely.

In the Noon of Science  
*The Atlantic Monthly*, Volume cx, September 1912 (p. 324)

**Cable, George W.** 1844–1925  
American writer and reformer

She loved no other part of botany quite so much as its Latin.

*Strong Hearts*  
The Entomologist  
Chapter II (p. 97)  
MSS Information Corporation. New York, New York, USA. 1970

**Corner, E. H. J.**  
No biographical data available

Botany needs help from the tropics. Its big plants will engender big thinking.

In Margaret D. Lowman  
*Life in the Treetops: Adventures of a Woman in Field Biology*  
Introduction (p. 1)  
Yale University Press. New Haven, Connecticut, USA. 1999

**Dickens, Charles** 1812–70  
English novelist

When he has learnt that bottinney means a knowledge of plants, he goes and knows ‘em. That’s our system, Nickleby; what do you think of it?

*Nicholas Nickleby*  
Chapter VIII (p. 78)  
Dodd, Mead & Company. New York, New York, USA. 1944

**Dickinson, Emily** 1830–86  
American lyric poet

I pull a flower from the woods, —  
A monster with a glass  
Computes the Stamens in a breath,  
And has her in a class.

*The Complete Poems of Emily Dickinson*  
No. 70 (p. 36)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

It is foolish to call them “flowers” —  
Need the wiser tell?

If the Savants “Classify” them,  
It is just as well!

*The Complete Poems of Emily Dickinson*  
No. 168 (p. 79)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Einstein, Albert** 1879–1955  
German-born physicist

One ought to be ashamed to make use of the wonders of science embodied in a radio set, the while appreciating them as little as a cow appreciates the botanic marvels in the plants she munches.

*Cosmic Religion, with Other Opinions and Aphorisms*  
On Radio (p. 93)  
Covici-Fiede. New York, New York, USA. 1931

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

To science there is no poison; to botany no weed; to chemistry no dirt.

*The Complete Works of Ralph Waldo Emerson* (Volume 12)  
Natural History of Intellect  
Chapter I (p. 55)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

But these young scholars, who invade our hills,  
Bold as the engineer who fells the wood,  
And travelling often in the cut he makes,  
Love not the flower they pluck, and know it not  
And all their botany is Latin names.

The old men studied magic in the flowers.  
*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
Blight (p. 140)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Henslow, John Stevens** 1796–1861  
English botanist

To obtain a knowledge of a science of observation, like botany, we need make very little more exertion at first than is required for adapting a chosen set of terms to certain appearances of which the eye takes cognizance, and when this has been attained, all the rest is very much like reading a book after we have learned to spell, where every page affords a fresh field of intellectual enjoyment.

*On the Requisites Necessary for the Advance of Botany*  
*Magazine of Zoology and Botany*, Volume 1, 1837 (p. 115)

**Jefferson, Thomas** 1743–18263<sup>rd</sup> president of the United States

And botany I rank with the most valuable sciences, whether we consider its subjects as furnishing the principal subsistence of life to man and beast, delicious varieties for our tables, refreshment from our orchards, the adornments of our flower-borders, shade and perfume of our groves, materials for our buildings or medicaments for our bodies...

In Eva Beard

Thomas Jefferson, Statesman and Scientist

*Nature Magazine*, April 1958 (p. 202)**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Forty years ago I asked Liebig walking somewhere in the country, if he believed that the grass and flowers which we saw around us grew by mere chemical forces; he answered, "NO, no more than I could believe that a book of botany describing them grew by mere chemical force."

In P. Thompson

*The Life of William Thomson* (Volume 2)

Letter to The Times, May 2, 1903 (pp. 1099–1100)

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

What toils, what science would be more wearisome and painful than Botany, did not some singular spell of desire, which I myself cannot define, often hurry us into this pursuit, so that the love of plants often overcomes our self-love? Good God! When I observe the fate of Botanists, upon my word I doubt whether to call them sane or mad in their devotion to plants.

*Critica Botanica*

Generic Names (p. 65)

The Ray Society. London, England. 1938

**Nuttall, Thomas** 1786–1859

English naturalist

Let us not, however, imagine that the science of Botany ends in the mere acquisition of imposed names; we may become acquainted with the structure of plants and their curious economy, like the human anatomist, without troubling ourselves materially with the particular name given to the individual subject. But we cannot proceed far, without employing something like definite language for the several parts of the object under view.

*An Introduction to Systematic and Physiological Botany*

Part I, Chapter I (pp. 1–2)

Hillard &amp; Brown. Cambridge, England. 1830

**Queneau, Raymond** 1903–76

French poet, novelist, and publisher

After nearly taking root under a heliotrope, I managed to graft myself on to a vernal speedwell where my hips and

haws were squashed indiscriminately and where there was an overpowering axillary scent. There I ran to earth a young blade or garden pansy whose stalk had run to seed and whose nut, cabbage or pumpkin was surmounted by a capsule encircled by snakeweed. This corny, creeping sucker, transpiring at the palms, nettled a common elder who started to tread his daisies and give him the edge of his bristly ox-tongue, so the sensitive plant stalked off and parked himself. Two hours later, in fresh woods and pastures new, I saw this specimen again with another willowy young parasite who was shooting a line, recommending the sap to switch the top bulbous vegetable ivory element of his mantle blue to a more elevated apex — as an exercise in style.

*Exercises in Style*

Botanical (pp. 171–172)

New Direction Publishing Corporation. New York, New York, USA.

1981

**Wakefield, Priscilla** 1750–1832

English writer and philanthropist

Botany is a branch of Natural History that possesses many advantages; it contributes to health of body and cheerfulness of disposition, by presenting an inducement to take air and exercise; it is adapted to the simplest capacity, and the objects of its investigation offer themselves without expense or difficulty, which renders them attainable to every rank in life; but with all these allurements, till of late years, it has been confined to the circle of the learned, which may be attributed to those books that treat of it, being principally written in Latin; a difficulty that deterred many, particularly the female sex, from attempting to obtain the knowledge of a science, thus defended, as it were, from their approach.

*An Introduction to Botany, in a Series of Familiar Letters, with Illustrative Engravings*

Thomas Burnside. Dublin, Ireland. 1796

**White, Gilbert** 1720–93

English naturalist and cleric

The standing objection to botany has always been that it is a pursuit that amuses the fancy and exercises the memory, without improving the mind or advancing any real knowledge: and where the science is carried no farther than a mere systematic classification, the charge is but too true.

*The Natural History of Selborne*

Letter XL (p. 192)

Robert M. McBride &amp; Company. New York, New York, USA. 1925

**BOWEL MOVEMENT****Hippocrates** 460 BCE–377 BCE

Greek physician

The excrement is best which is soft and consistent, is passed at the hour which was customary to the patient

when in health, in quantity proportionate to the ingesta; for when the passages are such, the lower belly is in a healthy state.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*

The Book of Prognostics, 11 (p. 21)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## BRAIN

**Ackerman, Diane** 1948–

American writer

Shaped a little like a loaf of French country bread, our brain is a crowded chemistry lab, bustling with nonstop neural conversations.

*An Alchemy of Mind. The Marvel and Mystery of the Brain*

Chapter 1 (p. 4)

Charles Scribner's Sons. New York, New York, USA. 2004

Imagine the brain, that shiny mound of being, that mouse-gray parliament of cells, that dream factory, that petit tyrant inside a ball of bone, that huddle of neurons calling all the plays, that little everywhere, that fickle pleasuredome, that wrinkled wardrobe of selves stuffed into the skull like too many clothes into a gym bag.

*An Alchemy of Mind. The Marvel and Mystery of the Brain*

Chapter 1 (p. 3)

Charles Scribner's Sons. New York, New York, USA. 2004

**Allport, Susan** 1950–

American naturalist and science writer

Most of us have spent some time wondering how our brain works. Brain scientists spend their entire lives pondering it, looking for a way to begin asking the question, How does the brain generate mind? The brain, after all, is so complex an organ and can be approached from so many different directions using so many different techniques and experimental animals that studying it is a little like entering a blizzard, the Casbah, a dense forest. It's easy enough to find a way in — an interesting phenomenon to study — but also very easy to get lost.

*Explorers of the Black Box: The Search for the Cellular Basis of Memory*

Chapter One (pp. 17–18)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Aristotle** 384 BCE–322 BCE

Greek philosopher

The seat of the soul and the control of voluntary movement — in fact, of nervous functions in general, — are to be sought in the heart. The brain is an organ of minor importance.

In *Great Books of the Western World* (Volume 9)

*On the Motion of Animals*

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Armstrong, John** 1709–79

American civil engineer and soldier

...the secret mazy channels of the brain.

*The Art of Preserving Health*

Book I, l. 178 (p. 11)

Printed by Hosea Sprague. Boston, Massachusetts, USA. 1802

**Bianchi, Leonardo** 1848–1927

Italian psychiatry researcher

The brain is the great factory of thought. To it are directed all the forces of nature, forces which, for thousands of years, have been expending themselves upon it and impressing on it a slow and continuous motion of evolution.

Translated by James H. Macdonald

*The Mechanism of the Brain and the Function of the Frontal Lobes*

Chapter I (p. 1)

William Wood & Company. New York, New York, USA. 1922

**Bush, George H. W.** 1924–

41<sup>st</sup> president of the United States

I, George Bush, President of the United States of America, do hereby proclaim the decade beginning January 1, 1990, as the Decade of the Brain. I call upon all public officials and the people of the United States to observe that decade with appropriate programs, ceremonies, and activities.

Presidential Proclamation 6158

July 17, 1990

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

My hand moves because certain forces — electric, magnetic, or whatever “nerve-force” may prove to be — are impressed on it by my brain. This nerve-force, stored in the brain, would probably be traceable, if Science were complete, to chemical forces supplied to the brain by the blood, and ultimately derived from the food I eat and the air I breathe.

*The Complete Works of Lewis Carroll*

Sylvie and Bruno

Chapter XXV (pp. 499–500)

The Modern Library. New York, New York, USA. 1936

**Coveney, Peter** 1958–

Theoretical chemist

It is unmatched in its ability to think, to communicate, and to reason. Most striking of all, it has a unique awareness of its identity and of its place in space and time. Welcome to the human brain, the cathedral of complexity.

*Frontiers of Complexity. The Search for Order in a Chaotic World* (p. 279)

Fawcett Columbine. New York, New York, USA. 1995

**Crick, Francis Harry Compton** 1916–2004

English biochemist

It is essential to understand our brains in some detail if we are to assess correctly our place in this vast and complicated universe we see all around us.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 14 (p. 163)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

### **Darwin, Charles Robert** 1809–82

English naturalist

It is certain that there may be extraordinary mental activity with an extremely small absolute mass of nervous matter: thus the wonderfully diversified instincts, mental powers, and affections of ants are notorious, yet their cerebral ganglia are not so large as the quarter of a small pin's head. Under this point of view, the brain of an ant is one of the most marvelous atoms of matter in the world, perhaps more so than the brain of a man.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Part I, Chapter II (p. 281)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Davis, Joel** 1948–

No biographical data available

The human brain is the last, and greatest, scientific frontier. It is truly an internal cosmos that lies contained within our skulls. The more than 100 billion nerve cells and trillion supporting cells that make up your brain and mine constitute the most elaborate structure in the known universe.

*Mapping the Mind: The Secrets of the Human Brain and How It Works*

Introduction: The Human Brain Project (p. 1)

Carol Publishing Group. New York, New York, USA. 1997

### **Day, Clarence** 1874–1935

American writer

When the brain fails to act with the body, or, worse, works against it, the body will sicken no matter what cures doctors try.

*This Simian World*

Chapter Ten (p. 59)

Alfred A. Knopf. New York, New York, USA. 1941

### **Diamond, Marian**

American neuroscientist

The brain is a three-pound mass you can hold in your hand that can conceive of a universe a hundred-billion light years across.

In John D. Barrow

*Impossibility*

Chapter 4. Complexity Matching (p. 96)

### **Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

You see, he explained, I consider that a man's brain originally is like a little empty attic, and you have to

stock it with such furniture as you choose. A fool takes in all the lumber of every sort that he comes across, so that the knowledge which might be useful to him gets crowded out, or at best is jumbled up with a lot of other things so that he has a difficulty in laying his hands upon it. Now the skilful workman is very careful indeed as to what he takes into his brain-attic. He will have nothing but the tools which may help him in doing his work, but of these he has a large assortment, and all in the most perfect order. It is a mistake to think that that little room has elastic walls and can distend to any extent. Depend upon it there comes a time when for every addition of knowledge you forget something that you knew before. It is of the highest importance, therefore, not to have useless facts elbowing out the useful ones.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 2 (p. 154)

Wings Books. New York, New York, USA. 1967

### **Fischbach, Gerald D.**

American physician

The brain immediately confronts us with its great complexity. The human brain weighs only three to four pounds but contains about 100 billion neurons. Although that extraordinary number is of the same order of magnitude as the number of stars in the Milky Way, it cannot account for the complexity of the brain. The liver probably contains 100 million cells, but 1,000 livers do not add up to a rich inner life.

Mind and Brain

*Scientific American*, Volume 267, Number 3, September, 1992 (p. 49)

### **Havemann, Joel**

American journalist

What seems astonishing is that a mere three-pound object, made of the same atoms that constitute everything else under the sun, is capable of directing virtually everything that humans have done: flying to the moon and hitting seventy home runs, writing Hamlet and building the Taj Mahal — even unlocking the secrets of the brain itself.

*A Life Shaken: My Encounter with Parkinson's Disease*

Chapter Three (p. 45)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Our brains are seventy-year clocks. The Angel of Life winds them up once for all, then closes the case, and gives the key into the hand of the Angel of the Resurrection.

*The Autocrat of the Breakfast-Table*

Chapter VIII (p. 185)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hooper, Judith**

American biology writer

**Teresi, Dick**

American science writer and editor

The brain is a little saline pool that acts as a conductor, and it runs on electricity.

*The Three-Pound Universe*

Chapter 2 (p. 29)

Macmillan Publishing Company. New York, New York, USA. 1986

**Huxley, Julian** 1887–1975

English biologist, philosopher, and writer

The brain alone is not responsible for mind, even though it is a necessary organ for its manifestation. Indeed an isolated brain is a piece of biological nonsense.

In Teilhard de Chardin

*The Phenomenon of Man*

Introduction (pp. 16–17)

Harper & Row, Publishers. New York, New York, USA. 1959

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

There's one sort who knowing nothing of Geometry or Mathematicks, will laugh at it as a whimsical and ridiculous undertaking. It's mere Conjunction to them to talk of measuring the Distance or Magnitude of the Stars: And for the Motion of the Earth, they count it, if not a false, at least a precarious Opinion; and no wonder then if they take what's built upon such a slippery Foundation for the Dreams of a fanciful Head and a distemper'd Brain.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Book the First, The Objections of ignorant Cavillers prevented (p. 5)

Printed for T. Childe. London, England. 1698

**Lowell, James Russell** 1819–91

American poet, critic, and editor

...most brains reflect but the crown of a hat.

*A Fable for Critics*

A Fabler for the Critics (p. 35)

G.P. Putnam. New York, New York, USA. 1848

**McGinn, Colin** 1950–

English philosopher

Brains cause technology, society, art, science, soap operas, sin. A remarkable set of effects for such a small chunk of coagulated atoms.

*The Mysterious Flame: Conscious Minds in a Material World*

Chapter 1 (p. 15)

Basic Books. New York, New York, USA. 1999

**Montagu, Ashley** 1905–99

English-born American anthropologist

You certainly can't tell anything from the microscopic structure of the brain whether the person was an idiot or a genius.

In D. Brian

*Genius Talk: Conversations with Nobel Scientists and Other Luminaries*

Chapter 19 (p. 349)

Plenum Press. New York, New York, USA. 1995

**Oates, Joyce Carol** 1938–

American novelist

The brain is a muscle of busy hills, the struggle of unthought things with things eternally thought.

*Love and Its Derangements*

The Grave Dwellers

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1970

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

If we could look through the skull into the brain of a consciously thinking person, and if the place of optimal excitability were luminous, then we should see playing over the cerebral surface, a bright spot with fantastic, waving borders constantly fluctuating in size and form, surrounded by a darkness more or less deep, covering the rest of the hemisphere.

*Twenty-five years of objective study of the higher nervous activity of animals* (p. 222)

Martin Lawrence. London, England. 1928

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The brain is as weak as the senses, and it would be lost in the complexities of the world were there not harmony in that complexity. After the manner of the short-sighted, we would see only detail after detail, losing sight of each detail before the examination of another, unable to bind them together.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 126)

Government Printing Office. Washington, D.C. 1910

**Posner, Michael I.** 1936–

American neuroscientist and psychology researcher

**Raichle, Marcus E.** 1937–

American professor of radiology and neurology

The microscope and telescope opened up unexpectedly vast domains of scientific discovery. A similar opportunity has now been created in the study of human cognition by the introduction of methods to visualize the brain systems involved as we think.

*Images of Mind*

Chapter Ten (p. 245)

Scientific American Library. New York, New York, USA. 1994

**Pugh, Emerson M.**

No biographical data available

Like the entomologist in pursuit of brightly coloured butterflies, my attention hunted, in the flower garden of the

gray matter, cells with delicate and elegant forms, the mysterious butterflies of the soul, the beating of whose wings may some day — who knows? — clarify the secret of mental life.

In S. Ramón y Cajal  
*Recollections of My Life*  
Chapter VII (p. 363)

The MIT Press. Cambridge, Massachusetts, USA. 1989

**Sagan, Carl** 1934–96

American astronomer and author

We are an intelligent species and the use of our intelligence quite properly gives us pleasure. In this respect the brain is like a muscle. When we think well, we feel good. Understanding is a kind of ecstasy.

*Broca's Brain: Reflections on the Romance of Science*  
Part I, Chapter 2 (p. 14)

Random House, Inc. New York, New York, USA. 1979

The human brain seems to be in a state of uneasy truce, with occasional skirmishes and rare battles. The existence of brain components with predispositions to certain behavior is not an invitation to fatalism or despair: we have substantial control over the relative importance of each component. Anatomy is not destiny, but it is not irrelevant either.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 8 (p. 199)

Random House, Inc. New York, New York, USA. 1977

**Vogt, Carl** 1817–95

German physician and naturalist

The brain...is simply an organ which excretes feeling as the kidneys excrete urine.

In Irving John Good (ed.)

*The Scientist Speculates*

Mind and Consciousness (p. 80)

BasicBooks. New York, New York, USA. 1962

**Young John Zachary** 1907–97

English zoologist

In order to understand what is meant by the word “brain” as it is used by neuroscientists, we must bear in mind the evidence that this organ contains in some recorded form the basis of one’s whole conscious life. It contains the record of all our aims and ambitions and is essential for the experience of all pleasures and pains, all loves and hates.

*Philosophy and the Brain*

Part I, Section 3 (p. 8)

Oxford University Press, Inc. Oxford, England. 1987

**BRIDGE**

**Andric, Ivo** 1892–1975

Yugoslavian writer

When the angels saw how unfortunate men could not pass those abysses and ravines to finish the work they had to do, but tormented themselves and looked in vain and shouted from one side to the other, they spread their wings above those places and men were able to cross. So men learned from the angels of God how to build bridges, and therefore, after fountains, the greatest blessing is to build a bridge...

*The Bridge on the Drina*

Chapter XVI (pp. 208–209)

George Allen & Unwin Ltd. London, England. 1959

**Broun, Heywood** 1888–1939

American writer, journalist, and critic

Men build bridges and throw railroads across deserts, and yet they contend successfully that the job of sewing on a button is beyond them. Accordingly, they don’t have to sew buttons.

*Seeing Things at Night*

Holding a Baby (p. 168)

Harcourt, Brace. New York, New York, USA. 1921

**Magna Carta**

No township or subject shall be compelled to make bridges at river banks, except those who by ancient usage are legally bound to do so.

In J.C. Dickinson

*The Great Charter*

Chapter 23 (p. 22)

Published by the Historical Association by G. Philip. London, England. 1955

**McGonagall, William** ca. 1825–1902

Scottish weaver, actor and poet

Oh! ill fated Bridge of the Silv’ry Tay,

I must now conclude my lay

By telling the world fearlessly and without the least dismay,

That your central girders would not have given way,

At least many sensible men do say,

Had they been supported on each side with buttresses,

At least many sensible men confesses,

For the stronger we our houses do build,

The less chance of being killed.

*Last Poetic Gems Selected from the Works of William McGonagall, Poet and Tragedian*

The Tay Bridge Disaster (p. 92)

David Winter & Son. Dundee, Scotland. 1968

**Mermin, Norman David** 1935–

Mathematician

Bridges would not be safer if only people who knew the proper definition of a real number were allowed to design them.

Topological Theory of Defects

*Review of Modern Physics*, Volume 51, Number 3, July 1979

**Petroski, Henry** 1942–  
American civil engineer

Designing a bridge or any other large structure is not unlike planning a trip or vacation. The end may be clear and simple: to go from here to there. But the means may be limited only by our imagination.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 64)  
St. Martin's Press. New York, New York, USA. 1985

**Roebling, John** 1806–69  
German-American civil engineer

The contemplated work, when constructed in accordance with my designs, will not only be the greatest Bridge in existence, but it will be the greatest engineering work of this continent, and of the age. Its most conspicuous features, the great towers, will serve as landmarks to the adjoining cities, and they will be entitled to be ranked as national monuments.

*Report to the New York Bridge Company*  
1867

**Schuyler, Montgomery** 1814–96  
American journalist and architectural critic

It so happens that the work which is likely to be our most durable monument, and to convey some knowledge of us to the most remote posterity, is a work of bare utility; not a shrine, not a fortress, not a palace but a bridge.

The Bridge as a Monument  
*Harper's Weekly*, Volume XXVII, Number 137927 May 1883 (p. 326)

**Steinman, D. B.**  
American engineer

Between two towers soaring high  
A parabolic arc is swung  
To form a cradle for the stars;  
And from this curve against the sky  
A span of gleaming steel is hung —  
A highway of speeding cars.  
Between the cable and the span  
A web of silver strands is spaced,  
With sky above and ships below  
In human dream was born the plan  
Of strength and beauty interplaced —  
A harp against the sunset glow!

Suspension Bridge  
*American Engineer*, February 22–28, 1953 (p. 33)

**Woodson, Thomas T.**  
No biographical data available

Poor arithmetic will make the bridge fall down just as surely as poor physics, poor metallurgy, or poor logic will.

*Introduction to Engineering Design* (p. 245)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

## BRUTES

**Melville, Herman** 1819–91  
American novelist

There are unknown worlds of knowledge in brutes; and whenever you mark a horse, or a dog, with a peculiarly mild, calm, deep-seated eye, make sure he is an Aristotle or a Kant, tranquility speculating upon the mysteries in man.

*Redburn*  
Chapter XL (p. 226)  
Jonathan Cape. London, England. 1937

## BUBBLE

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

But the pressure was too great. He would have to find something to make good the equilibrium. Something must come with him into the hollow void of death in his soul, fill it up, and so equalise the pressure within to the pressure without. For day by day he felt more and more like a bubble...

*Women in Love*  
Chapter XXIV (p. 308)  
The Viking Press. New York, New York, USA. 1950

**Maxwell, James Clerk** 1831–79  
Scottish physicist

On an Etruscan vase in the Louvre figures of children are seen blowing bubbles. Those children probably enjoyed their occupation just as modern children do. Our admiration of the beautiful and delicate forms, growing and developing themselves, the feeling that it is our breath that is turning dirty soap suds into spheres, the fear lest by an irreverent touch we may cause the gorgeous vision to vanish with a sputter of soapy water in our eyes, our wistful gaze as we watch the perfect bubble when it sails away from the pipe's mouth to join, somewhere in the sky, all the other beautiful things that have vanished before it.

*Nature*  
Plateau on Soap-Bubbles, Volume 10, Number 242, Thursday, June 18, 1874 (p. 119)

**Mukaiyama, Teruaki** 1927–  
Japanese chemist and scientific statesman

Vigorous evolution of gas, quick coloration to brown, and the formation of precipitates; there hidden, was the treasure of possibility in the bubbles of foam on the surface, which were observed in the reaction vessel in a corner of our small laboratory! For organic chemists, facing such an unpredictable phenomenon is not uncommon. In flasks, that which can be predicted by thought or discussion with co-workers often happens.



*Challenges In Synthetic Organic Chemistry*  
Prologue (p. 1)  
Clarendon Press. Oxford, England. 1990

## BUG

**Carryl, Charles Edward** 1841–1920  
American writer

...we carry home as prizes Funny bugs, of handy sizes,

Just to give the day a scientific tone.

In Edward Hodnett (ed., rev. edition, 1967)

*Poems to Read Aloud*

Davy and the Goblin, l. 40–42

W.W. Norton & Company, Inc. New York, New York, USA. 1967

**Cuppy, Will** 1884–1929  
American humorist and critic

You are a bug only if you belong to the order Hemiptera,  
formerly the suborder Heteroptera. Is that clear now?

*How to Attract the Wombat*

The Ladybug (fn 5, p. 164)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Glover, Townend** 1813–83  
American entomologist

From red-bugs and bed-bugs, from sand-flies and land-  
flies,

Mosquitoes, gallnippers and fleas,

From hog-ticks and dog-ticks, from hen-lice and men-lice,

We pray thee, good Lord, give us ease.

In Arnold Mallis

*American Entomologist*

Chapter 3 (pp. 64–65)

Rutgers University Press. New Brunswick, New Jersey, USA. 1971

**Holland, W. J.**  
No biographical data available

When the moon shall have faded out from the sky, and  
the sun shall shine at noonday a dull cherry-red, and the  
seas shall be frozen over, and the ice-cap shall have crept  
downward to the equator from either pole, and no keels  
shall cut the waters, nor wheels turn in mills, when all cit-  
ies shall have long been dead and crumbled into dust, and  
all life shall be on the very last verge of extinction on this  
globe; then, on a bit of lichen, growing on the bald rocks  
beside the eternal snows of Panama, shall be seated a tiny  
insect, preening its antenna in the glow of the worn-out  
sun, representing the sole survival of animal life on this  
our earth, — a melancholy “bug”.

*The Moth Book: A Popular Guide to a Knowledge of the Moths of North  
America*

The End (p. 445)

Doubleday, Page & Company. New York, New York, USA. 1904

**Oemler, Marie Conway** 1879–1932  
American novelist

“Where the Sam Hill,” he blazed, “do all these footy  
little devils come from, anyhow? Where am I to put a  
beast of a bug when the next one that’s exactly like it is  
entirely different the next time you look at it? There’s  
too much beginning and no end at all to this game!”

*Slippy Magee, Sometimes Known as Butterfly Man* (p. 72)

Grosset & Dunlap. New York, New York, USA. 1921

**Prelutsky, Jack** 1940–  
American poet

Bugs! Bugs!

I love bugs,

yes I truly do,

great big pink ones,

little green stink ones,

yellow bugs and blue.

I put you in my pockets,

and I wear you in my hair.

You are my close companions,

I take you everywhere.

*A Pizza the Size of the Sun: Poems*

Bugs! Bugs!

Greenwillow Books. New York, New York, USA. 1996

## BUILD

### Writer undetermined

Those who personally dominate are heroes for the hour;  
those who build are immortal.

*Journal of Engineering Education*, Volume 30, Number 3, November

1939 (p. 314)

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Michael A: Ah, to build, to build!

That is the noblest art of all the arts.

Painting and sculpture are but images,

Are merely shadows cast by outward things

On stone or canvas, having in themselves

No separate existence. Architecture,

Existing in itself, and not seeming

A something it is not, surpasses them

As substance shadow.

*The Poetical Works of Henry Wadsworth Longfellow*

Michael Angelo, III, San Silvestro

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

Therefore when we build, let us think that we build (pub-  
lic edifices) forever. Let it not be for present delight, nor  
for present use alone, let it be such work as our descen-  
dants will thank us for, and let us think, as we lay stone  
to stone, that a time is to come when those stones will  
be held sacred because our hands have touched them,

and that men will say as they look upon the labor and wrought substance of them, "See!"

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 3, The Lamp of Memory (pp. 142–143)

John Wiley & Sons, Inc. New York, New York, USA. 1860

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

When we mean to build,  
We first survey the plot, then draw the model.  
And when we see the figure of the house,  
Then must we rate the cost of the erection,  
Which if we find outweighs ability,  
What do we then but draw anew the mode  
In fewer offices, or at least desist  
To build at all?

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Second Part of King Henry the Fourth

Act I, Scene iii, l. 41

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Wooten, Henry**

No biographical data available

In *Architecture* as in all other *Operative Arts*, the end must direct the *Operation*.

The *end* is to build well.  
Well building hath three Conditions.  
Commodities, Firmness, and Delight.

*The Elements of Architecture*

The I. part (p. 1)

Printed by John Bill. London, England. 1624

## **BUILDER**

### **Ruskin, John** 1819–1900

English writer, art critic, and social reformer

No person who is not a great sculptor or painter can be an architect. If he is not a sculptor or painter, he can only be a builder.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 4, Sculpture (p. 209)

John Wiley & Sons, Inc. New York, New York, USA. 1860

## **BUILDINGS**

### **Gloag, John** 1896–1981

Architectural writer

Architecture cannot lie, and buildings, although inanimate, are to that extent morally superior to men.

Presentation

The Significance of Historical Research in Architectural and Industrial Design

Royal Society of Arts, 20 March 1963

### **Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Great edifices, like great mountains, are the work of ages.

*Notre-Dame de Paris*

Book III, Chapter 1 (p. 107)

J.M. Dent & Sons Ltd. London, England. 1910

### **Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Better the rudest work that tells a story or records a fact, than the richest without meaning. There should not be a single ornament put upon great civic buildings, without some intellectual intention.

*True and the Beautiful in Nature, Art, Morals and Religion, Selected from the Works of John Ruskin*

Part 3, The Lamp of Memory (p. 142)

John Wiley & Sons, Inc. New York, New York, USA. 1860

...we require from buildings, as from men, two kinds of goodness: first, the doing their practical duty well; then that they be graceful and pleasing in doing it; which last is itself another form of duty.

*The Works of John Ruskin*

*The Stones of Venice* (Volume 1)

Chapter II, Section 1 (p. 36)

John Wiley & Sons, Inc. New York, New York, USA. 1887

## **BUTTERFLY NET**

### **Gibson, William Hamilton** 1850–96

American illustrator, author, and naturalist

My butterfly-net and pocket magnifying-glass are rare companions for a walk in the country.

*Sharp Eyes: A Rambler's Calendar*

The Sweep-Nest Harvest

July 21<sup>st</sup> (p. 117)

Harper & Brothers Publishers. New York, New York, USA. 1900

## C

### CALCULATION

**Austen, Jane** 1775–1817  
English novelist

...if the first calculation is wrong, we make a second better...

*Mansfield Park*  
Chapter V (p. 38)  
J.M. Dent & Sons Ltd. London, England. 1906

**Belloc, Hilaire** 1870–1953  
French-born poet and historian

The student must be careful in calculations involving the decimal point to put it in its exact place, neither too much to the right nor too much to the left.

*The Aftermath*  
Appendix (fn, p. 147)  
Duckworth & Company. London, England. 1910

**Bennett, Charles H.**  
No biographical data available

Multiplication is vexation,  
Division is as bad;  
The Rule of Three doth puzzle me,  
And Practice drives me mad.

In Charles H. Bennett  
*Old Nurse's Book of Rhymes, Jingles and Ditties* (p. 25)  
Holp Shuppan. Tokyo, Japan. 1981

**Berkeley, Edmund C.** 1909–88  
American computer theoretician

The moment you have worked out an answer, start checking it — it probably isn't right.  
Right Answers — A Short Guide for Obtaining Them  
*Computers and Automation*, Volume 18, Number 10, September 1969 (p. 20)

**Billings, Josh (Henry Wheeler Shaw)** 1818–85  
American writer and humorist

Tew kno exackly whare the sighn iz, multiply the day ov the month bi the sighn, then find a dividend that will go into a divider four times without enny remains, subtrakt this from the sighn, add the fust quoshunt tew the last divider, then multiply the whole ov the man's boddy bi all the sighns, and the result will be jist what yu are looking after.

*Old Probability: Perhaps Rain — Perhaps Not*  
Signs of the Zodiac  
G.W. Carleton & Company, Publishers. New York, New York, USA. 1879

**Bloch, Felix** 1905–83  
American physicist and educator

Erwin with his psi can do  
Calculations quite a few.  
But one thing has not been seen  
Just what psi really mean.

In John D. Barrow  
*The World Within the World* (p. 141)  
Clarendon Press. Oxford, England. 1988

**Bolton, Henry Carrington** 1843–1903  
American chemist, bibliographer, and historian

In his calculations the chemist relies on the supposed chemical relations of the invisible, intangible, and immeasurable particles he calls atoms. These relations have been determined by others in whom he has confidence, and the accuracy of these constants has to be accepted on faith.

In Joseph William Mellor  
*Mellors Modern Inorganic Chemistry*  
Chapter 8 (p. 115)  
Longmans. London, England. 1967

**Buck, Pearl S.** 1892–1973  
American writer

“And if hydrogen, what about the hydrogen in sea water? Might not the explosion of the atomic bomb set off an explosion of the ocean itself? Nor was this all that Oppenheimer feared. The nitrogen in the air is also unstable, though less in degree. Might not it, too, be set off by an atomic explosion in the atmosphere?”

“The earth would be vaporized,” I said.  
“Exactly,” Compton said, and with what gravity! “It would be the ultimate catastrophe. Better to accept the slavery of the Nazis than to run the chance of drawing the final curtain on mankind!”

Again Compton took the lead in the final decision. If, after calculation, he said, it were proved that the chances were more than approximately three to one million that the earth would be vaporized by the atomic explosion, he would not proceed with the project. Calculation proved the figures slightly less — and the project continued.

*The Bomb — The End of the World?*  
*American Weekly*, March 8, 1959

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

The human story does not always unfold like a mathematical calculation on the principle that two and two make four. Sometimes in life they make five or minus three; and sometimes the blackboard topples down in the middle of the sum and leaves the class in disorder and the pedagogue with a black eye.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Calculation (p. 59)  
George Allen & Unwin Ltd. London, England. 1956

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

The sailing vessel itself was once a machine born of the calculations of engineers, yet it does not disturb our philosophers. The sloop took its place in the speech of men. There is a poetry of sailing as old as the world. There have always been seamen in recorded time. The man who assumes that there is an essential difference between the sloop and the airplane lacks historic perspective.

*Wind, Sand and Stars*

Chapter 3 (p. 72)

Reynal &amp; Hitchcock. New York, New York, USA. 1939

**Dickens, Charles** 1812–70

English novelist

...with affection beaming in one eye and calculation shining out of the other.

*Martin Chuzzlewit*

Chapter VIII (p. 127)

Dodd, Mead &amp; Company. New York, New York, USA. 1944

**Einstein, Albert** 1879–1955

German-born physicist

Your calculations are correct, but your physics is abominable.

In A. Berger

*The Big Bang and Georges Lemaître*

Monsignor Georges Lemaître (p. 370)

D. Reidel Publishing Company. Hingham, Massachusetts, USA. 1984

**Eisenhower, Dwight David** 1890–196934<sup>th</sup> president of the United States

...these calculations overlook the decisive element: what counts is not necessarily the size of the dog in the fight — it's the size of the fight in the dog.

Address to Republican National Committee

January 31, 1958

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Nature hates calculators; her methods are salutatory and impulsive.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

Experience (p. 483)

The Library of America. New York, New York, USA. 1983

**FitzGerald, Edward** 1809–83

English poet

For "IS" and "IS-NOT" though with Rule and Line  
And "UP-AND-DOWN" by Logic I define,

Of all that one should care to fathom, I

Was never deep in anything but — Wine.

Ah, but my Computations, People say,

Reduced the Year to better reckoning? — Nay,

‘Twas only striking from the Calendar

Unborn To-morrow and dead Yesterday.

*The Rubaiyat of Omar Khayyam*

Stanza LVI &amp; LVII

Thomas Y. Crowell &amp; Company. New York, New York, USA. 1800

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

To be in a position to discover the laws which link phenomena together, it is important to make use of the very powerful instrument of calculation ("*le calcul*") by means of which one may more easily grasp the relations between bodies.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 62)

Cambridge University Press. Cambridge, England. 1978

**Graham, L. A.**

The professor went to the board one day

And posed to his students, just for fun,

The question, "What is the only way

To link e, i, p, zero and one?"

Up spake little Euclid, our DIAL hero,

Who handles De Moivre with infinite ease,

"Sure,  $e^{i\pi} + 1 = 0$ ,

Give us a hard one. Next question, please!"

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 21

Dover Publications, Inc. New York, New York, USA. 1959

Jack be nimble, Jack be quick,

Jack jump over the candlestick,

But figure out b and also time T,

"a" due to gravity, velocity V,

And don't forget  $y = VT \sin b$ Minus  $1/2 a T^2$ , or you'll regret later.

Figure trajectory right to the inch

Or it might be a "sing" instead of a cinch!

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 10

Dover Publications, Inc. New York, New York, USA. 1959

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

If one finds a difficulty in a calculation which is otherwise quite convincing, one should not push the difficulty away; one should rather try to make it the centre of the whole thing.

In Jagdish Mehra and Helmut Rechenberg

*The Historical Development of Quantum Theory* (Volume 3)

The Formulation of Matrix Mechanics and Its Modifications, 1925–1926

(p. 94)

Springer-Verlag. New York, New York, USA. 1982

**Hesiod** ca. 700 BCE

Greek pastoral poet

...they do not how much more the half is than the whole.

Translated by M.L. West  
*Theogony and Work and Days*  
 Works and Days (p. 38)  
 Oxford University Press, Inc. Oxford, England. 1999

**Hugo, Victor** 1802–85  
 French author, lyric poet, and dramatist

Who can calculate the passage of a particle?  
*Les Misérables*  
 Volume IV, Book III, Chapter 3 (p. 67)  
 The Heritage Press. New York, New York, USA. 1938

**Huxley, Aldous** 1894–1963  
 English writer and critic

The demon of calculation possesses the mind.  
*Along the Road*  
 Part II, Views of Holland (p. 105)  
 Nan'-do. Tokyo, Japan. 1954

**Johnson, Samuel** 1696–1772  
 English critic, biographer, and essayist

...Nay, Madam, when you are declaiming, declaim; and when you are calculating, calculate.  
 Quoted in James Boswell  
*The Life of Samuel Johnson*  
 April 26, 1776  
 Everyman's Library. London, England. USA. 1906

**Mulliken, R. S.**  
 No biographical data available

...the more accurate the calculations became, the more the concepts tended to vanish into thin air.  
 Molecular Scientists and Molecular Science: Some Reminiscences  
*The Journal of Chemical Physics*, Volume 43, Number 10, 15 November 1965 (p. S2)

**Nietzsche, Friedrich** 1844–1900  
 German philosopher

No more fiction for us: we calculate; but that we may calculate, we had to make fiction first.  
 In Tobias Dantzig  
*Number: The Language of Science* (4<sup>th</sup> Edition)  
 Chapter Eight (p. 139)  
 The Macmillan Company. New York, New York, USA. 1954

**Plato** 428 BCE–347 BCE  
 Greek philosopher

He who can properly define and divide is to be considered a god.  
 In Francis Bacon  
*Novum Organum*  
 Second Book, Section 26 (p. 157)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I can show you that the art of computation has to do with odd and even numbers in their numerical relations to themselves and to each other.  
*Charmides*

Section 166 (p. 8)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49  
 American short story writer

...to calculate is not in itself to analyze.  
*The Complete Edgar Allan Poe Tales*  
 The Murders in the Rue Morgue  
 Avenel Books. New York, New York, USA. 1980

**Pohl, Frederik** 1919–  
 American science fiction writer

I sat down in the back, calculating as best I could. Number forty-two. Say, at the most optimistic, an average of a minute and a half a case. That meant the judge would get to me in a little over an hour.  
*The Coming of the Quantum Cats*  
 18 August 1983, 11:15 A.M. Nicky DeSota (p. 21)  
 Bantam Books. Toronto, Ontario, Canada. 1986

**Shaw, George Bernard** 1856–1950  
 Irish comic dramatist and literary critic

And nobody can get far without at least an acquaintance with the mathematics of probability, not to the extent of making its calculations and filling examination papers with typical equations, but enough to know when they can be trusted, and when they are cooked. For when their imaginary numbers correspond to exact quantities of hard coins unalterably stamped with heads and tails, they are safe within certain limits; for here we have solid certainty...but when the calculation is one of no constant and several very capricious variables, guesswork, personal bias, and pecuniary interests, come in so strong that those who began by ignorantly imagining that statistics cannot lie end by imagining, equally ignorantly, that they never do anything else.  
 In James R. Newman (ed.)  
*The World of Mathematics* (Volume 3)  
 The Vice of Gambling and the Virtue of Insurance (p. 1531)  
 Simon & Schuster. New York, New York, USA. 1956

**Thurber, James** 1894–1961  
 American writer and cartoonist

...I have figured for you the distance between the horns of a dilemma, night and day, and A and Z. I have computed how far is Up, how long it takes to get Away, and what becomes of Gone. I have discovered the length of the sea serpent, the price of priceless, and the square of the hippopotamus. I know where you are when you are at Sixes and Sevens, how much Is you have to have to make an Are, and how many birds you can catch with the salt in the ocean — 187,796,132, if it would interest you?  
 “There aren’t that many birds,” said the King.  
 “I didn’t say there were,” said the Royal Mathematician.  
 “I said if there were.”

*Many Moons*  
 Harcourt Brace & Company. San Diego, California, USA. 1971

**Verne, Jules** 1828–1905  
French novelist

Either my calculation is correct, or there is no truth in figures.

*A Journey to the Center of the Earth*  
Chapter 15 (p. 104)

The Limited Editions Club. New York, New York, USA. 1966

**Warner, Sylvia Townsend** 1893–1978  
English novelist and poet

He resumed: “In order to ascertain the height of the tree I must be in such a position that the top of the tree is exactly in a line with the top of a measuring stick or any straight object would do, such as an umbrella which I shall secure in an upright position between my feet. Knowing then that the ratio that the height of the tree bears to the length of the measuring stick must equal the ratio that the distance from my eye to the base of the tree bears to my height, and knowing (or being able to find out) my height, the length of the measuring stick and the distance from my eye to the base of the tree, I can, therefore, calculate the height of the tree.”

“What is an umbrella?”

*Mr. Fortune’s Maggot*

Mr. Fortune’s Maggot (p. 115)

New York Review of Books. New York, New York, USA. 1927

**Weinberg, Gerald M.** 1933–  
No biographical data available

Before you can count on anything, you’ve got to know something.

*Rethinking Systems Analysis and Design*

Part II, What Is the System — and Why Does the Question Count?  
(p. 32)

Little, Brown & Company. Boston, Massachusetts, USA. 1982

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The process of calculating brings about just this intuition. Calculation is not an experiment.

Translated by D.F. Pears & B.F. McGuinness

*Tractatus Logico-Philosophicus*

6.2331 (p. 134)

Routledge & Kegan Paul. London, England. 1961

## CALCULUS

**Berlinski, David** 1942–  
American mathematician

...the calculus serves to demonstrate with an eerie aptness the extent to which ordinary concepts are not ordinary at all. Simple speed seems a concept on the margins of the infinite, and yet the strangest thing of all, stranger by far than those black holes in space, is the fact that the

cat’s cradle of words that Cauchy offered the world [as a definition of limit] is sufficient to purge speed of its paradoxes.

*A Tour of the Calculus*

Chapter 14 (p. 119)

Pantheon Books. New York, New York, USA. 1995

**Boas, Ralph P.**

No biographical data available

Rewards in Math are plenty

But this obstacle looms big:

How can you shine in calculus

If you won’t learn any trig?

Reprinted in Ralph P. Boas, Jr.

*Lion Hunting and Other Mathematical Pursuits* (p. 102)

Mathematical Association of America. Washington, D.C. 1995

## Cambridge Conference on School Mathematics

The calculus is one of the grandest edifices constructed by mankind.

*Goals for School Mathematic* (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1963

**Comte, Auguste** 1798–1857

French philosopher

The business of concrete mathematics is to discover the equations which express the mathematical laws of the phenomenon under consideration; and these equations are the starting point of the calculus, which must obtain from them certain quantities by means of others.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter II (p. 47)

John Chapman. London, England. 1853

**de Morgan, Augustus** 1806–71

English mathematician and logician

There are no limits in mathematics, and those that assert there are, are infinite ruffians, ignorant, lying blackguards. There is no differential calculus, no Taylor’s theorem, no calculus of variations, &c. in mathematics. There is no quackery whatever in mathematics...

*A Budget of Paradoxes*

John Walsh’s Delusion (p. 155)

Longmans, Green. London, England. 1872

**Fredrickson, Hal**

No biographical data available

Hooray for calculus.

Old Newton’s rootin’ tootin’ calculus.

The class were letting delta x near zero

Can make a herooof students.

Teachers will say,

Just take the limit,

Be brief not dim, it’s

likely to be finite and you’re on your way.

Hooray for Calculus

*Mathematical Magazine*, Volume 61, Number 3, June 1988 (p. 147)

**Klein, Felix** 1849–1925  
German mathematician

Every one who understands the subject will agree that even the basis on which the scientific explanation of nature rests, is intelligible only to those who have learned at least the elements of the differential and integral calculus, as well as of analytical geometry.

*Jahresbericht der Deutschen Mathematiker Vereinigung*, Volume 11, 1902 (p. 131)

### Mathematical Sciences Education Board

Although discrete mathematics and statistics provide necessary foundations for computer engineering and social sciences, calculus remains the archetype of higher mathematics. It is a powerful and elegant example of the mathematical method, leading both to major applications and to major theories. The language of calculus has spread to all scientific fields; the insight it conveys about the nature of change is something that no educated person can afford to be without.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Curriculum (pp. 51–52)

National Academy Press. Washington, D.C., USA. 1989

**Newman, James Roy** 1911–66  
Mathematician and mathematical historian

...it is to the definite integral that structural engineers must render thanks for the Golden Gate Bridge, for it rests on this even more than on concrete and steel.

*Mathematics and the Imagination*

Chance and Chanceability—The Calculus (p. 340)

Simon & Schuster. New York, New York, USA. 1940

### O'Brien, Katharine

American mathematician

How dear to my heart are cylindrical wedges,  
when fond recollection presents them once more,  
and boxes from tin by upturning the edges,  
and ships landing passengers where on the shore.  
The ladder that slid in its slanting projection,  
the beam in the corridor rounding the ell,  
the rarest of all in that antique collection  
the leaky old bucket that hung in the well —  
the creaky old bucket, the squeaky old bucket,  
the leaky old bucket that hung in the well.

The Old Oaken Calculus Problem

*The American Mathematical Monthly*, Volume 73, Number 8, October 1966 (p. 881)

**Thompson, Silvanus P.** 1851–1916  
English physics professor and author

Considering how many fools can calculate, it is surprising that it should be thought either a difficult or a tedious task for any other fool to learn how to master the same tricks.

Some calculus-tricks are quite easy. Some are enormously difficult. The fools who write the textbooks of advanced mathematics — and they are mostly clever fools — seldom take the trouble to show you how easy the easy calculations are. On the contrary, they seem to desire to impress you with their tremendous cleverness by going about it in the most difficult way. Being myself a remarkably stupid fellow, I have had to unteach myself the difficulties, and now beg to present to my fellow fools the parts that are not hard. Master these thoroughly, and the rest will follow. What one fool can do, another can.

*Calculus Made Easy: Being a Very-Simplest Introduction to Those Beautiful Methods of Reckoning Which Are Generally Called by the Terrifying Names of the Differential Calculus and the Integral Calculus* (2<sup>nd</sup> edition)

Prologue (p. xi)

The Macmillan Company. New York, New York, USA. 1929

**Tolstoy, Leo** 1828–1910  
Russian writer

If they'd told me at college that other people understood the integral calculus, and I didn't, then pride would have come in.

*Anna Karenina*

Part III, Chapter III (p. 228)

Barnes & Noble Books. New York, New York, USA. 2003

## CALORIE

### High school chemistry student

A calorie is the amount of pressure required to push 1 gm of water 1 degree C.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

## CANCER

**Fibiger, Johannes** 1867–1928  
Danish pathologist

The study of the manifold problems presented by cancer has, in recent years, seemed to offer many more riddles than were previously thought to exist; but the history of medicine has never known a period in which problems could be attacked in so many different ways as those made accessible today by the working methods now at our command.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1926

Investigations on Spiroptera Carcinoma and the Experimental Induction of Cancer (p. 148)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

I wish I had the voice of Homer  
To sing of rectal Carcinoma,

Which kills a lot more chaps, in fact,  
 Than were bumped off when Troy was sacked.  
 I noticed I was passing blood  
 (Only a few drops, not a flood).  
 So passing on my way homeward way  
 From Tallahassee to Bombay  
 I asked a doctor, now my friend,  
 To peer into my hinder end,  
 To prove or to disprove the rumor  
 That I had a malignant tumor.  
 Cancer's a Funny Thing  
*New Statesman*, 21 February 1964 (p. 298)

**Hippocrates** 460 BCE–377 BCE  
 Greek physician

It is better not to apply any treatment in cases of occult cancer; for, if treated, the patient dies quickly; but if not treated, they hold out for a long time.  
 In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
 Aphorisms, Section VI, 38 (p. 141)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mayo, Charles Horace** 1865–1939  
 American physician

While there are several chronic diseases more destructive to life than cancer none is more feared.  
 Carcinoma of the Right Segment of the Colon  
*Annals of Surgery*, Volume 83, March 1926

**Smithers, Sir David** 1908–95  
 British cancer physician, writer, and research scientist

Cancer is no more a disease of cells than a traffic jam is a disease of cars. A lifetime of study of the internal combustion engine would not help anyone to understand our traffic problems. A traffic jam is due to a failure in normal relationships between driven cars and their environment.  
 In Gothard Booth  
*The Cancer Epidemic: Shadow of the Conquest of Nature* (p. 20)  
 Mellen Press. New York, New York, USA. 1979

**Wells, H. G. (Herbert George)** 1866–1946  
 English novelist, historian, and sociologist

...the motive that will conquer cancer will not be pity nor horror; it will be curiosity to know how and why.  
 And the desire for service, said Lord Tamar.  
 As the justification of that curiosity, said Mr. Sempack, but not as a motive. Pity never made a good doctor, love never made a good poet. Desire for service never made a discovery.  
*Meanwhile*  
 Chapter 5 (p. 44)  
 George H. Doran. New York, New York, USA. 1927

## CANDLE

**Faraday, Michael** 1791–1867  
 English physicist and chemist

There is no law under which any part of this universe is governed which does not come into play and is touched upon in these phenomena. There is no better, there is no more open door by which you can enter into the study of natural philosophy, than by considering the physical phenomena of a candle.  
*The Chemical History of a Candle* (p. 1)  
 Larlin Corporation. Marietta, Georgia. 1978

## CATALOGUE

**Darwin, G. H.** 1809–82

A mere catalogue of facts, however well arranged has never led to any important scientific generalisation.  
 Address to British Association  
*Nature*, Section A, Volume 34, Number 879, September 2, 1886 (p. 420)

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

Consider what you have in the smallest chosen library. A company of the wisest and wittiest men that could be picked out of all civil countries, in a 1000 years, have set in best order the results of their learning and wisdom. The men themselves were hid and inaccessible, solitary, impatient of interruption, fenced by etiquette; but the thought which they did not uncover to their bosom friend is here written out in transparent words to us, the strangers of another age.  
*The Complete Works of Ralph Waldo Emerson* (Volume 7)  
 Society and Solitude  
 Books (p. 190)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Melancon, Robert**  
 No biographical data available

A great public library, in its catalogue and its physical disposition of its books on shelves, is the monument of literary genres.  
*World Literature Today*, Spring 1982 (p. 231)

## CATASTROPHE

**Gould, Stephen Jay** 1941–2002  
 American paleontologist, evolutionary biologist, and historian of science

[T]he catastrophists were much more empirically minded than [Sir Charles] Lyell. The geologic record does seem to record catastrophes: rocks are fractured and contorted; whole faunas are wiped out .... To circumvent this literal appearance, Lyell imposed his imagination upon the



evidence. The geologic record, he argued, is extremely imperfect and we must interpolate into it what we can reasonably infer but cannot see. The catastrophists were the hardnosed empiricists of their day, not the blinded theological apologists.

This View of Life. Catastrophes and Steady State Earth  
*Natural History*, Volume 84, Number 2, February 1975 (pp. 16–17)

In the great debates of early-nineteenth century geology, catastrophes followed the stereotypical method of objective science — empirical literalism. They believed what they saw, interpolated nothing, and read the record of the rocks directly.

*Hen's Teeth and Horse's Toes*  
The Stinkstones of Oeningen (p. 105)  
W.W. Norton & Company, Inc. New York, New York, USA. 1983

It seems the height of antiquated hubris to claim that the universe carried on as it did for billions of years in order to form a comfortable abode for us. Chance and historical contingency give the world of life most of its glory and fascination. I sit here happy to be alive and sure that some reason must exist for “why me?” Or the earth might have been totally covered with water, and an octopus might now be telling its children why the eight-legged God of all things had made such a perfect world for cephalopods. Sure we fit. We wouldn't be here if we didn't. But the world wasn't made for us and it will endure without us.

*An Urchin in the Storm: Essays About Books and Ideas*  
Chapter 14 (p. 206)  
W.W. Norton & Company, Inc. New York, New York, USA. 1987

In the bad old days, before men rose from their armchairs to look at rocks in the field, biblical limitations of the Mosaic chronology precluded any understanding of our earth's history.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*  
Chapter 1 (p. 5)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

### Vitaliano, Dorothy

American geologist

For unless human nature has changed considerable through the ages, what is considered news, and therefore may be remembered when the normal events of daily life are long forgotten, is the unusual, particularly the violently unusual. And what is more violently unusual than a natural catastrophe?

*Legends of the Earth*  
Chapter 2 (p. 11)  
Indiana University Press. Bloomington, Indiana, USA. 1973

## CAUSALITY

### Gell-Mann, Murray 1929–

American physicist

Physical causality can be traced directly to the existence of a simple initial condition of the universe. But how does that initial condition enter into the theory?

*The Quark and the Jaguar: Adventures in the Simple and the Complex*  
(p. 216)

W.H. Freeman. New York, New York, USA. 1994

### Planck, Max 1858–1947

German physicist

The law of causality is neither true nor false. It is rather a heuristic principle, a signpost — an in my opinion, our most valuable signpost — to help us find our bearings in a bewildering maze of occurrences, and to show us the direction in which scientific research must advance in order to achieve fertile results.

*Scientific Autobiography and Other Papers*  
The Concept of Causality in Physics (p. 149)  
Philosophical Library. New York, New York, USA. 1949

## CAUSATION

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

All philosophers, of every school, imagine that causation is one of the fundamental axioms or postulates of science, yet, oddly enough, in advanced sciences such as gravitational astronomy, the word “cause” never occurs.... The reason why physics has ceased to look for causes is that, in fact, there are no such things. The law of causality, I believe, like much that passes muster among philosophers, is a relic of a bygone age, surviving, like the monarchy, only because it is erroneously supposed to do no harm.

In C.A. Fritz, Jr. (ed.)  
*On the Philosophy of Science*  
On the Notion of Cause (p. 163)  
Bobbs-Merrill. Indianapolis, Indiana, USA. 1965

## CAUSE AND EFFECT

### Akenside, Mark 1721–70

English poet and physician

Give me to learn each secret cause;  
Let number's figure motion's laws  
Revealed before me stand;  
These to great Nature's secret apply,  
And round the Globe, and through the sky,  
Disclose her working hand.

*The Poetical Works of Mark Akenside*  
Hymn to Science in Works of the English Poets  
Associated University Presses. Cranbury, New Jersey, USA. 1996

### Aquinas, St. Thomas 1227?–74

Dominican philosopher and theologian

The universal cause is one thing, a particular cause another. An effect can be haphazard with respect to the

plan of the second, but not of the first. For an effect is not taken out of the scope of one particular cause save by another particular cause which prevents it, as when wood doused with water, will not catch fire. The first cause, however, cannot have a random effect in its own order, since all particular causes are comprehended in its causality. When an effect does escape from a system of particular causality, we speak of it as fortuitous or a chance happening...

*Summa Theologiae*

Part I, Question 22. God's Providence, Article 2, Is Everything Subject to Divine Providence?

McGraw-Hill Book Company, Inc. New York, New York, USA. 1975

**Aristotle** 384 BCE–322 BCE

Greek philosopher

Thus all the action of men must necessarily be referred to seven causes: chance, nature, compulsion, habit, reason, anger, and desire.

*The Art of Rhetoric*

Book I, Chapter X

Harvard University Press. Cambridge, Massachusetts, USA. 1959

**Arthur, Timothy Shay** 1809–85

American writer

Only a few look at causes, and trace them to their effects.

In Donald A. Koch (ed.)

*Ten Nights in a Bar Room and What I Saw There*

Night the Fifth

Harvard University Press. Cambridge, Massachusetts, USA. 1964

**Atherton, Gertrude** 1857–1948

American novelist

The law of cause and effect does not hide in the realm of the unexpected when intelligent beings go looking for it.

*Senator North*

Book II, XXI (p. 240)

John Lane: The Bodley Head. New York, New York, USA. 1900

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

In the series of things those which follow are always aptly fitted to those which have gone before...

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, # 45 (p. 267)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

The end of our foundation is the knowledge of causes, and secret motions of things; and the enlarging of the bounds of human empire, to the effecting of all things possible.

*New Atlantis* (p. 288)

D. Van Nostrand Company, Inc. New York, New York, USA. 1942

**Bergson, Henri** 1859–1941

French philosopher

...the present contains nothing more than the past, and what is found in the effect was already in the cause.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter I (p. 17)

The Modern Library. New York, New York, USA. 1944

**Bernard, Claude** 1813–78

French physiologist

First causes are outside the realm of science; they forever escape us in the sciences of living as well as in those of inorganic bodies.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter I, Section iv (p. 66)

Henry Schuman, Inc. New York, New York, USA. 1927

**Boole, George** 1815–64

English mathematician

So to apprehend in all particular instances the relation of cause and effect, as to connect the two extremes in thought according to the order in which they are connected in nature (for the modus operandi is, and must ever be, unknown to us), is the final object of science.

*An Investigation of the Law of Thought*

Chapter XX (p. 320)

Dover Publications, Inc. New York, New York, USA. 1951

**Burnet, Thomas** 1635–1715

English cleric and scientist

There is nothing doth more awaken our thoughts or excite our minds to enquire into the causes of such things, than the actual view of them; as I have had experience my self when it was my fortune to cross the Alps and Apennine Mountains; for the sight of those wild, vast and indigested heaps of Stones and Earth, did so deeply strike my fancy, that I was not easie till I could give my self some tolerable account how that confusion came in Nature.

*The Sacred Theory of the Earth (Second Edition)*

Book I, Chapter XI (p. 110)

Printed by R. Norton. London. 1691

**Chamberlin, T. C.** 1843–1928

American geologist

There is no nobler aspiration of the human intellect than desire to compass the cause of things. The disposition to find explanations and to develop theories is laudable in itself. It is only ill use that is reprehensible. The vitality of study quickly disappears when the object sought is a mere collection of dead unmeaning facts.

The Method of Multiple Working Hypotheses

*Science*, Volume 148, Number 3671, 7 May 1965 (p. 755)

**Chuang Tzu** 4<sup>th</sup> or 3<sup>rd</sup> century BCE  
Taoist philosopher

Everything can be a “that”; everything can be a “this.”  
One man cannot see things as another sees them....  
Therefore it is said “That” comes from “this” and “this”  
comes from “that” — which means “that” and “this” give  
birth to one another.

Translated by Gia-Fu Feng and Jane English  
*Chuang-Tzu: Inner Chapters*  
Chapter Two (p. 29)  
Alfred A. Knopf. New York, New York, USA. 1974

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

The Causes of events are ever more interesting than the  
events themselves.

*Epistolae ad atticum*  
Book IX, Section 5  
Belles Lettres. Paris, France. 1984

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

We know the effects of many things, but the causes of  
few; experience, therefore, is a surer guide than imagina-  
tion, and inquiry than conjecture.

*Lacon; or Many Things in a Few Words* (p. 111)  
William Gowans. New York, New York, USA. 1849

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

There is no result in nature without a cause; understand  
the cause and you will have no need for the experiment.

*Leonardo da Vinci's Note Books*  
Of the Intellectual Life (p. 54)  
Duckworth & Company. London, England. 1906

**Spinoza, Baruch de** 1632–77  
Dutch philosopher

I understand that to be CAUSE OF ITSELF (*causa sui*)  
whose essence involves existence and whose nature can-  
not be conceived unless existing.

*Ethics*  
Concerning God, Definition I  
J.M. Dent & Sons Ltd. London, England. 1941

...all men are born ignorant of the causes of things,  
and...all have a desire of acquiring what is useful...

*Ethics*  
Concerning God, Appendix  
J.M. Dent & Sons Ltd. London, England. 1941

**Disraeli, Benjamin, 1<sup>st</sup> Earl of  
Beaconsfield** 1804–81  
British statesman and novelist

But great things spring from causalities.  
*Sybil, or The Two Nations*

Book V, III (p. 345)  
T.A. Contall Ltd. Edinburgh, Scotland. 1927

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

...you have erred perhaps in attempting to put colour and  
life into each of your statements, instead of confiding  
yourself to the task of placing upon record that severe  
reasoning from cause to effect which is really the only  
notable feature about the thing.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
The Adventure of the Copper Beeches (p. 114)  
Wings Books. New York, New York, USA. 1967

A coincidence! Here is one of the three men who we had  
named as possible actors in this drama, and he meets a  
violent death during the very hours when we know that  
the drama was being enacted. The odds are enormous  
against its being a coincidence. No figures could express  
them. No, my dear Watson, the two events are connected  
— must be connected. It is for us to find the connection.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
The Adventure of the Second Stain (p. 308)  
Wings Books. New York, New York, USA. 1967

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

Happy the man, who studying Nature's laws,  
Through known effects can trace the secret cause —  
His mind, possessing in a quiet state,  
Fearless of fortune and resigned to fate.

*The Poetical Works of Dryden*  
Translation of Virgil, The Second Book of the Georgics  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician  
Yea, the first Morning of Creation wrote  
What the Last Dawn of Reckoning shall read.

*The Nature of the Physical World*  
Chapter XIV (p. 293)  
The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955  
German-born physicist

In classical mechanics, and no less in the special theory  
of relativity, there is an inherent epistemological defect  
which was, perhaps for the first time, clearly pointed out  
by Ernst Mach.... No answer can be admitted as epis-  
temologically satisfactory, unless the reason given is an  
observable fact of experience. The law of causality has  
not the significance of a statement as to the world of ex-  
perience, except when observable facts ultimately appear  
as causes and effects.

*The Principles of Relativity* (pp. 112–113)  
Cambridge University Press. Cambridge, England. 1922

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Some play at chess, some at cards, some at the Stock Exchange. I prefer to play at Cause and Effect.

*The Journals of Ralph Waldo Emerson* (p. 234)

Random House, Inc. New York, New York, USA. 1960

Shallow men believe in luck, believe in circumstances....

Strong men believe in cause and effect.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Worship (p. 1065)

The Library of America. New York, New York, USA. 1983

Do not clutch at sensual sweetness until it is ripe on the slow tree of cause and effect.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Prudence (p. 360)

The Library of America. New York, New York, USA. 1983

Cause and effect, the chancellors of God.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Prudence (p. 282)

The Library of America. New York, New York, USA. 1983

Cause and effect, means and ends, seed and fruit, cannot be severed; for the effect already blooms in the cause; the end preexists in the means, the fruit in the seed.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Compensation (p. 290)

The Library of America. New York, New York, USA. 1983

Cause and effect are two sides of one fact.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Circles (p. 410)

The Library of America. New York, New York, USA. 1983

**Empiricus, Sextus** fl. Second century AD

Medical doctor and teacher

...if there were no causes, everything would come from everything, and by chance. For example, perhaps horses would come from mice, and elephants from ants; and in Egyptian Thebes there would have been rainstorms and snow and the south would have no rain, if there had not been a cause on account of which the south is stormy in winter, and the east is dry.

Translated by Benson Mates

*The Skeptic Way: Sextus Empiricus's Outlines of Pyrrhonism*

Sextus Empiricus: Outlines of Pyrrhonism

Book III, Section 5 (p. 176)

Oxford University Press, Inc. New York, New York, USA. 1996

**Fourier, (Jean Baptiste-) Joseph** 1768–1830

French mathematician and physicist

Primary causes are unknown to us; but are subject to simple and constant laws, which may be discovered by

observation, the study of them being the object of natural philosophy.

In *Great Books of the Western World* (Volume 43)

*The Analytical Theory of Heat*

Preliminary Discourse (p. 169)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Froude, James Anthony** 1818–94

English historian and biographer

Every effect has its cause.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 12)

Charles Scribner's Sons. New York, New York, USA. 1890

**Heise, David R.** 1937–

American sociologist and mathematician

Causation depends on an extraordinary turning of reality at a particular instant such that one event transmutes into another.

*Causal Analysis* (p. 6)

John Wiley & Sons, Inc. New York, New York, USA. 1975

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The chain of cause and effect could be quantitatively verified only if the whole universe were considered as a single system — but then physics has vanished, and only a mathematical scheme remains. The partition of the world into observing and observed system prevents a sharp formulation of the law of cause and effect.

*The Physical Principles of the Quantum Theory*

Translated by Carl Eckhart and Frank C. Hoyt (p. 58)

The University of Chicago Press. Chicago, Illinois, USA. 1930

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

But he who, blind to universal laws,  
Sees but effects, unconscious of the causes, —

*The Complete Poetical Works of Oliver Wendell Holmes*

A Metrical Essay

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Hume, David** 1711–76

Scottish philosopher and historian

From causes which appear similar we expect similar effects. This is the sum of all our experimental conclusions.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section IV, Part II (p. 462)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is universally allowed that nothing exists without a cause of its existence, and that chance, when strictly examined, is a mere negative word, and means not any real power which has anywhere a being in nature.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section VIII, Part I (p. 478)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Here is a billiard ball lying on the table, and another ball moving toward it with rapidity. They strike; the ball which was formerly at rest now acquires a motion. This is as perfect an instance of the relations of cause and effect as any which we know either by sensation or reflection.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
 An Abstract of a Treatise of Human Nature (pp. 186–187)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In a word, then, every effect is a distinct event from its cause.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
 Section IV, Part I (p. 460)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

All effects follow not with like certainty from their supposed causes.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
 Section X (p. 489)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huxley, Thomas Henry** 1825–95  
 English biologist

All that can be ascertained concerning the structure, succession of conditions, actions, and position in space of the earth, is the matter of fact of its natural history. But, as in biology, there remains the matter of reasoning from these facts to their causes, which is just as much science as the other, and indeed more; and this constitutes geological etiology.

*Collected Essays* (Volume 8)  
*Discourses, Biological and Geological*  
 Geological Reform (p. 318)  
 Macmillan & Company Ltd. London, England. 1904

**Jackson, Hughlings** 1835–1911  
 English neurologist

The study of the causes of things must be preceded by the study of things caused.

In W.I.B. Beveridge  
*The Art of Scientific Investigation*  
 Chapter One (p. 10)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1957

**James, William** 1842–1910  
 American philosopher and psychologist

With earth's first clay they did the last man knead,  
 And there of the last harvest sowed the seed.  
 And the first morning of creation wrote  
 What the last dawn of reckoning shall read.

The Dilemma of Determinism  
*Unitarian Review and Religious Magazine*, Volume XXII, Number 3,  
 September 1884

As in the night all cats are gray, so in the darkness of metaphysical criticism all causes are obscure.

*The Principles of Psychology* (Volume 1)  
 Chapter V (p. 140)  
 Harvard University Press. Cambridge, Massachusetts, US. 1981

**Kant, Immanuel** 1724–1804  
 German philosopher

Pure mathematics can never deal with the possibility, that is to say, with the possibility of an intuition answering to the conceptions of the things. Hence it cannot touch the question of cause and effect, and consequently, all the finality there observed must always be regarded simply as formal, and never as a physical end.

In Ernst Behler (ed.)  
*Philosophical Writings*  
 The Critique of Judgment  
 Critique of Teleological Judgment, p. 63, fn  
 Continuum. New York, New York, USA. 1986

**Kepler, Johannes** 1571–1630  
 German astronomer

Some physical causes are recognized by all; others, by only very few people; indeed, many things exist naturally, but from causes hitherto known to no man. And of the causes, which we know, there are some whose kind and nature we all usually understand, and others whose kind or indirect cause are understood by very few people, or by nobody.

*Fundamentis. Astrologiae Certioribus*  
 Thesis IV  
 Prague, Czechoslovakia. 1602

**Laplace, Pierre Simon** 1749–1827  
 French mathematician, astronomer, and physicist

We ought to regard the present state of the universe as the effect of its anterior state and as the cause of the one that is to follow.

*A Philosophical Essay on Probabilities*  
 Chapter II (p. 4)  
 Dover Publications, Inc. New York, New York, USA. 1951

An intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it — an intelligence sufficiently vast to submit these data to analysis — it would embrace in the same formula the movements of the greatest bodies of the universe and those of the lightest atoms; for it, nothing would be uncertain and the future, as the past, would be present to its eyes. The human mind offers, in the perfection which it has been able to give to astronomy, a feeble idea of this intelligence.

*A Philosophical Essay on Probabilities*  
 Chapter II (p. 4)  
 Dover Publications, Inc. New York, New York, USA. 1951

**Lee, Hannah Farnham** 1780–1865  
American writer

Causes are often disproportionate to effects.  
*The Log Cabin, or, the World Before You*  
Part the Second  
Appleton. Philadelphia, Pennsylvania, USA. 1844

**Levins, Richard** 1930–  
American evolutionary ecologist, biomathematician, and philosopher of science

**Lewontin, Richard C.** 1929–  
American evolutionary geneticist and philosopher of science

Lines of causality run from part to whole, from atom to molecule, from molecule to organism, from organism to collectivity. As in society, so in all of nature, the part is ontologically prior to the whole.  
*The Dialectical Biologist*  
Introduction (p. 2)  
Harvard University Press. Cambridge, Massachusetts, USA. 1985

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

Man is a creature who searches for causes; he could be named the cause-searcher within the hierarchy of minds.  
*Lichtenberg: Aphorisms and Letters*  
Aphorisms (p. 62)  
Jonathan Cape. London, England. 1969

**Lyell, Sir Charles** 1797–1875  
English geologist

When we are unable to explain the monuments of past changes, it is always more probable that the difference arises from our ignorance of all the existing agents, or all their possible effects in an indefinite lapse of time, than that some cause was formerly in operation which has ceased to act...  
*Principles of Geology* (Volume 1)  
Chapter IX (pp. 164–165)  
John Murray. London, England. 1830

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

In speaking of cause and effect we arbitrarily give relief to those elements to whose connection we have to attend in the reproduction of a fact in the respect in which it is important to us. There is no cause nor effect in nature; nature has but an individual existence; nature simply is. Recurrences of like cases in which A is always connected with B, that is, like results under like circumstances, that is again, the essence of the connection of cause and effect, exist but in the abstraction which we perform for the purpose of mentally reproducing the facts.  
*The Science of Mechanics* (5<sup>th</sup> Edition)  
Chapter IV, Part IV, Section 3 (p. 580)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Meredith, Owen (Edward Robert Bulwer-Lytton, 1<sup>st</sup> Earl Lytton)** 1831–91  
English statesman and poet

To all facts there are laws,  
The effect has its cause, and I mount to the cause.  
*Lucile*  
Part II, Canto III, Stanza 8  
Belford, Clarke & Company. Chicago, Illinois, USA. 1889

**Mill, John Stuart** 1806–73  
English political philosopher and economist

The truth that every fact which has a beginning has a cause, is coextensive with human experience.  
*A System of Logic, Rationative and Inductive* (Volume 1)  
Book III, Chapter V, Section 1 (p. 363)  
Longman, Green, Reader & Dyer. London, England. 1868

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

It has been well remarked that that writer would be equally in danger or error who would assign very abstruse motives for the conduct of great bodies of men, or very obvious causes for the great phenomena of nature.  
*The Testimony of the Rocks: of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Tenth (p. 392)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Nietzsche, Friedrich** 1844–1900  
German philosopher

Before the effect one believes in other causes than after the effect.  
*The Complete Works of Fredrich Nietzsche* (Volume 10)  
The Joyful Wisdom, III, Number 217  
T.N. Foulis. Edinburgh, Scotland. 1910

**Ovid** 43 BCE–17 AD  
Roman poet

The cause is hidden, but the enfeebling power of the fountain is well known.  
Translated by Frank Justus Miller  
*Metamorphoses* (Volume 1)  
Book IV, l. 287 (p. 199)  
William Heinemann. London, England. 1916

**Pascal, Blaise** 1623–62  
French mathematician and physicist

*Rem Viderunt, Causomnon Viderunt*

They saw the thing, but not the cause  
In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section III, 235  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95  
French chemist

All things are hidden, obscure and debatable if the cause of the phenomena be unknown, but everything is clear if this cause be known.

*The Harvard Classics* (Volume 38)

The Germ Theory and Its Application to Medicine and Surgery (p. 366)

P.F. Collier & Son. New York, New York, USA. 1938

### **Pettie, George** 1548–89

English writer

Sutch as the cause of every thing is, sutch wilbe the effect.

*A Petite Pallace of Pettie His Pleasure* (Volume 1)

Germanicus and Agrippina

AMS Press. New York, New York, USA. 1970

### **Plotinus** ca. 205–270

Egyptian-Roman philosopher

On the assumption that all happens by Cause, it is easy to discover the nearest determinants of any particular act or state to trace it plainly to them.

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Third Ennead I.1 (p. 78)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Polybius** ca. 203 BCE–120 BCE

Greek historian

We must rather seek for a cause, for every event whether probable or improbable must have some cause.

*The Histories*

Book II, 38.5

Harvard University Press. Cambridge, Massachusetts, USA. 1960

### **Prakash, Satya**

No biographical data available

If the law of the relation of effect and cause does not exist, then the non-existence of cause will follow also from non-existence of effect. Non-existence of effect is not instrumental towards the non-existence of cause; but non-existence of cause is instrumental towards non-existence of effect.

*Founders of Sciences in Ancient India* (p. 322)

The Research Institute of Ancient Scientific Studies. New Delhi, India.

1965

### **Priestley, Joseph** 1733–1804

English theologian and scientist

One of the most intimate of all associations in the human mind is that of cause and effect. They suggest one another with the utmost readiness upon all occasions; so that it is almost impossible to contemplate the one, without having some idea of, or forming some conjecture about the other.

*The History and Present State of Electricity*

Part III, Section I (p. 441)

Printed for J. Dodsley. London, England. 1767

### **Rohault, Jacques** 1618–72

French philosopher and physicist

Every Effect Presupposes some Cause.

*Rohault's System of Natural Philosophy*

Volume I, Part I, Chapter 5, 6

Johnson Reprint Corporation. New York, New York, USA. 1969

### **Rousseau, Jean-Jacques** 1712–78

Swiss-French philosopher

...for no more by the law of reason than by the law of nature can anything occur without a cause.

Translated by G.D.H. Cole

*The Social Contract*

Book II, Chapter 4

E.P. Dutton & Company. New York, New York, USA. 1950

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The notion of causality has been greatly modified by the substitution of space-time for space and time.... Thus geometry and causation become inextricably intertwined.

*The Analysis of Matter*

Chapter XXX (p. 313)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

But we are not likely to find science returning to the crude form of causality believed in by Fijians and philosophers of which the type is "lightning causes thunder."

*The Analysis of Matter*

Chapter XI (p. 102)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

### **Scrope, George Poulett** 1797–1876

English geologist and political economist

...in the process of argument from effects up to causes, no chain of reasoning can be stronger, no conclusion can be more imperative, than when...we are possessed of a considerable number of facts, all, without one exception, going to support a certain origin, and that not an imaginary species of phenomenon invented for the occasion, but the same which is observed in its continual operation on other spots to produce the same results, and the only one amongst all known natural processes that is capable of producing them.

*Considerations on Volcanoes*

Appendix, Number 2 (pp. 269–270)

W. Phillips & George Yarp. London, England. 1825

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

Thou art the cause, and most accursed effect.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Tragedy of King Richard the Third

Act I, Scene ii, l. 120

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There is occasions and causes why and wherefore in all things.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
 The Life of King Henry the Fifth  
 Act V, Scene i, l. 3  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952  
 ...and now remains

That we find out the cause of this effect,  
 Or rather say, the cause of this defect,  
 For this effect defective comes by cause.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Hamlet, Prince of Denmark  
 Act II, Scene ii, l. 100  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Thompson, Francis 1859–1907

English writer

All things by immortal power,  
 Near or far  
 Hiddenly

To each other linked are,  
 That thou canst not stir a flower  
 Without troubling of a star.

*Complete Poetical Works of Francis Thompson*  
 The Mistress of Vision, Stanza XXII  
 Boni & Liveright, Inc., Publishers. New York, New York, USA. 1923

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

Our last deed, like the young of the land crab, winds its way to the sea of cause and effect as soon as born, and makes a drop there to eternity.

*Journal* (Volume 1: 1837–1844)  
 March 14, 1838 (p. 38)  
 Princeton University Press. Princeton, New Jersey, USA. 1981

### Tolstoy, Leo 1828–1910

Russian writer

Man's mind cannot grasp the causes of events in their completeness, but the desire to find those causes is implanted in man's soul. And without considering the multiplicity and complexity of the conditions any one of which taken separately may seem to be the cause, he snatches at the first approximation to a cause that seems to him intelligible and says: "This is the cause!"

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
 Book Thirteen, Chapter I (p. 563)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Virgil 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

How blest the sage! Whose soul can pierce each cause  
 Of changeful Nature, and her wondrous laws.

*Georgics*  
 II, 490

## CAVE

### Cowen, Richard

No biographical data available

Caves are wonderful places for lairs  
 For sabertooth tigers and bears  
 "But try to eject us!"

Said Homo erectus  
 "We need this place for our heirs."

*History of Life*  
 Chapter Nineteen (p. 414)  
 Blackwell Scientific Publications. Boston, Massachusetts, USA. 1990

### Shaler, Nathaniel Southgate 1841–1906

American geologist

It is the unseen which most attracts us. Therefore, in all times men have speculated as to the contents of the nether earth. Its crevices and caverns afford in their dark recesses a world which the imagination can people at its will.

*Aspects of the Earth: A Popular Account of Some Familiar Geological Phenomena*  
 Caverns and Cavern Life (p. 98)  
 Charles Scribner's Sons. New York, New York, USA. 1889

### Teilhard de Chardin, Pierre 1881–1955

French Jesuit, paleontologist, and biologist

Caves are the privileged homes of the documents of pre-history.

*The Appearance of Man*  
 Chapter I (p. 18)  
 Harper and Row, Publishers. New York, New York, USA. 1965

## CAVERN

### Harrington, Thomas

No biographical data available

If we could descend into the bowels of the Earth, we should there see dark chambers and apartments, strange subterraneous passages, holes and caverns, some filled with smoke and fire, some with water, and some with vapour and mouldy air...

*Science Improved, or The Theory of the Universe*  
 Section III (p. 18)  
 Printed for the Author. London, England. 1774

## CAVITY

### Davies, Robertson 1913–95

Canadian novelist

I went to my dentist today in a high state of apprehension. None of my teeth were hurting me, but I know from bitter experience that a tooth of mine can have a cavity as big as the Grotto at Lourdes before it informs me of the fact.



*The Table Talk of Samuel Marchbanks* (p. 202)  
Clarke, Irwin. Toronto, Ontario, Canada. 1949

### Walis, Claudia

No biographical data available

Tooth decay was a perennial national problem that meant a mouthful of silver for patients, and for dentists a pocketful of gold.

Today's Dentistry: A New Drill  
*Time*, September 9, 1985 (p. 73)

## CELESTIAL

### Aristotle 384 BCE–322 BCE

Greek philosopher

The glory, doubtless, of the heavenly bodies fills us with more delight than the contemplation of these lowly things, but the heavens are high, and far off, and the knowledge of celestial things that our senses give us, is scanty and dim.

In Edith Hamilton

*The Greek Ways*

Chapter II (p. 32)

W.W. Norton & Company, Inc. New York, New York, USA. 1993

## CELESTIAL MOTION

### Lucretius ca. 99 BCE–55 BCE

Roman poet

...we must well grasp the principle of things above, the principle by which the courses of the sun and moon go on, the force by which every thing on earth proceeds.

In *Great Books of the Western World* (Volume 12)

*Lucretius: On the Nature of Things*

Book One, l. 124–127 (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Milton, John 1608–74

English poet

That day, as other solemn dayes, they spent  
In song and dance about the sacred Hill,  
Mystical dance, which yonder starrie Sphere  
Of Planets and of fixt in all her Wheelles  
Resembles nearest, mazes intricate,  
Eccentric, intervovl'd, yet regular  
Then most, when most irregular they seem:  
And in their motions harmonic Divine  
So smooths her charming tones, that God's own ear  
Listens delighted.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book V, l. 618–627

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CELL

### Anderson, Poul 1926–2001

American science fiction writer

The cell is a sea where molecules drift on thermal tides.

In Byron Preiss and William R. Alschuler (eds.)

*The Microverse*

Death Wish (p. 140)

Bantam Books. New York, New York, USA. 1989

### Bastin, Ted

No biographical data available

As far as one can judge at all, the cell cannot be understood in its behavior as the basis of events at the molecular level. One would judge this because the control processes of detailed cell physiology seem to proliferate endlessly in the sense that the more one understands a given chain of reactions and their associated background dynamics, the larger is the number of ancillary, trigger and other processes which it seems necessary to call in to achieve completeness of explanation and a self-contained causal scheme.

In A.R. Peacock

*Zygon*

Reductionism: A Review of the Epistemological Issues and Their Relevance to Biology and the Problem of Consciousness, Volume 11, Number 4, 4 December 1976 (p. 327)

### Bateson, William 1861–1926

English biologist and geneticist

When I look at a dividing cell I feel as an astronomer might do if he beheld the formation of a double star: that an original act of creation is taking place before me.

*Problems of Genetics*

Chapter II (p. 41)

Yale University Press. New Haven Connecticut, USA. 1913

### Benchley, Robert 1889–1945

American humorist and critic

The scene is a plateau of primeval ooze. Things are in terrible shape. Nobody knows what to do because there is nobody. The Earth is practically new and nothing is alive except a lot of — what shall we say?

*20,000 Leagues Under the Sea or David Copperfield*

It Seems There Were a Couple of Cells (p. 176)

Blue Ribbon Books. New York, New York, USA. 1928

### Chargaff, Erwin 1905–2002

Austrian biochemist

The cell is more than a chemical slum.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 1 (p. 5)

The Seabury Press. New York, New York, USA. 1977

### Claude, Albert 1898–1983

Belgian-American cytologist

We have entered the cell, the Mansion of our birth, and started the inventory of our acquired wealth.

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company, Singapore, 1992

For over two billion years, through the apparent fancy of her endless differentiations and metamorphosis, the Cell, as regards its basic physiological mechanisms, has remained one and the same. It is life itself, and our true and distant ancestor.

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company, Singapore, 1992

### Cudmore, Lorraine Lee

American cell biologist

We are made of cells. And of stars.

*The Center of Life: A Natural History of the Cell*

Biochemical Evolution (p. 27)

New York Times Book Company, New York, New York, USA, 1977

Our cells, the ones we love, are repositories of such fantastic architectural flights — pleasure domes far beyond even the most opiated dreams of Coleridge, a Xanadu percolating with the directed chaos of those hundreds of thousands of simultaneous chemical reactions that are life.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 5)

New York Times Book Company, New York, New York, USA, 1977

Some cells are extremely visible — the egg of an ostrich, of a hen or puffin. But we cell biologists see these the way anyone would, as a large globe of yellow yolk surrounded by a transparent glutinous mass; interesting only by virtue of their behavior in soufflé or omelet.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 5)

New York Times Book Company, New York, New York, USA, 1977

Every living thing is made of cells, and everything a living thing does is done by the cells that make it up.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 6)

New York Times Book Company, New York, New York, USA, 1977

Cells have everything. Except visibility.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 6)

New York Times Book Company, New York, New York, USA, 1977

Cells let us walk, talk, think, make love and realize the bath water is cold.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 6)

New York Times Book Company, New York, New York, USA, 1977

A cell always leaves the same first impression. It is incredibly crowded in there; a welter of structures crammed

together like rush-hour riders in Tokyo or New York subways, with no apparent breathing space.

*The Center of Life: A Natural History of the Cell*

Cellular Evolution (p. 50)

New York Times Book Company, New York, New York, USA, 1977

### Davies, Paul Charles William 1946–

British-born physicist, writer, and broadcaster

The living cell is the most complex system of its size known to mankind. Its host of specialized molecules, many found nowhere else but within living material, are themselves already enormously complex. They execute a dance of exquisite fidelity, orchestrated with breathtaking precision. Vastly more elaborate than the most complicated ballet, the dance of life encompasses countless molecular performers in synergetic coordination. Yet this is a dance with no sign of a choreographer. No intelligent supervisor, no mystic force, no conscious controlling agency swings the molecules into place at the right time, chooses the appropriate players, closes the links, uncouples the partners, moves them on. The dance of life is spontaneous, self-sustaining, and self-creating.

*The Fifth Miracle: The Search for the Origin of Life*

Chapter 1 (p. 29)

Simon & Schuster, New York, New York, USA, 1996

### Delbrück, Max 1906–81

German-born American biologist

The closer one looks at these performances of matter in living organisms, the more impressive the show becomes. The meanest living cell becomes a magic puzzle box full of elaborate and changing molecules, and far outstrips all chemical laboratories of man in the skill of organic synthesis performed with expedition and good judgment of balance.... [A]ny living cell carries with it the experience of a billion years of experimentation by its ancestors. You cannot expect to explain so wise an old bird in a few simple words.

A Physicist Looks at Biology

*Transactions of The Connecticut Academy of Sciences*, Volume 38, 1949 (p. 191)

No, any living cell carries with it the experiences of a billion years of experimentation by its ancestors. You cannot expect to explain so wise an old bird in a few simple words.

*The Connecticut Academy of Arts and Sciences*

A Physicist Looks at Biology, Volume 38, December 1949

### Reichenbach, Hans 1891–1953

German philosopher of science

The production of just one living cell from inorganic matter is the most urgent problem which concerns the biologist who wants to make the theory of evolution complete.... Presumably, biologists will someday construct synthetic albumen molecules of the gene type and

of the protoplasm type, put them together, and thus produce an aggregate which possesses all the characteristics of a living cell. Should the experiment succeed, it would demonstrate conclusively that the origin of life can be traced back to inorganic matter.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 202)

University of California Press. Berkeley, California, USA. 1951

### Rubin, Harry

No biographical data available

...we cannot disrupt the cell to understand its living behavior because in doing so we destroy the very property we wish to understand...

Cancer as a Developmental Disorder

*Cancer Research*, Volume 45, July 1985 (p. 2940)

### Sherrington, Sir Charles 1857–1952

English physiologist

Essential for any conception of the cell is that it is no static system. It is dynamic. It is energy-cycles, suites of oxidation and reduction, concatenated ferment-actions. It is like a magic hive the walls of whose chambered spongework are shifting veils of ordered molecules, and rend and renew as operations rise and cease. A world of surfaces and streams. We seem to watch battalions of specific catalysts, like Maxwell's "demons," lined up, each waiting, stop-watch in hand, for its moment to play the part assigned to it. Yet each step is understandable chemistry.

*Man on His Nature*

Chapter III (p. 80)

Doubleday Anchor Books. Garden City, New York, USA. 1955

### Szent-Györgyi, Albert 1893–1986

Hungarian-born American biochemist

The cell knows but one fuel: — hydrogen.

In Kenneth Thimann

*The Life of Bacteria: Their Growth, Metabolism and Relationships*

Chapter V (p. 167)

The Macmillan Company. New York, New York, USA. 1963

### Thomas, Lewis 1913–93

American physician and biologist

The uniformity of earth's life, more astonishing than its diversity, is accountable by the high probability that we derived, originally, from some single cell, fertilized in a bolt of lightning as the earth cooled. It is from the progeny of this parent cell that we all take our looks; we still share genes around, and the resemblance of the enzymes of grasses to those of whales is in fact a family resemblance.

*The Lives of a Cell: Notes of a Biology Watcher*

The Lives of a Cell (p. 5)

The Viking Press. New York, New York, USA. 1974

## CENTRAL LIMIT THEOREM

### Massey, William A.

No biographical data available

When you are listening to corn pop, are you hearing the Central Limit Theorem?

*Chance News*

Correspondence with J. Laurie Snell

January 9, 1996

## CERTAINTY

### Bacon, Sir Francis 1561–1626

English lawyer, statesman, and essayist

...if a man will begin with certainties he shall end in doubts, but if he will be content to begin with doubts, he shall end in certainties.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

First Book, Chapter V, Section 8 (p. 16)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Baggott, Jim

Science writer

It is in the nature of theoretical science that there can be no such thing as certainty. A theory is only "true" for as long as the majority of the scientific community maintain the view that the theory is the one best able to explain the observations.

*The Meaning of Quantum Theory*

Chapter 4 (p. 157)

Oxford University Press, Inc. Oxford, England. 1992

### Belloc, Hilaire 1870–1953

French-born poet and historian

Oh! let us never doubt

What nobody is sure about!

*Complete Verse*

The Microbe

Gerald Duckworth. London, England. 1970

### Butler, Samuel 1612–80

English novelist, essayist, and critic

There is one thing certain, namely that we can have nothing certain; and therefore it is not certain that we can have nothing certain.

*Samuel Butler's Notebooks* (p. 195)

Jonathan Cape. London, England. 1951

### Camus, Albert 1913–60

Algerian-French novelist, essayist, and playwright

...we're not sure, we can't be sure. Otherwise, there would be a solution; at least one could get oneself taken seriously.

*The Fall* (p. 74)

Alfred A. Knopf. New York, New York, USA. 1958

**Dampier-Whetham, William** 1867–1952

English science writer

Sometimes the probability in favor of a generalization is enormous, but the infinite probability of certainty is never reached.

*Science and the Human Mind*

Chapter X

Longmans, Green &amp; Company. New York, New York, USA. 1912

**Froude, James Anthony** 1818–94

English historian and biographer

It was not a PERHAPS; it was a certainty.

*Short Studies on Great Subjects* (Volume 1)

Times of Erasmus, Desiderius and Luther, Lecture I (p. 52)

Longmans, Green &amp; Company. London, England. 1879

**Galsworthy, John** 1867–1933

English novelist and dramatist

If one thing is more certain than another — which is extremely doubtful —

*End of the Chapter*

Maid in Waiting, Chapter 13 (p. 108)

Charles Scribner's Sons. New York, New York, USA. 1937

**Hesiod** ca. 700 BCE

Greek pastoral poet

He is a fool who leaves certainties for uncertainties.

*Fragments*Frag 18, Quoted by Plutarch, *Moralia*, Section 505D (p. 278)**Hoffer, Eric** 1902–83

American longshoreman and philosopher

We can be absolutely certain only about things we do not understand.

*The True Believer*

Part 3, Chapter XII, Section 57 (p. 79)

Harper &amp; Row, Publishers, New York 1951

**Holmes, Jr., Oliver Wendell** 1841–1935

American jurist

But certainty generally is illusion, and repose is not the destiny of man.

*The Path of the Law**Harvard Law Review*, Volume 10, Number 7, February 25, 1897 (p. 466)

Certitude is not the test of certainty. We have been cocksure of many things that were not so.

Natural Law

*Harvard Law Review*, Volume 32, Number 1, November 1918

Heads I win, Tails you lose.

*The Professor at the Breakfast-Table*

Chapter VIII (p. 252)

Ticknor &amp; Fields. Boston, Massachusetts, USA. 1860

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

Anyone who takes the sure road is as good as dead.

*Memories, Dreams, Reflections*

Chapter X (p. 297)

Vintage Books. New York, New York, USA. 1970

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

Yet I shall not deny that the number of phenomena which are happily explained by a given hypothesis may be so great that it may be taken as morally certain.

*Philosophical Papers and Letters* (Volume 1)

On the Elements of Natural Science (p. 347)

The University of Chicago Press. Chicago, Illinois, USA. 1956

**Locke, John** 1632–1704

English philosopher and political theorist

...the highest probability amounts not to certainty, without which there can be no true knowledge.

*In Great Books of the Western World* (Volume 35)*An Essay Concerning Human Understanding*

Book IV, Chapter III, Section 14 (p. 316)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mansfield, Lord, William Murray** 1705–93

Chief justice of England

As mathematical and absolute certainty is seldom to be attained in human affairs, reasoning and public utility require that judges and all mankind in forming their opinion of the truth of facts should be regulated by the superior number of probabilities on the one side or the other.

In Francis Wellman

*The Art of Cross-Examination* (p. 168)

The Macmillan Company. New York, New York, USA. 1923

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

With the idol of certainty (including that of degrees of imperfect certainty or probability) there falls one of the defences of obscurantism which bar the way of scientific advance. For the worship of this idol hampers not only the boldness of our questions, but also the rigor and the integrity of our tests. The wrong view of science betrays itself in the craving to be right; for it is not his possession of knowledge, of irrefutable truth, that makes the man of science, but his persistent and recklessly critical quest for truth.

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (pp. 280–281)

Basic Books, Inc. New York, New York, USA. 1959

**Sagan, Carl** 1934–96

American astronomer and science writer

Humans may crave absolute certainty; they may aspire to it; they may pretend, as partisans of certain religions do, to have attained it. But the history of science — by far the most successful claim to knowledge accessible to humans

— teaches that the most we can hope for is successive improvement in our understanding, learning from our mistakes, an asymptotic approach to the Universe, but with the proviso that absolute certainty will always elude us. We will always be mired in error. The most each generation can hope for is to reduce the error bars a little, and to add to the body of data to which error bars apply.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 2 (p. 28)  
Random House, Inc. New York, New York, USA. 1995

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Not a resemblance, but a certainty.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Measure for Measure  
Act IV, Scene ii, l. 203  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

I must have certainty. Give it to me; or I will kill you when next I catch you asleep.

*Back to Methuselah*  
Part I, Act 1 (p. 15)  
Constable & Company Ltd. London, England. 1921

**Walker, Marshall**

No biographical data available

All predictions are statistical, but some predictions have such a high probability that one tends to regard them as certain.

*The Nature of Scientific Thought*  
Chapter VI (p. 70)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

**CHANCE**

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

A tree is known by its fruits — and the fruits of chance are incoherence, incompleteness, unsteadiness, the stammering utterance of blind, unreasoning force.

*Geological Structures*  
Chapter I (p. 21)  
Ticknor & Fields. Boston, Massachusetts, USA. 1866

**Ambler, Eric** 1909–98

English novelist

A Frenchman named Chamfort, who should have known better, once said that chance was a nickname for Providence.

*A Coffin for Dimitrios*  
Chapter I (p. 1)  
Sun Dial Press. New York, New York, USA. 1939

**Aquinas, St. Thomas** 1227?–74

Dominican philosopher and theologian

In all such beings chance occurs, not in the sense that everything about them occurs by chance, but that in each of them there is room for chance and this very fact is a sign that they are subject to someone's rule.

*Summa Theologiae*  
Part I, Question 103, God's Government Taken as a Whole, Article 5,  
Whether All Things Are Subject to God's Government

**Aron, Raymond** 1905–83

French sociologist and historian

...rational action is merely a question of calculating the chances.

*The Opium of the Intellectuals*  
Chapter VI (p. 165)  
Secker & Warburg. London, England. 1957

**Astaire, Fred** 1899–1955

American dancer, actor, and singer

Chance is the fool's name for fate.

*The Gay Divorcee*  
Film (1934)

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Even the effects already discovered are due to chance and experiment, rather than to the sciences; for our present sciences are nothing more than peculiar arrangements of matters already discovered, and not methods for discovery or plans for new operations.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 8 (p. 107)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Men are further beholding...generally to chance, or anything else, than to logic, for the invention or arts and sciences.

In *Great Books of the Western World* (Volume 30)  
*The Advancement of Learning*  
Second Book, Chapter XIII, Section 2 (p. 57)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Games of chance are probably as old as the human desire to get something for nothing; but their mathematical implications were appreciated only after Fermat and Pascal in 1654 reduced chance to law.

*The Development of Mathematics* (p. 154)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Blake, William** 1757–1827

English poet, painter, and engraver

Every night and every morn  
Some to misery are born;

Every morn and every night  
Some are born to sweet delight.

*The Complete Poetry and Prose of William Blake*  
Auguries of Innocence, l. 119–121  
University of California Press. Berkeley, California, USA. 1982

**Boethius** ca. 475–524  
Roman philosopher and statesman

Then said she, “Think you that this universe is guided  
only at random and by mere chance? or think you there is  
any rule of reason constituted in it?”

*The Consolation of Philosophy* (Trans. W.V. Cooper, 1902)  
Book I (p. 22)  
J.M. Dent & Sons Ltd. London, England. 1902

**Borel, Félix Edouard Justin Emile** 1871–1956  
French mathematician

Can there be laws of chance? The answer, it would  
seem, should be negative, since chance is in fact defined  
as the characteristic of the phenomena which follow no  
law, phenomena whose causes are too complex to per-  
mit prediction.

Translated by Maurice Baudin  
*Probabilities and Life*  
Introduction (p. 1)  
Dover Publications. New York, New York, USA. 1962

**Born, Max** 1882–1970  
German-born English physicist

...the conception of chance enters into the very first steps  
of scientific activity in virtue of the fact that no obser-  
vation is absolutely correct. I think chance is a more  
fundamental conception than causality; for whether in a  
concrete case, a cause — effect relationship holds or not  
can only be judged by applying the laws of chance to the  
observation.

*Natural Philosophy of Cause and Chance*  
Chapter VI (p. 47)  
At The Clarendon Press. Oxford, England. 1949

**Bridgman, Percy Williams** 1882–1961  
American physicist

Chance has no meaning except in the setting of order.  
*The Nature of Physical Theory*  
Chapter IX (p. 123)  
Princeton University Press. Princeton, New Jersey, USA. 1936

**Buchner, Ludwig** 1824–99  
German physician and philosopher

What we still designate as chance, merely depends on a  
concatenation of circumstances, the internal connection  
and the final causes of which we have as yet been unable  
to unravel.

*Force and Matter*  
The Fitness of Things in Nature (p. 179)  
Truth Seeker. New York, New York, USA. 1930

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

We see but a part, and being thus unable to generalize  
human conduct, except very roughly, we deny that it is  
subject to any fixed laws at all, and ascribe much both  
of a man’s character and actions to chance, or luck, or  
fortune...

*Erewhon and Erewhon Revisited*  
Chapter XXV (p. 246)  
The Modern Library. New York, New York, USA. 1955  
Quoth She: I’ve heard old cunning Stagers  
Say, Fools for Arguments use wagers.”  
*The Poetical Works of Samuel Butler* (Volume 1)  
The Second Part, Canto I, l. 298–299  
Bell & Daldy. London, England. 1835

It must always be remembered that man’s body is what it  
is through having been molded into its present shape by  
the chances and changes of an immense time...

*Erewhon; and Erewhon Revisited*  
Chapter XXIV (p. 242)  
The Modern Library. New York, New York, USA. 1955

**Chamfort, Sebastien Roch** 1741–94  
French writer

*Quelqu’un disait que la providence strat le nom  
de bapteme du hasard....* Chance is a nickname of  
Providence.

*Maximes et Pensées*  
I, b. 62  
Le Livre de Poche. Paris, France. 1970

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English writer

“Proof!” he cried. Good God! the man is looking for  
proof! Why, of course, the chances are twenty to one that  
it has nothing to do with them. But what else can we do?  
Don’t you see we must either follow one wild possibility  
or else go home to bed.

*Favorite Father Brown Stories*  
The Blue Cross (p. 8)  
Dover Publications. New York, New York, USA. 1993

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

...but things that happen by chance cannot be certain.  
Translated by William Armistead Falconer  
*Cicero: De Senectute, De Amicitia, De Divinatione*  
De Divinatione, II, IX (p. 397)  
Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Claude, Albert** 1898–1983  
Belgian-American cytologist

Of course, we know the laws of trial and error, of large  
numbers and probabilities. We know that these laws  
are part of the mathematical and mechanical fabric of

the universe, and that they are also at play in biological processes. But, in the name of the experimental method and out of our poor knowledge, are we really entitled to claim that everything happens by chance, to the exclusion of all other possibilities?

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company. Singapore. 1992

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

As in the game of billiards, the balls are constantly producing effects from mere chance, which the most skillful player could neither execute nor foresee, but which, when they do happen, serve mainly to teach him how much he has still to learn...

*Lacon; or, Many Things in a Few Words* (p. 345)

William Gowans. New York, New York, USA. 1849

**Comfort, Alex** 1920–2000

English gerontologist and author

One has to be extraordinarily lucky, in our society, to meet one nymphomaniac in a lifetime.

*Darwin and the Naked Lady: Discursive Essays on Biology and Art*

The Rape of Andromeda (p. 87)

G. Braziller. New York, New York, USA. 1961

**Conrad, Joseph** 1857–1924

Polish-born English novelist

And if you ask me how, wherefore, for what reason? I will answer you: Why, by chance! By the merest chance, as things do happen, lucky and unlucky, terrible or tender, important or unimportant; and even things which are neither, things so completely neutral in character that you would wonder why they do happen at all if you didn't know that they, too, carry in their insignificance the seeds of further incalculable chances.

*Chance: A Tale in Two Parts*

Chapter IV (pp. 99–100)

Doubleday, Page & Company. New York, New York, USA. 1924

.... Chance, whose ally is Time that cannot be hurried, and whose enemy is Death, that will not wait.

*Lord Jim*

Chapter XXXIV (p. 278)

Rinehart & Company, Inc. New York, New York, USA. 1957

**Cowper, William** 1731–1800

English poet

A fool must now and then be right, by chance.

*The Poetical Works of William Cowper*

Conversation, I. 96

John W. Lovell Company. New York, New York, USA. No date

**Crick, Francis Harry Compton** 1916–2004

English biochemist

When times get tough, true novelty is needed — novelty whose important features cannot be preplanned — and for this we must rely on chance. Chance is the only source of true novelty.

*Life Itself: Its Origin and Nature*

Chapter 4 (p. 58)

Simon & Schuster. New York, New York, USA. 1981

**da Costa, J. Chalmers** 1863–1933

American physician

Even in the tangled threads of what we call “Chance,” there is order, and there was law in the tangling. We don't happen to see the order and know the law, but both are there.

*The Trials and Triumphs of the Surgeon*

Stepping Stones and Stumbling Blocks (p. 235)

Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

**Dante, Alighieri** 1265–1321

Italian poet and writer

When the game of hazard is broken up, he who loses remains sorrowful...

In *Great Books of the Western World* (Volume 21)

*The Divine Comedy of Dante Alighieri*

Purgatory, Canto VI, l. 1–2

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Darwin, Charles Robert** 1809–82

English naturalist

When we look at the plants and bushes clothing an entangled bank, we are tempted to attribute their proportional numbers and kinds to what we call chance. But how false a view this is!

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter III (p. 37)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I cannot think that the world as we see it is the result of chance; and yet I cannot look at each separate thing as the result of Design. ... I am, and shall ever remain, in a hopeless muddle.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Darwin to Gray, 26 November, 1860 (p. 146)

D. Appleton & Company. New York, New York, USA. 1896

I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

C. Darwin to Asa Gray, May 22<sup>nd</sup> [1860] (p. 105)

D. Appleton & Company. New York, New York, USA. 1896

**de Moivre, Abraham** 1667–1754

French-born mathematician

And thus in all cases it will be found, that although Chance produces irregularities, still the Odds will be

infinitely great, that in process of Time, those Irregularities will bear no proportion to the recurrency of that Order which naturally results from Original Design.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play (Third Edition)*

A Method of Approximating the Sum of the Terms of the Binomial... (p. 251)

Printed for Millar. London, England. 1756

...some of the Problems about Chance having a great appearance of Simplicity, the Mind is easily drawn into a belief, that their Solution may be attained by the meer Strength of natural good Sense; Which generally providing otherwise and the Mistakes occasioned thereby being not unfrequent. 'Tis presumed that a Book of this Kind, which teaches to distinguish Truth from what seems nearly to resemble it, will be looked upon as a help to good reasoning.

*The Doctrine of Chances*

Preface (p. iii)

Printed for W. Pearson. London, England. 1718

...there are Writers, of a Class indeed very different from that of James Bernoulli, who insinuate as if the Doctrine of Probabilities could have no place in any serious Enquiry; and that studies of this kind, trivial and easy as they be, rather disqualify a man for reasoning on every other subject. Let the Reader chuse.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play (Third Edition)*

A Method of Approximating the Sum of the Terms of the Binomial... (p. 254)

Printed for Millar. London, England. 1756

**Democritus of Abdera** 460 BCE–370 BCE

Greek philosopher

Nothing can come into being from that which is not, or pass away into what is not.

In Diogenes Laterius

*Lives of Eminent Philosophers*

Chapter IX

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Chance has put in our way a most singular and whimsical problem, and its solution is its own reward.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes (Volume 2)*

The Adventure of the Blue Carbuncle (p. 467)

Wings Books. New York, New York, USA. 1967

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Be juster, Heaven: such virtue punished thus,  
Will make us think that Chance rules all above,  
And shuffles, with a random hand, the Lots  
Which Man is forc'd to draw.

*The Poetical Works of Dryden*

All For Love

Act V

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

The laws of chance have rendered, and will continue to render, immense services to science. It is inconceivable that we could do without them, but they only express an admirable, subjective interpretation of certain inorganic phenomena and of their evolution. They are not a true explanation of objective reality.

*Human Destiny*

Chapter 3 (p. 37)

Longmans, Green & Company. London, England. 1947

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

There was once a brainy baboon,

Who always breathed down a bassoon,

For he said "It appears

That in billions of years,

I shall certainly hit on a tune."

*New Pathways in Science*

Chapter III, Section IV (p. 62)

The Macmillan Company. New York, New York, USA. 1935

We have swept away the anti-chance from the field of our current physical problems, but we have not got rid of it. When some of us are so misguided as to try to get back milliards of years into the past we find the sweepings piled up high like a high wall, forming a boundary — a beginning of time — which we cannot climb over.

*New Pathways in Science*

Chapter III, Section III (p. 60)

The Macmillan Company. New York, New York, USA. 1935

**Einstein, Albert** 1879–1955

German-born physicist

In our scientific expectation we have grown antipodes. You believe in God playing and I in perfect laws in the world of things existing as real objects, which I try to grasp in a wildly speculative way.

Letter to Max Born, 7 November 1944

**Eldridge, Paul** 1888–1982

American educator

Value depends upon price and price upon chance and caprice.

*Maxims for a Modern Man*

1855

T. Yoseloff. New York, New York, USA. 1965

**Euripides** ca. 480 BCE–406 BCE

Greek playwright

Great Jove!

What shall I say? that thou from Heaven look'st down  
Upon mankind, or have they rashly formed



A vain opinion, deeming that the race  
Of gods exists, though fortune governs all?

In *Great Books of the Western World* (Volume 5)

*The Plays of Euripides*

Hecuba, l. 486

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Fermi, Enrico** 1901–54

Italian-born American physicist

A general is a man who takes chances. Mostly he takes  
a fifty-fifty chance; if he happens to win three times in  
succession he is considered a great general.

In Leo Szilard

*Leo Szilard: His Version of the Facts*

Chapter V (p. 147)

The MIT Press. Cambridge, Massachusetts, USA. 1978

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The effects of chance are the most accurately calculable,  
and therefore the least doubtful of all the factors of an  
evolutionary situation.

Croonian Lecture: Population Genetics

*Proceedings of the Royal Society of London*, Volume 141, 1955 (p. 515)

**Galsworthy, John** 1867–1933

English novelist and dramatist

It's all chance, but we can't stop now.

*End of the Chapter*

Maid in Waiting, Chapter 28 (p. 229)

Charles Scribner's Sons. New York, New York, USA. 1937

**Guest, Judith** 1936

American writer

He had left off being a perfectionist then, when he dis-  
covered that not promptly kept appointments; not a house  
circumspectly clean, not even membership in Onwentsa,  
or the Lake Forest Golf and Country Club, or the Law-  
yer's Club, not power — not anything — cleared you  
through the terrifying office of chance; that it is chance  
and not perfection that rules the world.

*Ordinary People*

Chapter 11 (p. 90)

The Viking Press. New York, New York, USA. 1976

**Helvetius, Claude Adrien** 1715–1771

French philosopher

If chance be generally acknowledged to be the author of  
most discoveries in almost all the arts, and if in specula-  
tive sciences its power be less sensibly perceived, it is not  
perhaps less real...

*On Mind*

Essay III, Chapter IV (p. 331)

Printed for the translator. London, England. 1751

...chance, that is, an infinite number of events, with  
respect to which our ignorance will not permit us to

perceive their causes, and the chain that connects them  
together. Now, this chance has a greater share in our  
education than is imagined. It is this that places certain  
objects before us and, in consequence of this, occasions  
more happy ideas, and sometimes leads us to the great-  
est discoveries...

*On Mind*

Essay III, Chapter I

Printed for the translator. London, England. 1751

**Herodotus** 484 BCE–432 BCE

Greek historian

...it is well to bear in mind that chances rule men, and  
not men chances.

In *Great Books of the Western World* (Volume 6)

*The History of Herodotus*

The Seventh Book, Section 49 (p. 225)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Heyward, DuBose**

Roll dem bones...

*Carolina Chansons: Legends of the Low Country*

Gamesters All

Macmillan & Company Ltd. London, England. 1922

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Chance, if such a thing exists, is far-seeing.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter VI (p. 434)

The Heritage Press. New York, New York, USA. 1961

**Hume, David** 1711–76

Scottish philosopher and historian

Though there be no such thing as Chance in the world,  
our ignorance of the real cause of any event has the same  
influence on the understanding, and begets a like species  
of belief or opinion.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section VI (p. 469)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Jevons, William Stanley** 1835–82

English economist and logician

Happily the Universe in which we dwell is not the result  
of chance, and where chance seems to work it is our own  
deficient faculties which prevent us from recognizing the  
operating of Law and of Design.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter I (p. 2)

Macmillan & Company Ltd. London, England. 1887

**John of Salisbury** ca. 1115–80

English author and diplomatist

Chance blows together the atoms into an immense heap

so that this very globe of the world comes into being,  
and so that the elements are fixed in their places under  
an eternal law.

In John van Laarhoven (ed.)

*Entheticus Maior and Minor* (Volume One)

Part II, Section I, Notes from Epicurus, l. 567–569

E.J. Brill. Leiden, Netherlands. 1987

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Nothing was ever said with uncommon felicity, but by  
the cooperation of chance; and therefore, wit, as well as  
valor must be content to share its honors with fortune.

*The Yale Edition of The Works of Samuel Johnson*

The Idler and the Adventurer, Idler Number 58

Yale University Press. New Haven, Connecticut, USA. 1978

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

...chance has not reality in itself; it is only a term fit to  
designate our ignorance concerning the manner in which  
the different parts of a phenomenon are arranged among  
themselves and in relation to the rest of Nature.

In K.M. Baker

*Condorcet: From Natural Philosophy to Social Mathematics*

Chapter 3 (p. 168)

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Longfellow, Henry Wadsworth** 1807–82

American poet

I shot an arrow into the air,  
It fell to earth I know not where,  
For so swift it flew, the sight  
Could not follow it in its flight.

*The Poetical Works of Henry Wadsworth Longfellow*

The Arrow and the Song

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Masters, Dexter** 1908–89

American writer

But then I was reading in the paper just the other day  
about one of them saying there wasn't more than one  
chance in God-knows-what, a trillion maybe, that  
these Bikini bombs could blow up the world. I said to  
myself, this seems pretty safe odds. But then I said to  
myself, hey! how come any odds at all? Who's running  
this show anyway? I sort of get to wondering every  
once in a while whether anybody knows the middle and  
the end of what's going on as well as the beginning.

*The Accident*

Part VII, Chapter 7 (p. 382)

Alfred A. Knopf. New York, New York, USA. 1955

"I should estimate," this scientist was supposed to have  
said, "that there is one chance in ten nothing will happen  
with the bomb, and one chance in a hundred that it will  
ignite the atmosphere."

*The Accident*

Part I, Chapter 3 (p. 16)

Alfred A. Knopf. New York, New York, USA. 1955

**Merz, John Theodore** 1840–1922

German-born British industrial chemist and philosopher

The study of blind chance in theory and practice is one of  
the great performances of the nineteenth century.

*A History of European Thought in the Nineteenth Century* (Volume 2)  
(p. 624)

William Blackwood & Sons. Edinburgh, Scotland. 1903

**Milton, John** 1608–74

English poet

...that power which erring men call Chance.

*The Poetical Works of John Milton* (Volume 2)

Comus, l. 587

AMS Press. New York, New York, USA. 1973

.... Chance governs all.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book II, l. 910

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Monod, Jacques** 1910–76

French biochemist

...chance alone is at the source of every innovation, of  
all creation in the biosphere. Pure chance, absolutely free  
but blind, at the very root of the stupendous edifice of  
evolution: this central concept of modern biology is no  
longer one among other possible or even conceivable  
hypotheses. It is today the sole conceivable hypotheses,  
the only one that squares with observed and tested....  
There is no scientific concept, in any of the sciences,  
more destructive of anthropocentrism than this one,  
and no other so arouses an instinctive protest from the  
intensely teleonomic creatures that we are.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern  
Biology*

Chapter VI (pp. 112–113)

Vintage Books. New York, New York, USA. 1972

**Motz, Lloyd** 1910–2004

American astronomer

Thus, the very chance and randomness that prevent man  
from predicting the future are the tools that nature uses to  
insure not only the emergence of life in each expansion  
cycle of the universe but also the approach to perfection  
and complete harmony as more and complex forms of  
life evolve.

*The Universe: Its Beginning and End*

Epilogue (p. 325)

Charles Scribner's Sons. New York, New York, USA. 1975

**Nietzsche, Friedrich** 1844–1900

German philosopher

No conqueror believes in chance.

*The Complete Works of Friedrich Nietzsche*  
The Joys of Wisdom, III, Number 258

**Paley, William** 1743–1805

English theologian

There must be chance in the midst of design; by which we mean, that events which are not designed, necessarily arise from the pursuit of events which are designed. One man traveling to York, meets another man traveling to London.

*The Works of William Paley, D.D.*

Natural Theology

Chapter XXVI (p. 254)

Ward, Lock & Company. London, England. No date

The appearance of chance will always bear a proportion to the ignorance of the observer.

*The Works of William Paley, D.D.*

Natural Theology

Chapter XXVI (p. 254)

Ward, Lock & Company. London, England. No date

**Pasteur, Louis** 1822–95

French chemist

In the field of experimentation, chance favors only the prepared mind.

In René Dubos

*Louis Pasteur: Free Lance of Science*

Chapter IV (p. 101)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Peers, John**

No biographical data available

Nick the Greek's Law of Life. All things considered, life is 9 to 5 against.

*1001 Logical Laws, Accurate Axioms, Profound Principles, Trusty Truisms, Homey Homilies, Colorful Corollaries, Quotable Quotes, and Rambunctious Ruminations for All Walks of Life* (p. 50)

Doubleday & Company, Inc. Garden City, New York, USA. 1979

**Plato** 428 BCE–347 BCE

Greek philosopher

The lover of intellect and knowledge ought to explore causes of intelligent nature first of all, and, secondly, of those things which, being moved by others, are compelled to move others. And this is what we too must do. Both kinds of causes should be acknowledged by us, but a distinction should be made between those which are endowed with mind and are the workers of things fair and good, and those which are deprived of intelligence and always produce chance effects without order or design.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 46 (p. 455)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

CRITO: But you see, Socrates, that the opinion of the many must be regarded, for what is now happening shows that they can do the greatest evil to any one who has lost their good opinion.

SOC: I only wish it were so, Crito; and that the many could do the greatest evil; for then they would be able to do the greatest good — and what a fine thing this would be! But in reality they can do neither, for they cannot make a man either wise or foolish; and whatever they do is the result of chance.

*Crito*

Section 44 (p. 214)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

ATHENIAN STRANGER: They say that the greatest and fairest things are the work of nature and of chance, the lesser of art, which, receiving from nature the greater and primeval creations, molds and fashions all those lesser works which are generally termed artificial.

In *Great Books of the Western World* (Volume 7)

*Laws*

Book X, 889 (p. 760)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...in human affairs chance is almost everything.

In *Great Books of the Western World* (Volume 7)

*Laws*

Book IV, 709 (p. 679)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pohl, Frederik** 1919–

American science fiction writer

But from outside there is no knowing which is true. From outside, there is a five-tenths chance that the cat's alive. But a cat can't be five-tenths alive.

*The Coming of the Quantum Cats*

22 August 1983, 4:20 A.M., Senator Dominic DeSota (p. 69)

Bantam Books. Toronto, Ontario, Canada. 1986

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The greatest bit of chance is the birth of a great man. It is only by chance that the meeting of two germinal cells, of different sex, containing precisely, each on its side, the mysterious elements whose mutual reaction must produce the genius. One will agree that these elements must be rare and that their meeting is still more rare. How slight a thing it would have required to deflect from its route the carrying spermatozoon. It would have suffered to deflect it a tenth of a millimeter and Napoleon would not have been born and the destinies of a continent would have been changed. No example can better make us understand the veritable characteristics of chance.

*The Foundations of Science*

Science and Method, Book I

Chapter IV, Section IX (pp. 410–411)

The Science Press. New York, New York, USA. 1913

Every phenomenon, however minute, has a cause; and a mind infinitely powerful, infinitely well-informed about the laws of nature, could have foreseen it from the beginning of the centuries. If such a mind existed, we could not play with it at any game of chance; we should always lose.

*The Foundations of Science*

Science and Method, Book I

Chapter IV, Section I (p. 395)

The Science Press. New York, New York, USA. 1913

And first, what is chance? The ancients distinguished between phenomena seemingly obeying harmonious laws, established one and for all, and those which they attributed to chance; these were the ones unpredictable because rebellious to all law. In each domain the precise laws did not decide everything, they only drew limits between which chance might act. In this conception the word chance had a precise and objective meaning: what was chance for one was also chance for another and even for the gods.

*The Foundations of Science*

Science and Method, Book I

Chapter IV, Section I (p. 395)

The Science Press. New York, New York, USA. 1913

Chance is only the measure of our ignorance.

*The Foundations of Science*

Science and Method, Book I

Chapter IV, Section I (p. 395)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

All chance, direction, which thou canst not see;  
All discord, harmony, not understood,  
All partial evil, universal good:  
And, spite of Pride, in erring Reason's spite,  
One truth is clear, "Whatever is, is Right."

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle

I, 289

Houghton Mifflin Company. New York, New York, USA. 1903

**Priestley, Joseph** 1733–1804

English theologian and scientist

...more is owing to what we call chance...than to any proper design or preconceived theory in this business.

*Experiments and Observations on Different Kinds of Air* (Volume 2)

Book IV, Part I, Section I (p. 102–103)

Thomas Pearson. Birmingham, England. 1790

**Reichenbach, Hans** 1891–1953

German philosopher of science

Like pebbles on the beach, biological species are ordered through a selective cause; chance in combination with selection produces order.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 199)

University of California Press. Berkeley, California, USA. 1951

**Rhinehart, Luke (George Cockcroft)** 1932–

American writer

In the beginning was Chance, and Chance was with God and Chance was God. He was in the beginning with God. All things were made by Chance and without him was not anything made that was made. In Chance was life and the life was the light of men.

*The Dice Man*

Chapter Ninety-Three (p. 410)

The Overlook Press. Woodstock, New York, USA. 2001

**Rohault, Jacques** 1618–72

French philosopher and physicist

Thus we must content our selves for the most part, to find out how Things may be; without pretending to come to a certain knowledge and determination of what they really are.

*Rohault's System of Natural Philosophy*

Volume I, Part I, Chapter 3

Johnson Reprint Corporation. New York, New York, USA. 1969

**Runyon, Damon** 1884–1946

American newspaperman and writer

I long ago came to the conclusion that all life is 6 to 5 against.

A Nice Place

*Collier's*, 8 September 1934 (p. 8)

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

There's no such thing as chance;  
And what to us seems merest accident  
Springs from the deepest source of destiny.

*The Death of Wallenstein*

Act II, Scene III

F.A. Nichols. Boston, Massachusetts, USA. 1902

**Schopenhauer, Arthur** 1788–1860

German philosopher

Consider that chance, which, with error, its brother, and folly, its aunt, and malice, its grandmother, rules in this world; which every year and every day, by blows great and small, embitters the life of every son of earth, and yours too.

*Parerga and Paralipomena: Short Philosophical Essays*

Wisdom of Life: Aphorisms

Clarendon Press. Oxford, England. 2000

**Scott, Sir Walter** 1771–1832

Scottish novelist and poet

Chance will not do the work — Chance sends the breeze;  
But if the pilot slumbers at the helm,  
The very wind that wafts us toward the port

May dash us on the Shelves — The steersman's part is vigilance,

Blow it or rough or smooth.

*Fortunes of Nigel*

Chapter XXII (p. 320)

Oxford University Press. London, England. 1912

**Selye, Hans** 1907–82

Austrian endocrinologist

Chance is a lady who smiles only upon those who know how to appreciate her artful charms; those connoisseurs she rarely neglects — the secret of the game is art appreciation.

*From Dream to Discovery: On Being a Scientist*

Chapter 3 (p. 92)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...I spake of most disastrous chances...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Othello, The Moor of Venice

Act I, Scene iii, l. 134

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

You must take your chance,

And either not attempt to choose at all

Or swear before you choose, if you choose wrong...

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Merchant of Venice

Act II, Scene i, l. 38

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In terms of choice I am not solely led

By nice direction of a maiden's eyes;

Besides, the lottery of my destiny

Bars me the right of voluntary choosing.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Merchant of Venice

Act II, Scene i, l. 13

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Give up yourself merely to chance and hazard,

From firm security.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Anthony and Cleopatra

Act III, Scene vi, l. 48

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

If chance will have me King, why, chance may crown me...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Macbeth

Act I, Scene iii, l. 143

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shelley, Percy Bysshe** 1792–1822

English poet

Of Fate, and Chance, and God, and Chaos old...

*The Poems of Percy Bysshe Shelley*

Prometheus Unbound, Act II, Scene III, l. 92

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Fate, Time, Occasion, Chance and Change — to these all things are subject.

*The Complete Poetical Works of Percy Bysshe Shelley*

Prometheus Unbound, Act II, Scene IV, l. 119

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Tennyson, Alfred (Lord)** 1809–92

English poet

And grasps the skirt of happy chance...

*Alfred Tennyson's Poetical Works*

In Memoriam A.H.H., Part 1, xiv

Oxford University Press, Inc. London, England. 1953

**Terence** 190 BCE–158 BCE

Roman comic dramatist

Blessed be the gods, by whose aid things happen that we wouldn't even dare hope for!

In George E. Duckworth

*The Complete Roman Drama*

Phormio

Act V, Scene 4, l. 757

Random House, Inc. New York, New York, USA. 1942

## The Bible

Let us cast lots to find out who is to blame for our misfortune.

*The Revised English Bible*

Jonah 1:7

Oxford University Press, Inc. Oxford, England. 1989

**Thierry, Paul Henri, Baron d'Holbach** 1723–89

German-born French philosopher

...chance; a word void of sense, which we always oppose to that of intelligence without attaching to it any certain ideas.

Translated by M. Mirabaud

*System of Nature; or The Laws of the Moral and Physical World* (Volume First)

Part First, Chapter II (p. 71)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

How many things are now at loose ends! Who knows which way the wind will blow tomorrow.

*The Writings of Henry David Thoreau* (Volume 4)

Paradise (to Be) Regained (p. 283)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Thucydides** ca. 460 BCE–ca. 400 BCE

Athenian aristocrat

For sometimes the course of things is as arbitrary as the plans of man; indeed this is why we usually blame chance

for whatever does not happen as we expected.

In *Great Books of the Western World* (Volume 6)  
*The History of the Peloponnesian War*  
 Book I, 140 (p. 384)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tolstoy, Leo** 1828–1910

Russian writer

Why did it happen in this and not in some other way?  
 Because it happened so!

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
 First Epilogue, Chapter II (p. 646)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CHANGE

**Alexander, Christopher** 1936–

Austria-born English architect

Even the most aimless changes will eventually lead to well-fitting forms, because of the tendency to equilibrium inherent in the organization of the process. All the agent need do is recognize failures when they occur, and to react to them. And this even the simplest man can do. For although only few men have sufficient integrative ability to invent form of any clarity, we are all able to criticize existing forms. It is especially important to understand that the agent in such a process needs no creative strength. He does not need to be able to improve the form, only to make some sort of change when he notices a failure. The changes may not always be for the better; but it is not necessary that they should be, since the operation of the process allows only the improvements to persist.

*Notes on the Synthesis of Form*  
 Chapter 4 (pp. 52–53)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1964

**Allen, Robert Porter** 1905–63

American author and conservationist

A million years have done little to change the aspect of a hidden pool inside the mangrove. If you don't believe it, crawl with crocodiles and terrapin through the slime and watch the lowly gastropod leave his smooth track beside yours. A million years have not changed them. Best of all, stay out there at night. You will listen to the silence of centuries and you will hear, as I have, the noiseless murmur of the Pleistocene.

*On the Trail of Vanishing Birds*  
 Chapter II (p. 19)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1957

**Aristotle** 384 BCE–322 BCE

Greek philosopher

But the whole vital process of the earth takes place so gradually and in periods of time which are so immense

compared with the length of our life, that these changes are not observed, and before their course can be recorded from beginning to end whole nations perish and are destroyed.

In *Great Books of the Western World* (Volume 8)  
*Meteorology*  
 Book I, Chapter 14 (p. 457)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Beattie, James** 1735–1803

Scottish poet and essayist

Of chance or change O let not man complain,  
 Else shall he never, never cease to wail:  
 For, from the imperial dome, to where the swain  
 Rears the lone cottage in the silent dale, All feel the  
 assault of fortune's fickle gale;  
 Art, empire, earth itself to change are doom'd;  
 Earthquakes have raised to heaven the humble vale,  
 And gulphs the mountain's mighty mass entomb'd,  
 And where the Atlantic rolls wide continents have  
 bloom'd.

*The Minstrel; or, the Progress of Genius* — Book II  
 G. Routledge. London, England. 1858

**Burns, Robert** 1759–96

Scottish poet

Look abroad through Nature's range  
 Nature's mighty law is change.

*The Complete Poetical Works of Robert Burns*  
 Inconstancy in Love  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**Cuvier, Georges** 1769–1832

French zoologist and statesman

We now propose to examine those changes which still take place on our globe, investigating the causes which continue to operate on its surface.... This portion of the history of the earth is so much the more important, as it has been long considered possible to explain the more ancient revolutions on its surface by means of these still existing causes.... But we shall presently see that unfortunately this is not the case in physical history; the thread of operations is here broken, the march of nature is changed, and none of the agents that she now employs were sufficient for the production of her ancient works.

*An Essay on the Theory of the Earth*  
 Section 8 (p. 44)  
 Kirk & Mercein. New York, New York, USA. 1818

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

There are no fixtures in nature. The universe is fluid and volatile. Permanence is but a word of degrees. Our globe seen by God is a transparent law, not a mass of facts. The law dissolves the fact and holds it fluid.

*Ralph Waldo Emerson: Essays and Lectures*  
 Essays: First Series

Circles (p. 403)  
The Library of America. New York, New York, USA. 1983

### Grainger, Elena

No biographical data available

Our earth is vigorous with life, and like all living things must change. Change will continue constructively if we allow it to continue, and perhaps therein lies the future role of geologists. They seek to understand scenery of the earth, the life upon it, the resources under its soil and waters, in its rocks, came into being. It is they who can direct the way from destruction to preservation and restoration, restraining humankind from impending or even destroying the immemorial process of change and evolution.

*The Remarkable Reverend Clarke: The Life and Times of the Father of Australian Geology*  
Chapter 23 (p. 254)  
Oxford University Press, Inc. Melbourne, Australia. 1982

### Hussey, Russell C.

No biographical data available

Nothing is static forever in nature; change is going on everywhere.

*Historical Geology: The Geologic History of North America*  
Chapter XXI (p. 445)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1947

### Hutton, James 1726–97

Scottish geologist, chemist, and naturalist

...from the top of the mountain to the shore of the sea, which are the two extremities of our land, every thing is in a state of change; the rock and solid strata dissolving, breaking, and decomposing, for the purpose of becoming soil; the soil traveling along the surface of the earth, in its way to the shore; and the shore wearing and wasting by the agitation of the sea...

*The Theory of the Earth* (Volume 2)  
Part II, Chapter VII (p. 236)  
Messrs. Cadwell, Junior & Davies. London, England. 1795

### Mitchell, Maria 1818–89

American astronomer and educator

We may turn our gaze [to other stars] as we turn a kaleidoscope, and the changes are infinitely more startling, the combinations infinitely more beautiful; no flower garden presents such a variety and such delicacy of shades.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter XI (p. 235)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

### Ovid 43 BCE–17 AD

Roman poet

Nothing retains its own form; but Nature, the great renewer, ever makes up forms from other forms. Be sure,

there's nothing perishes in the whole universe; it does but vary and renew its form.

Translated by Frank Justus Miller  
*Metamorphoses* (Volume 2)  
Chapter XV, l. 252 (p. 383)  
William Heinemann. London, England. 1916

All things are in a state of flux, and everything is brought into being with a changing nature. Time itself flows on in constant motion, just like a river. For neither the river nor the swift hour can stop its course; but, as wave is pushed on by wave, and as each wave as it comes is both pressed on and itself presses the wave in front, so time both flees and follows and is ever new.

Translated by Frank Justus Miller  
*Metamorphoses* (Volume 2)  
Book XV, l. 178–182 (p. 377)  
William Heinemann. London, England. 1916

### Rohault, Jacques 1618–72

French philosopher and physicist

Daily Experience, and a Thousand Observations made by the Industry of Men in past Ages, and which we our selves have confirmed, do sufficiently convince us, that there is no part of the Earth, be it never so great or small, but that in Time it undergoes some Alteration...

*Rouhault's System of Natural Philosophy* (Volume 2)  
Part III, Chapter I  
Johnson Reprint Corporation. New York, New York, USA. 1969

### Sagan, Carl 1934–96

American astronomer and science writer

Our epoch is unpredictable because it is simultaneously complex and changing rapidly. This seems also to be the reason for the madness of our times. There is in no moment in the history of mankind when so many changes in so many different areas — social, political, economic, scientific, technological, sexual, and educational — have occurred. They are happening too fast for too many people. Madness is one way of coping.

*Other Worlds* (p. 139)  
BantamBooks. New York, New York, USA. 1975

### Sexton, Anne 1928–74

American poet and writer

Rocks crumble, make new forms,  
oceans move the continents,  
mountains rise up and down like ghosts  
yet all is natural, all is change.

*The Complete Poems*  
The Wall  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1981

### Tennyson, Alfred (Lord) 1809–92

English poet

O earth, what changes hast thou seen!

*Alfred Tennyson's Poetical Works*  
In Memoriam A.H.H., Part CXXIII, Stanza 1

Oxford University Press, Inc. London, England. 1953

Forward, Forward let us range,  
Let the great world spin for ever down the ringing  
groves of change.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 91

Oxford University Press, Inc. London, England. 1953

### **Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

Change is the handmaiden Nature requires to do her  
miracles with.

*Roughing It* (Volume 2)

Chapter XV (p. 150)

Harper & Brothers Publishers. New York, New York, USA. 1899

## **CHAOS**

### **Adams, Henry Brooks** 1838–1918

American man of letters

Briefly, chaos is all that science can logically assert of the  
supersensuous.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XXXI (p. 451)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

Chaos often breeds life, when order breeds habit.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XVI (p. 249)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

.... Chaos was the law of nature; Order was the dream  
of man.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XXXI (p. 451)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

### **Blackie, John Stuart** 1809–95

Scottish scholar

Chaos, Chaos, infinite wonder!

Wheeling and reeling on wavering wings....

*Musa Burschicosa: A Book of Songs for Students and University Men*

A Song of Geology, Second stanza

Edmonston & Douglas. Edinburgh, Scotland. 1869

### **Bradley, Jr., John Hodgdon** 1898–1962

American geologist

From the smallest satellite slave of the smallest star to  
the largest super-galaxy of worlds in space, everything  
bows to the first law of nature. Chaos and caprice do  
not exist.

*Parade of the Living*

Part I, Chapter I (p. 3)

Coward-McCann, Inc. New York, New York, USA. 1930

### **Devaney, Robert L.**

No biographical data available

It has been said that the three great developments in  
twentieth century science are relativity, quantum me-  
chanics, and chaos. That strikes me the same as saying  
that the three great developments in twentieth century  
engineering are the airplane, the computer, and the pop-  
top aluminum can. Chaos and fractals are not even twen-  
tieth century ideas: chaos was first observed by Poincaré  
and fractals were familiar to Cantor a century ago, al-  
though neither man had the computer at his disposal to  
show the rest of the world the beauty he was seeing.

Introduction: Special Issue on Dynamical Systems

*College Mathematics Journal*, Volume 22, Number 1, January 1991 (p. 2)

### **Dylan, Bob** 1941–

American pop-folk singer, composer, and musician

Chaos is a friend of mine.

The Two Lives of Bob Dylan

*Newsweek*, 9 December 1985 (p. 93)

### **Figenbaum, Mitchell** 1944–

American mathematical physicist

What will prove altogether remarkable is that some very  
simple schemes to produce erratic numbers behave identi-  
cally to some of the erratic aspects of natural phenomena.

Universal Behavior in Nonlinear Systems

*Los Alamos Science*, Summer, 1980 (p. 4)

### **Ford, Joseph**

No biographical data available

Unfortunately, non-chaotic systems are very nearly as  
scarce as hen's teeth, despite the fact that our physi-  
cal understanding of nature is largely based upon their  
study.

How Random Is a Coin Toss?

*Physics Today*, Volume 36, Number 4, April 1983 (p. 40)

### **Frost, Robert** 1874–1963

American poet

Let chaos storm!

Let cloud shapes swarm!

I wait for form.

*Complete Poems of Robert Frost*

Pertinax

Henry Holt & Company. New York, New York, USA. 1949

### **George, William H.**

No biographical data available

One man's explanation may be another man's chaos.

*The Scientist in Action: A Scientific Study of His Methods*

Personal Basis (p. 331)

William & Norgate. London, England. 1936

### **Gleick, James** 1954–

American author, journalist, and essayist



Where chaos begins, classical science stops. For as long as the world has had physicists inquiring into the laws of nature, it has suffered a special ignorance about disorder in the atmosphere, in the fluctuations of the wildlife populations, in the oscillations of the heart and the brain. The irregular side of nature, the discontinuous and erratic side these have been puzzles to science, or worse, monstrosities.

*Chaos: Making a New Science*

Prologue (p. 3)

The Viking Press. New York, New York, USA. 1987

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

History includes too much chaos, or extremely sensitive dependence on minute and unmeasurable differences in initial conditions, leading to massively divergent outcomes based on tiny and unknowable disparities in starting points. And history includes too much contingency, or shaping of present results by long chains of unpredictable antecedent states, rather than immediate determination by timeless laws of nature. *Homo sapiens* did not appear on the earth, just a geologic second ago, because evolutionary theory predicts such an outcome based on themes of progress and increasing neural complexity. Humans arose, rather, as a fortuitous and contingent outcome of thousands of linked events, any one of which could have occurred differently and sent history on an alternative pathway that would not have led to consciousness.

The Evolution of Life on Earth

*Scientific American*, Volume 271, Number 4, October 1994 (pp. 85–86)

**Grassé, Pierre P.** 1895–1985

French zoologist

Although everything is not as it should be, the living world is not at all chaotic and life results from a very well-defined order. As soon as some disorder, even slight, appears in an organized being, sickness, then death follow. There is no possible compromise between the phenomenon of life and anarchy.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*

Chapter IV (p. 9)

Academic Press. New York, New York, USA. 1977

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

Perhaps, in the ultimate and unimaginable chaos of a big bang, there lurks the cosmogenic genie who conjures and launches multitudes of universes, each equipped with its own unique laws and fundamental constants...

*Cosmology, the Science of the Universe*

Chapter 15 (p. 300)

Cambridge University Press. Cambridge, England. 1981

**Heim, F.**

No biographical data available

Chaos engenders order.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Biologic Relations Between Plants and Ants (p. 454)

Government Printing Office. Washington, D.C. 1898

**Hofstadter, Douglas** 1945–

American cognitive scientist and author

It turns out that an eerie type of chaos can lurk just behind a facade of order — and yet, deep inside the chaos lurks an even eerier type of order.

In James Gleick

*Chaos: Making a New Science*

Back cover

Penguin Books. New York, New York, USA. 1988

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

In disorder there can be no fecundation. Chaos is a celibate.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 406)

The Heritage Press. New York, New York, USA. 1961

**Keats, John** 1795–1821

English Romantic lyric poet

There is nothing stable in the world; uproar's your only music.

*The Complete Poetical Works and Letters of John Keats*

Letter to George and Thomas Keats

13 January 1818 (p. 280)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

Developmental work is always a slightly organized chaos.

In T.A. Boyd

*Professional Amateur*

Part II Chapter IX (p. 71)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

**Maxim, Hiram S.**

No biographical data available

...the grandest words ever uttered by any man on this planet were spoken by Lord Kelvin when he said that if all the matter in the Universe were reduced to its ultimate atoms and equally divided through all space, the disturbance caused by the beating of the wing of one mosquito would bring about everything we find in the material Universe today.

Matter and Motion in Space

*Nature*, Volume 66, Number 1705, July 3, 1902 (p. 223)

**Miller, Henry** 1891–1980  
American writer

The world is what it is and I am what I am.... This out there and this in me, all this, everything, the resultant of inexplicable forces. A Chaos whose order is beyond comprehension. Beyond human comprehension.

*Black Spring*

Third or Fourth Day of Spring (p. 25)

Grove Press. New York, New York, USA. 1963

...chaos is the score upon which reality is written.

*Tropic of Cancer* (p. 2)

Grove Press. New York, New York, USA. 1961

**Milton, John** 1608–74  
English poet

To whom these most adhere,  
He rules a moment: Chaos Umpire sits,  
And by decision more embroils the fray  
By which he reigns.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book II, l. 907–909

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

May hope, when everlasting Fate shall yield  
To fickle Chance, and Chaos judge the strife...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book II, l. 232–233

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In the Beginning, how the Heav'ns and Earth  
Rose out of Chaos...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book I, l. 9–10

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...where eldest Night

And chaos, ancestors of nature, hold

Eternal anarchy amidst the noise

Of endless wars.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book II, l. 894

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nietzsche, Friedrich** 1844–1900  
German philosopher

You must have chaos in your heart to give birth to a dancing star.

In Eugene F. Mallove

*The Quickening Universe: Cosmic Evolution and Human Destiny*

Prologue (p. xiii)

St. Martin's Press. New York, New York, USA. 1987

**Ovid** 43 BCE–17 AD  
Roman poet

...chaos: a rough, unordered mass of things...

Translated by Frank Justus Miller

*Metamorphoses* (Volume 1)

Book I, l. 7 (p. 3)

William Heinemann. London, England. 1916

**Packard, Norman**

American physicist

The phenomenon of chaos could have been discovered long, long ago. It wasn't, in part because this huge body of work on the dynamics of regular motion didn't lead in that direction. But if you just look, there it is.

In James Gleick

*Chaos: Making a New Science*

The Dynamical Systems Collective (p. 251)

The Viking Press. New York, New York, USA. 1987

**Pope, Alexander** 1688–1744

English poet

Then rose the seed of Chaos, and of Night,  
To blot out Order, and extinguish Light...

*The Complete Poetical Works* (Volume 4)

The Duncaid, Book IV, l. 13–14

Houghton Mifflin Company. New York, New York, USA. 1903

Not chaos-like, together crust'd and bruis'd,  
But, as the world, harmoniously confused:

Where order in variety we see,

And where, tho' all things differ, all agree.

*The Complete Poetical Works*

Windsor Forest, l. 13–16

Houghton Mifflin Company. New York, New York, USA. 1903

Lo! thy dread empire, Chaos! is restor'd;

Light dies before thy uncreating word;

Thy hand great Anarch! lets the curtain fall;

And universal Darkness buries all.

*The Complete Poetical Works* (Volume 4)

The Duncaid, Book IV, l. 653–656

Houghton Mifflin Company. New York, New York, USA. 1903

Here she beholds the Chaos dark and deep,

Where nameless something's in their causes sleep...

*The Complete Poetical Works* (Volume 4)

The Duncaid, Book I, l. 55–56

Houghton Mifflin Company. New York, New York, USA. 1903

**Santayana, George (Jorge Agustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

Chaos is a name for any order that produces confusion in our minds...

Chaos is perhaps at the bottom of everything: which would explain why perfect order is so rare and precarious.

*Dominations and Powers: Reflections on Liberty, Society, and Government*

Book First, Part One, Chapter 1 (p. 33)

Charles Scribner's Sons. New York, New York, USA. 1951

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Chaos is come, again.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Othello, The Moor of Venice  
Act III, Scene iii, l. 92  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shapley, Harlow** 1885–1972  
American astronomer

Chaos is but unperceived order; it is a word indicating the limitations of the human mind and the paucity of observational facts. The words “chaos,” “accidental,” “chance,” “unpredictable” are conveniences behind which we hide our ignorance.

*Of Stars and Men: Human Response to an Expanding Universe*  
Chapter 4 (fn, p. 63)  
Beacon Press. Boston, Massachusetts, USA. 1958

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

Do you see O my brothers and sisters? It is not chaos or death — it is form, union, plan — it is eternal life — it is Happiness.

*Complete Poetry and Collected Prose*  
Leaves of Grass  
Song of Myself  
The Library of America. New York, New York, USA. 1982

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Is this the end of all that primal force  
Which, in its changes being still the same,  
From eyeless Chaos cleft its upward course,  
Through ravenous seas and whirling rocks and flame,  
Till the suns met in heaven and began  
Their cycles, and the morning stars sang, and the Word  
was Man!

*Poems*  
Humanitad, Stanza 72  
George Munro's Sons. New York, New York, USA. 1896

**Yorke, James**  
American mathematician

The first message is that there is disorder.... People say what use is disorder. But people have to know about disorder if they are going to deal with it. The auto mechanic who doesn't know about sludge in valves is not a good mechanic.

In James Gleick  
*Chaos: Making a New Science*  
Life's Ups and Downs (p. 68)  
The Viking Press. New York, New York, USA. 1987

## CHEMICAL

**Berzelius, Jöns Jacob** 1779–1848  
Swedish chemist

The devil may write chemical textbooks...because every few years the whole thing changes.

In Bernard Jaffe  
*Crucibles: The Story of Chemistry*  
Chapter IX (p. 116)  
Dover Publications. New York, New York, USA. 1976

It is easier to write an abbreviated word than to draw a figure. The chemical signs ought to be letters for the greater ease of writing and not to disfigure a printed book. I shall therefore take for the chemical sign the initial letter of the Latin name of each chemical element, thus, C, H, N, O, S, and P. If the first letter be common to two metals, I shall use both the initial letter and another letter they have not in common...

In Bernard Jaffe  
*New World of Chemistry*  
Chapter 6 (p. 66)  
Silver, Burdett & Company. New York, New York, USA. 1935

**Callen, Charles Lane**  
No biographical data available

“Does accident often play a part in chemical discoveries?” I inquired. “At times it does, but not as rule,” Dr. Stine replied. “Even when it does, the circumstance is not, strictly speaking, accidental...the chemist invariably has to put in some mighty hard work in order to bring about fortunate accidents.”

If the Chemist Stepped Out of Your Life  
*The American Magazine*, May 1926. (p. 189)

**Cook, Joseph**  
No biographical data available

Oh, sing a song of phosphates,  
Fibrine in a line,  
Four-and-twenty follicles  
In the van of time.  
When the phosphorescence  
Evolved brain,  
Superstition ended,  
Men began to reign.

In Sara and John E. Brewton and John Brewton Blackburn  
*Of Quarks, Quasars, and Other Quirks: Quizzical Poems for the Supersonic Age*  
Boston Nursery Rhymes, Rhyme for a Chemical Baby (p. 41)  
Crowell. New York, New York, USA. 1977

**Davy, Sir Humphry** 1778–1829  
English chemist

Whilst chemical pursuits exalt the understanding, they do not depress the imagination or weaken genuine feeling; whilst they give the mind habits of accuracy, by obliging it to attend to facts, they likewise extend its analogies; and, though conversant with the minute forms of things, they have for their ultimate end the great and magnificent objects of nature.

*Consolations in Travel, or the Last Days of a Philosopher*  
Dialogue V (p. 245)  
John Murray. London, England. 1830

The foundations of chemical philosophy, are observation, experiment, and analogy. By observation, facts are distinctly and minutely impressed on the mind. By analogy, similar facts are connected. By experiment, new facts are discovered; and, in the progression of knowledge, observation, guided by analogy, lends to experiment, and analogy confirmed by experiment, becomes scientific truth.

*Elements of Chemical Philosophy* (Volume 4)

Part I, Volume I, Introduction (p. 2)

Printed for J. Johnson & Company. London, England. 1812

[The chemical philosopher's mind] should always be awake to devotional feeling, and in contemplating the variety and the beauty of the external world, and developing its scientific wonders, he will always refer to that infinite wisdom through whose beneficence he is permitted to enjoy knowledge; and, in becoming wiser, he will become better, he will rise at once in the scale of intellectual and moral existence, his increased sagacity will be subservient to a more exalted faith, and in proportion as the veil becomes thinner through which he sees the causes of things, he will admire more the brightness of the divine light by which they are rendered visible.

*Consolations in Travel; or the Last Days of a Philosopher*

Dialogue V (p. 255)

John Murray. London, England. 1830

### **Dickinson, Emily** 1830–86

American lyric poet

The Chemical conviction

That Nought be lost

Enable in Disaster

My fractured Trust —

*The Complete Poems of Emily Dickinson*

No. 954 (p. 446)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

### **Editorial**

Our chemical heritage — the record of our achievements and our shortcomings — has a vital role to play in developing a more adequate public understanding of science. The past must be preserved, deployed, and made known. We all — whether Chief Executive officers, chemical scientists, school teachers, or representatives of the media — need a better understanding of the human dimensions of the chemical sciences. Chemical history, our chemical heritage, can help inform our decision making. A positive view of the past chemical achievements will lend a modest but firm realism to our plans for the future.

*Beckman Center for the History of Science*, Volume 9, Spring 1992

### **Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

The ingredients are known; they can be had on any drug-store shelf. You can take them yourself and pour them and wait hopefully for the resulting slime to crawl. It

will not. The beautiful pulse of streaming protoplasm, that unknown organization of an unstable chemistry which makes up the life process, will not begin. Carbon, nitrogen, hydrogen, and oxygen you have mixed, and the same dead chemicals they remain.

*The Immense Journey* (p. 1)

Victor Gollancz. London, England. 1958

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

‘Tis a superstition to insist on a special diet. All is made at last of the same chemical atoms.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Culture (p. 1027)

The Library of America. New York, New York, USA. 1983

### **Fischer, Emil** 1852–1919

German chemist

To use a picture, I will say that enzyme and glucoside must join one another as lock and key, in order to be able to exert a chemical effect.

*Berichte der Deutschen Chemischen Gesellschaft*, Column 27, 1894

(p. 2992)

### **Frederick the Great** 1712–1786

King of Prussia

Is it not true that the doctrine of attraction and gravity has done nothing but astonish our imagination? Is it not true that all the chemical discoveries have done only the same?

Letter to Jean le Rond D'Alembert, January 7, 1768

### **Haldane, John Burdon Sanderson** 1892–1964

English biologist

Shelly and Keats were the last English poets who were at all up to date in their chemical knowledge.

*Daedalus, or Science and the Future*

Paper read to the Heretics, Cambridge, England

February 4<sup>th</sup>, 1923

### **Hinshelwood, Sir Cyril** 1897–1967

English chemist

Nobody, I suppose, could devote many years to the study of chemical kinetics without being deeply conscious of the fascination of time and change: this is something that goes outside science into poetry; but science, subject to the rigid necessity of always seeking closer approximations to the truth, itself contains many poetical elements.

*Nobel Lectures, Chemistry 1942–1962*

Nobel lecture for award received in 1956

Chemical Kinetics in the Past Few Decades (p. 474)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

### **Hoffmann, Roald** 1937–

Polish-born American chemist

The chemical article is an artistic creation.... It is not a laboratory notebook, and one knows that that notebook in turn is only a partially reliable guide to what took place. It is a more or less (one wishes more) carefully constructed, man- or woman-made text.... If one is lucky, it creates an emotional or aesthetic response in its readers.

Under the Surface of the Chemical Article  
*Angewandte Chemie International Edition in English*, Volume 27, 1988

**Kornberg, Arthur** 1918–  
American biochemist

Life is a chemical process.  
*Biochemistry*, Volume 26, 1987 (p. 6888)

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

The principle object of chemical experiments is to decompose natural bodies, so as separately to examine the different substances which enter into their composition. By consulting chemical systems, it will be found that this science of chemical analysis has made rapid progress in our own times.... Thus, as chemistry advances towards perfection, by dividing and subdividing, it is impossible to say where it is to end; and these things we at present suppose simple may soon be found quite otherwise. All we dare venture to affirm of any substance is, that it must be considered as simple in the present state of our knowledge, and so far as chemical analysis has hitherto been able to show.

*Elements of Chemistry in a New Systematic Order*  
Part II, Section I (p. 176)  
W. Creech. Edinburgh, Scotland. 1790

...one day the precision of the data might be brought to such perfection that the mathematician in his study would be able to calculate any phenomenon of chemical combination in the same way...as he calculates the movement of the heavenly bodies.

*Memories de l'Académie Royale des Sciences*  
Mémoire sur l'affoimoté du principe oxygine (p. 534)  
1782 [Published 1785]

**Lehn, Jean-Marie** 1939–  
French chemist

The essence of chemical science thus finds its full expression in the words of Leonardo da Vinci: "Where nature finishes producing its own species, man begins, using natural things and in harmony with this very nature, to create an infinity of species."

Perspectives in Supermolecular Chemistry  
*Angewandte Chemie International Edition in English*, Volume 29, Number 11, 1990 (p. 1337)

**Ostwald, Friedrich Wilhelm** 1853–1932  
Latvian-born German chemist

Thus there was for him nothing small or great in Nature. Every phenomenon embraced for him an endless diversity of factors, and in the yellow flame of an ordinary alcohol lamp whose wick was sprinkled with salt, he saw the possibility of accomplishing the chemical analysis of the most distant stars.

In Mary Elvira Weeks  
*The Discovery of the Elements* (p. 363)  
Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

A chemical compound might be expected to be quite as much a proposition as like an algebraic invariant.  
The Logic of Relations  
*Monist*, Volume 7, 1896 (p. 169)

**Shoemaker, Sydney** 1931–  
American philosopher

If what I want when I drink fine wine is information about its chemical properties, why don't I just read the label?  
In Daniel C. Dennett  
*Consciousness Explained*  
Chapter 12 (p. 383)  
Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Süskind, Patrick** 1931–  
German writer and screenwriter

There's jasmine! Alcohol there! Bergamont there! Grenouille went on crowing, and at each name he pointed to a different spot in the room, although it was so dark that at best you could only surmise the shadows of the cupboards filled with bottles.  
Translated by John E. Woods  
*Perfume: The Story of a Murderer*  
Chapter 14 (p. 75)  
Alfred A. Knopf. New York, New York, USA. 1986

**Teepel, John E.** 1874–1931  
American chemist

The manufacturer of chemicals has all the griefs of a maker of shoes, or bolts and nuts, or ready-to-wear clothes, and has just one more grief in addition — *i.e.*, troubles occurring in chemical transformations.  
Is the Practice of Chemistry a Profession, a Trade, or a Tool?  
*The Journal of Industrial and Engineering Chemistry*, Volume 17, Number 7, July 1925 (p. 666)

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

Warned by such errors as that of Comte, who declared that Man could never know anything as to the chemical composition of the heavenly bodies, we have learned to be cautious in not putting in "full stops".  
*The System of Animate Nature* (Volume 1)  
Lecture I (p. 15)  
William & Norgate. London, England. 1920

**Winkler, C.**

No biographical data available

The world of chemical reaction is like a stage, on which scene after scene is ceaselessly played. The actors on it are the elements.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 2)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Getting hold of the difficulty deep down is what is hard.

Because if it is grasped near the surface it simply remains the difficulty it was. It has to be pulled out by the roots; and that involves our beginning to think about these things in a new way. The change is as decisive as, for example, that from the alchemical to the chemical way of thinking. The new way of thinking is what is so hard to establish.

Translated by Peter Winch

*Culture and Value* (p. 48e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**CHEMICAL AFFINITIES****Aesop** ca. 620 BCE–560 BCE

Greek fabulist and author

There can be little liking where there is no likeness.

*Fables*

The Collier and the Fuller

The University of Chicago Press. Chicago, Illinois, USA. 1960

**Berthollet, C. L.** 1748–1822

French chemist

A theory of chemical affinities solidly established, and serving as a basis for the explanation of all chemical questions, ought to be a collection of, or contain, all the principles from which the causes of chemical phenomena can proceed, in every possible variety of circumstances; because observation has proved that all these phenomena are only the various effects of that affinity, to which all the various chemical powers of bodies may be attributed.

Translated by M. Farrell

*Researches into the Laws of Chemical Affinity*

Researches

Article I (pp. 1–2)

Philip H. Nicklin & Company. 1809

**Duckham, Sir Arthur**

No biographical data available

Many times in the short existence of the Institution have the Council endeavored to describe a chemical engineer.... We have come to the conclusion that a chemical engineer as such does not in reality exist today.

Presidential Address

*Transactions of the Institute for Chemical Engineering*, Volume 2, 1924 (p. 15)

**Macquer, Pierre Joseph** 1718–84

French chemist

...perhaps time, experience, the increase of chemical knowledge, lastly, the zeal of persons skilled in mathematics and chemistry, will hereafter throw much more light upon these subjects, of which now we have but confused notions. However, I cannot but consider them as the true key of the most hidden phenomena of chemistry, and consequently of all natural philosophy.

In D.S.L. Cardwell (ed.)

*John Dalton & the Progress of Science*

Quoted by Arnold Thackeray

Quantified Chemistry — The Newtonian Dream (p. 102)

Manchester University Press. Manchester, England. 1968

**McGee, Jr., H. A.**

No biographical data available

As a profession we are justly proud of our great breadth, for we are the only applied science profession with in-depth training in chemistry as well as in physics and mathematics. Our background and perspective as scientist-engineers make for flexibility and adaptability that is the envy of our sister disciplines.

*Chemical Engineering Education*, Volume 9, Number 2, 1974 (p. 94)

**Pigford, R. L.**

No biographical data available

The chemical engineer...needs to understand chemistry, physics, and mathematics in approximately equal proportion in order that he, apparently better than those from other backgrounds, can assemble and evaluate whatever knowledge is required to "bring things together."

Chemical Engineering Technology: The Past 100 Years

*Chemical Engineering News*, Volume 54, Number 15, 1976 (p. 190)

**Reese, C. L.**

No biographical data available

Our friends from the Massachusetts Institute of Technology have, perhaps, done more to establish the idea of what a chemical engineer is than anyone else, and there idea is that a chemical engineer is one who understands and knows and has learned the fundamentals of the elementary processes such as distillation, filtration, precipitation, flow of gases and liquids, heat transmission, and so on.

Presidential Address

*Transactions of the Institute of Chemical Engineering*, Volume 2, 1924 (p. 16)

## CHEMICAL BOND

### Brown, I. David

No biographical data available

It is unlikely that, left to themselves, theoretical chemists in the twentieth century would have ever created the idea of a chemical bond had not the concept already been central to the language of structural chemistry. To this day, the chemical bond remains largely an empirical concept.

*The Chemical Bond in Inorganic Chemistry: The Bond Valence Model*  
Chapter 1 (p. 30)

Oxford University Press, Inc. Oxford, England. 2002

## CHEMICAL CHANGE

### Author undetermined

The difference between a physical and a chemical change is that a chemical change evaporates and a physical change remains the same.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

## CHEMICAL ENGINEERING

### Davis, George E.

No biographical data available

Chemical Engineering must not be confounded with either Applied Chemistry or with Chemical Technology, as the three studies are distinct. Chemical Engineering runs through the whole range of manufacturing chemistry, while Applied Chemistry simply touches the fringes of it and does not deal with the engineering difficulties even in the slightest degree, while Chemical Technology results from the fusion of the studies of Applied Chemistry and Chemical Engineering, and becomes specialised as the history and details of certain manufactured products.

*A Handbook of Chemical Engineering* (Volume 1)

Chapter 1 (p. 4)

Davis Brothers. Manchester, England. 1904

### Whitney, Willis Rodney 1868–1958

American chemical and electrical engineer

Chemistry was the plaything of magicians, monks and pure-science teachers centuries before chemical engineering became a comprehensible term.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry

*Science*, Volume 65, Number 1862, March 25, 1927 (p. 288)

## CHEMIST

### Armstrong, Henry Edward 1848–1937

English chemist

The fact is, there has been a split of chemistry into two schools since the intrusion of the Arrhenic faith, rather it should be said, the addition of a new class of worker into our profession — people without knowledge of the laboratory arts and with sufficient mathematics at their command to be led astray by curvilinear agreements; without the ability to criticize, still less of giving any chemical interpretation.

The fact is, the physical chemists never use their eyes and are most lamentably lacking in chemical culture. It is essential to cast out from our midst, root and branch, this physical element and return to our laboratories.

*Historical Studies in the Physical Sciences* (Volume 7)

In R.G.A. Dolby

Debates Over the Theory of Solution

Volume 7, 1976 (p. 389)

Princeton University Press. Princeton, New Jersey, USA. 1976

### Arnheim, Rudolf 1904–2007

German-born author, film theorist, and psychologist

Just as chemists “isolate” a substance from contaminations that distort his view of nature and effects, so the work of art purifies significant appearance. It presents abstract themes in their generality, but not reduced to diagrams.

*Visual Thinking*

Chapter 14 (p. 273)

Faber & Faber Ltd. London, England. 1969

### Atkins, Peter William 1940–

English physical chemist and writer

Chemists currently strive to achieve the fine control exercised by nature. To do so, they stir, pour, heat, and distill, just as they have done ever since their intellectual ancestors vainly sought a reaction that would produce gold from lead. These crude processes seem to be ways of bending matter to our will and forcing it to undergo specific change. Modern chemists, though, use these techniques to direct reactions more precisely and rationally than alchemists, cooks, and Faraday’s contemporaries. They may seek to build complex molecules, and to do so proceed by stealth and subtlety.... They have found ways to emulate (and sometimes improve on) nature by mixing, stirring, and heating in such a way that they do not break asunder what they have already joined — even though they cannot manipulate the atoms directly.

Atoms, Electrons, and Change (p. 11)

*Scientific American Series*, Number 36, 1991

### Ball, Philip 1962–

English science writer

Geologists brave the awesome fury of volcanoes and earthquakes; oceanographers plumb the hidden depths of the world. What do chemists do? Well, they make paint, among other things.

*Designing the Molecular World: Chemistry at the Frontier*  
Introduction (p. 4)  
Princeton University Press, Princeton, New Jersey, USA. 1994

**Becher, Johann Joachim** 1635–82  
German physician, alchemist, and early chemist

The chymists are a strange class of mortals impelled by an almost insane impulse to seek their pleasure among smoke and vapour, soot and flame, poisons and poverty; yet among all these evils I seem to live so sweetly, that may I die if I would change places with the Persian King.

In H.E. Howe (ed.)

*Chemistry in Industry* (Volume 1)

Frontispiece

The Chemical Foundation, Inc. New York, New York, USA. 1924

**Black, Joseph** 1728–99  
Scottish chemist and physician

The chemist studies the effects produced by heat and by mixture, in all bodies, or mixtures of bodies, natural or artificial, and studies them with a view to the improvement of arts, and the knowledge of nature.

*Lectures on the Elements of Chemistry* (Volume 1)

Lectures on the Elements of Chemistry (11)

Volume II (p. 415)

Printed for Mathew Carey, Philadelphia, Pennsylvania, USA. 1807

**Bogert, Marston Taylor** 1868–1954  
American physical chemist

Practically everything your eat, taste, wear, smell and see has resulted in some way from the ingenuity of chemists.

The New Marvels of Chemistry in Your Everyday Life

*The American Magazine*, September 1921 (p. 19)

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

And indeed, I fear that the chief Reason why Chymists have written so obscurely of their three Principles, may be, That not having Clear and Distinct Notions of them themselves, they cannot write otherwise than Confusedly of what they but Confusedly Apprehend...

*The Sceptical Chymist*

The Fourth Part (pp. 202–203)

Dawsons of Pall Mall, London, England. 1965

...me thinks the chymists, in their searches after truth, are not unlike the Navigator of Solomon's Tarshish Fleet, who brought home from their long and tedious voyages, not only gold, and silver, and ivory, but apes and peacocks too; for so the writings of several...of your hermetick philosophers present us, together with divers substantial and noble experiments, theories, which either like peacock feathers make a great shew, but are neither solid nor useful; or else like apes, if they have some appearance of being rational, are blemished with some absurdity or other, that when they are attentively considered, makes them appear ridiculous.

*The Sceptical Chymist*  
The Conclusion (pp. 429–430)  
Dawsons of Pall Mall, London, England. 1965

**Bridges, Robert Seymour** 1844–1930  
English poet

... 'twas no unique, ultimately separable thing,  
as is a chemic element; far rather our moods,  
influences and spirital affections are like  
those many organic substances which, tho' to sense  
wholly dissimilar and incomparable in kind,  
are yet all combinations of the same simples,  
and even in like proportions differently disposed;  
so that whether it be starch, oil, sugar, or alcohol  
'tis ever our old customers, carbon and hydrogen,  
pirouetting with oxygen in their morris antics;  
the chemist booketh all of them as CHO.

*The Testament of Beauty*

Book III, l. 928–938

Oxford University Press, Inc. Oxford, England. 1930

**Browning, Robert** 1812–89  
English poet

Once I saw a chemist take a pinch of powder  
— Simple dust it seemed — and half unstop a phial.  
— Outdropped harmless dew.

*The Poems and Plays of Robert Browning*

Two Camels, l. 109–111

The Modern Library, New York, New York, USA. 1934

**Bullock, J. Lloyd**  
No biographical data available

There is a further use in thus becoming a good practical chemist; it will enable you to be the counselor of the agriculturalist, of the manufacturer, of the physician — to spread the love and practice of chemistry.

A Lecture on the State of Pharmacy in England and Its Importance to the Public; with remarks on the Pharmaceutical Society

*The Chemist*, Volume 5, 1844 (p. 282)

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Chemists do not have to bother about the sociology of molecules...

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 1 (p. 5)

The Seabury Press, New York, New York, USA. 1977

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

The eyeless Chemist heard the process rise,  
The stormy Chalice bubbled up in sighs....

*The Complete Poems of Samuel Taylor Coleridge*

Kisses, l. 11–12

Harper & Brothers, New York, New York, USA. 1884

**Corey, E. J.**  
No biographical data available



The synthetic chemist is more than a logician and strategist; he is an explorer strongly influenced to speculate, to imagine, and even to create. These added elements provide the touch of artistry which can hardly be included in a cataloguing of the basic principles of Synthesis, but they are very real and extremely important...

General Methods for the Construction of Complex Molecules  
*Pure and Applied Chemistry*, Volume 14, 1967 (p. 30)

### **Crookes, Sir William** 1832–1919

English chemist and physicist

Chemists do not usually stutter. It would be very awkward if they did, seeing that they have at times to get out such words as methylethylamylphenylium.

In William H. Brock

*The Norton History of Chemistry*

Introduction (p. xxvi)

W.W. Norton & Company, Inc. New York, New York, USA. 1933

It is the chemist who must come to the rescue of the threatened communities. It is through the laboratory that starvation may ultimately be turned to plenty.

*Report of the British Association for the Advancement of Science*  
1898 (p. 4)

### **Crowther, Greg**

American biologist

Mamas don't let your babies grow up to be chemists.

Don't let 'em teach or go or work at the Hutch;

Make 'em be bankers and lawyers and such.

Mamas don't let your babies grow up to be chemists.

With every involvement, they end up in solvent,

Smelling bad and inhaling too much.

*Mamas Don't Let Your Babies Grow Up to Be Chemists*

Sung to the tune of "Mamas Don't Let Your Babies Grow Up To Be Cowboys"

### **Curie, Eve** 1904–

French concert pianist and journalist

By definition, a chemist only believes in the existence of a new substance when he has seen the substance, touched it, weighed and examined it, confronted it with acids, bottled it, and when he has determined its "atomic weight."

*Madame Curie*

Chapter XIII (p. 165)

The Literary Guild of America, Inc. New York, New York, USA. 1937

### **Davy, Sir Humphry** 1778–1829

English chemist

A steady hand and a quick eye are most useful auxiliaries; but there have been very few great chemists who have preserved these advantages throughout life; for the business of the laboratory is often a service of danger and the elements, like the refractory spirits of romance, through the obedient slave of the magician, yet sometimes escape the influence of his talisman and endanger

his person. Both the hands and the eyes of others however may sometimes advantageously [be] made use of.

*Consolations in Travel; or The Last Days of a Philosopher*

Dialogue V (pp. 251–252)

John Murray. London, England. 1830

### **Dibdin, Charles Isaac Mungo** 1768–1833

English songwriter

Thee, wond'rous chemist! Who canst make, at will,  
Wash-balls from dew-drops; and canst blooms distil;  
With blooms and dews, Dame Nature's self canst pose,  
And brew, like spiders, poison from the rose!

*Mirth and Metre*

The Age

A Satire, an Argument, l. 262–265

Printed for Vernon, Hood & Sharpe. London, England. 1807

### **Dickens, Charles** 1812–70

English novelist

...like a gloomy Analytical Chemist; always seeming to say, after "Chablis, Sir?" — "You wouldn't if you knew what it was made of."

*Our Mutual Friend*

Book the First, Chapter 2 (p. 11)

The Modern Library. New York, New York, USA. 1960

### **Dryden, John** 1631–1700

English poet, dramatist, and literary critic

A man so various that he seemed to be

Not one, but all mankind's epitome.

Stiff in opinions, always in the wrong;

Was everything by starts, and nothing long:

But, in the course of one revolving moon,

Was chemist, fiddler, statesman, and buffoon.

*The Poetical Works of Dryden*

Absalom and Achitophel

Part 1, l. 545–560

The Riverside Press. Cambridge, Massachusetts, USA. 1949

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The sea is the chemist that dissolves the mountains and the rocks, pulverizes old continents and builds new, forever redistributing the solid matter of the globe.

In Bernard Jaffe

*New World of Chemistry*

Chapter 14 (p. 182)

Silver, Burdett & Company. New York, New York, USA. 1935

### **Farrell, Hugh**

No biographical data available

The chemist is revolutionizing industry. He is developing new products and new ideas every hour of every day. As a result of his work, flourishing industries are being scrapped overnight. There is no industry — not one — that is not in danger of waking up tomorrow and finding that the chemist has made a discovery that might revolutionize it.

In Bernard Jaffe  
*New World of Chemistry*  
 Chapter 34 (p. 495)  
 Silver, Burdett & Company. New York, New York, USA. 1935

**Frost, Robert** 1874–1963  
 American poet

Even while we talk some chemist at Columbia  
 Is stealthily contriving wool from jute...  
*Complete Poems of Robert Frost*  
 Build Soil  
 Henry Holt & Company. New York, New York, USA. 1949

**Fry, Harold Shipley** 1878–1949  
 American chemist

The structural formula of the organic chemist is not the  
 canvas on which the cubist artist should impose his draw-  
 ings which he alone can interpret.  
 A Pragmatic System of Notation for Electronic Valence Conceptions in  
 Chemical Formulas  
*Chemical Reviews*, Volume 5, 1928 (pp. 558–559)

**Fuller, R. Buckminster** 1895–1983  
 American engineer and architect

Nature has made certain things which we call natural, and  
 everything else is “man-made”, ergo artificial. But what  
 one learns in chemistry is that Nature wrote all the rules  
 of structuring; man does not invent chemical structuring  
 rules; he only discovers the rules. All the chemist can do  
 is find out what Nature permits, and any substances that  
 are thus developed or discovered are inherently natural.  
*The Buckminster Fuller Reader* (p. 318)  
 Jonathan Cape. London, England. 1970

**Girtanner, Christopher** 1760–1800  
 Swiss chemist and physician

Every chemist and every artist will make gold; kitchen  
 utensils will be of silver, and even gold, which will con-  
 tribute more than anything else to prolonged life, poi-  
 soned at present by the oxides of copper, lead, and iron,  
 which we daily swallow with our food.  
*Philosophical Magazine*, Volume vi (p. 383)

**Hafiz, Mohammed Shems-ed-Deen** ca. 1300–88  
 Persian poet

The chemist of love  
 Will this perishing mould,  
 Were it made out of mire,  
 Transmute into gold.  
*Divan*

**Herbert, George** 1593–1633  
 English metaphysical poet

The subtle chymick can devest  
 And strip the creature naked, till he finde  
 The callow principles within their nest:

There he imparts to them his minde,  
 Admitted to their bed-chamber before  
 They appeare trim and drest  
 To ordinate suitours at the doore.  
*The Temple*  
 The Church, Vanity, l. 15–21 (p. 126)  
 Medieval & Renaissance Texts & Studies. Binghamton, New York,  
 USA. 1995

**Hoffmann, Roald** 1937–  
 Polish-born American chemist

I had written three pages  
 on how insects are such good chemists, citing  
 the silkworm sex attractant, and the bombardier beetle,  
 spraying out hot hydrogen peroxide when threatened.  
*Gaps and Verges*  
 Evolution (p. 3)  
 University of Central Florida Press. Orlando, Florida, USA. 1990

**Holmes, Harry N.**  
 No biographical data available

The chemist deals with a very material world, even  
 though philosophers assure him that he doesn't really  
 know matter, that he only perceives its attributes or prop-  
 erties. However, he is not to be argued out of his dinner  
 by mere words.  
*Out of the Test Tube*  
 Chapter II (p. 24)  
 Emerson Books, Inc. New York, New York, USA. 1941

**Ihde, Aaron J.**  
 No biographical data available

The person who is merely trained to carry out analyses  
 or syntheses can do his job quite satisfactorily with-  
 out knowing any history of chemistry. On the other  
 hand, the chemist who is in a position where he has  
 significant responsibility for the planning of investiga-  
 tions needs to know something about the past history of  
 chemical investigation and the development of chemi-  
 cal thought. Without such knowledge, he is merely a  
 chemical technologist.  
 Let's Teach History of Chemistry to Chemists!  
*Journal of Chemical Education*, Volume 48, 1971 (pp. 686–687)

**Laitinen, H. A.**  
 No biographical data available

The analytical chemist properly serves his role as a  
 chemical measurements specialist only if he is a full part-  
 ner in the interdisciplinary team concerned with solving  
 the problem.  
*Annals of Chemistry*, Volume 47, 1975 (p. 2073)

**Lavoisier, Antoine Laurent** 1743–94  
 French chemist

It ought likewise to be considered, that very little of  
 chemistry can be learned in a first course, which is hardly

sufficient to make the language of the science familiar to the ears, or the apparatus familiar to the eyes. It is almost impossible to become a chemist in less than three or four years of constant application.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xix)

Printed for William Creech. Edinburgh, Scotland. 1790

### **Lehn, Jean-Marie** 1939–

French chemist

Like the artist, the chemist engraves into matter the products of creative imagination. The stone, the sounds, the words do not contain the works that the sculptor, the composer, the writer express from them. Similarly, the chemist creates original molecules, new materials and novel properties from the elements produced by nature, indeed entire new worlds, that did not exist before they were shaped at the hands of the chemist, like matter is shaped by the hands of the artist, as so powerfully rendered by August Rodin.

*Supramolecular Chemistry: Concepts and Perspectives: A Personal Account Built upon the George Fisher Baker Lectures in Chemistry at Cornell University (and the) Lezione Lincee, Accademia Nazionale dei Lincei, Roma*

Chapter 10.3 (p. 206)

VCH. Weinheim, Germany. 1995

### **Leonard, Jonathan Norton** 1903–75

American writer

It isn't the fault of the chemists that this change of pace has occurred. It is because chemistry, more than other sciences, is limited by definition. Its province is the molecule and its transformations. It does not penetrate into the atom. That is physics. It does not pry into the living cell. That is biology. There's an invisible line beyond which a modern chemist cannot go without becoming a physicist or a biologist. The chemists are like a group of settlers on a large and fertile island who have pushed their frontier to the sea on all sides and are left with the choice of migrating to other lands or staying at home to develop the ground they have won.

*Crusaders of Chemistry: Six Makers of the Modern World*

The Harvest of Peaceful Middle Age

Doubleday, Doran. Garden City, New York, USA. 1930

### **Levi, Primo** 1919–87

Italian writer and chemist

A chemist cannot find, already in his mind, the laws and the phenomena which govern matter.

*The Natural History of a Savant*

Chapter XI (p. 126)

J.M. Dent & Sons Ltd. London, England. 1927

### **Sidgwick, N. V.**

No biographical data available

The chemist... must resist the temptation to make his own physics; if he does it will be bad physics — just as the

physicist has sometimes been tempted to make his own chemistry, and then it was bad chemistry.

In Joseph Needham and Ernest Baldwin

*Hopkins & Biochemistry* (p. 204)

W. Heffer & Sons Ltd. Cambridge, England. 1949

### **Standen, Anthony**

American science writer

Chemists are, on the whole, like physicists, only “less so”. They don't make quite the same wonderful mistakes, and much what they do is an art, related to cooking, instead of a true science. They have their moments, and their sources of legitimate pride. They don't split atoms, as the physicists do. They join them together, and a very praiseworthy activity that is.

*Science Is a Sacred Cow*

Chapter III (pp. 77–78)

E.P. Dutton & Company. New York, New York, USA. 1950

### **Prudhomme, Sully** 1839–1907

French poet

Surrounded by beakers, by strange coils,

By ovens and flasks with twisted necks,

The chemist, fathoming the whims of attractions,

Artfully imposes on them their precise meetings.

In Helen Plotz

*Imagination's Other Place*

The Naked World

Thomas Y. Crowell Company. New York, New York, USA. 1955

### **Thompson, Sir D'Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

The learned chemist is still a learned man; in love and knowledge of the arts the chemists are hardly beaten by the scholars.

*Science and the Classics*

Chapter I (p. 4)

Oxford University Press, Inc. London, England. 1940

### **Turgenev, Ivan** 1818–83

Russian novelist and dramatist

“A good chemist is twenty times more useful as any poet,” broke in Bazarov.

Translated by Constance Garnett

*Fathers & Sons*

Chapter VI (p. 28)

Harper & Brothers. New York, New York, USA. 1951

### **von Liebig, Justus** 1803–73

German organic chemist

The loveliest theories are being overthrown by these damned experiments; it is no fun being a chemist any more.

In William H. Brock

*Justus von Liebig*

Letter to J.J. Berzelius, 22 July 1834 (p. 72)

Cambridge University Press. Cambridge, England. 1997

**West, Philip**

No biographical data available

There is no quick way to become a chemist. Simply reading books and learning chemical theories can no more produce a true chemist than learning the theory of music can produce a real musician.

*Annals of Chemistry*, Volume 46, 1974 (p. 784A)

**CHEMISTRY****Aldersey-Williams, Hugh** 1959–

Author and journalist

Chemistry is the science of molecules, and it is a messy science.

*The Most Beautiful Molecule*

Chapter 1 (p. 14)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Armstrong, Henry Edward** 1848–1937

English chemist

Prof. W.L. Bragg asserts that in sodium chloride there appear to be no molecules represented by NaCl. The equality in numbers of sodium and chlorine atoms is arrived at by a chessboard pattern of these atoms; it is a result of geometry and not of a pairing-off of these atoms.... Chemistry is neither chess nor geometry, whatever X-ray physics may be.... It were time the chemists took charge of chemistry once more and protected neophytes against the worship of false gods; at least taught them to ask for something more than chessboard evidence.

Letter to the Editor, *Poor Common Salt*

*Nature*, Volume 120, Number 3022, October 1, 1927 (p. 478)

**Asimov, Isaac** 1920–92

American author and biochemist

Beginning students of chemistry often think of the science as a mere collection of disconnected data to be memorized by brute force. Not at all! Just look at it properly and everything hangs together and makes sense. Of course, getting the hang of the proper look isn't always easy.

*From Earth to Heaven*

To Tell a Chemist (p. 113)

Doubleday & Company, Inc. Garden City, New York, USA. 1996

**Atkins, Peter William** 1940–

English physical chemist and writer

Chemistry stands at the pivot of science. On the one hand it deals with biology and provides explanations for the processes of life. On the other hand it mingles with physics and finds explanations for chemical phenomena in the fundamental processes and particles of the universe. Chemistry links the familiar with the fundamental.

*Molecules* (p. 2)

W.H. Freeman & Company. New York, New York, USA. 1987

Immediately south of nitrogen is phosphorus, which was first isolated by the distillation and treatment of urine — an indication of the lengths to which chemists are prepared to go, or perhaps only a sign of the obsessive, scatological origins of their vocation.

*The Periodic Kingdom: A Journey into the Land of the Chemical Elements*  
Chapter 2 (p. 20)

Basic Books, Inc., Publishers. New York, New York, USA. 1995

**Austin, Alfred** 1835–1913

English author

LUCIFER: Only the chemistry of love can make  
Two atoms one.

*Prince Lucifer*

Act IV, Scene V, l. 64–65

Macmillan & Company Ltd. London, England. 1891

**Bailar, Jr., John C.** 1904–91

No biographical data available

**Moeller, Therald**

No biographical data available

Look around you. That's how chemistry began — in the limitless curiosity of human beings about their surroundings.

*Chemistry*

Chapter 1 (p. 1)

Academic Press. New York, New York, USA. 1978

**Bartlett, Elisha** 1804–55

American physician

Let chemistry push her researches into the remotest accessible recesses of the living economy, and let her claim, for her own, every process, every act, every transformation, over which she can establish a legitimate jurisdiction.

*An Essay on the Philosophy of Medical Science*

Part II, Chapter 15

Lea and Blanchard. Philadelphia, Pennsylvania, USA. 1844

**Bartow, Edward** 1870–1958

American chemist

...chemistry is dependent on other sciences in the building of what we might call The House of Chemistry... The House of Chemistry, or perhaps we should call it the Mansion, Castle, or Palace of Chemistry, cannot stand alone. Can we not imagine that it is built on the rocks of geology and mineralogy?... This mansion is built in the garden of agriculture. Its foundation is in the healing art of medicine... Physics is the window, where physical instruments shed light on the intricacies of the composition of matter.... Astronomy is the upper story, from which chemistry looks out on the universe, and studies the composition of the stars. History is the walls, which bind the various parts together, and includes chemistry and the sciences in one homogeneous system.

Presidential Address, Progress in Sanitation  
*Industrial and Engineering Chemistry: News Edition*, Volume 14, Number 19, 10 October 1936 (p. 385)

**Beguinus, Jean** ca. 1550–ca.1620  
 French chemist and first published chemist

Chymistry is the Art of dissolving natural mixed bodies, and of coagulating the same when dissolved, and of reducing into salubrious, safe, and grateful medicaments.  
*Tyrocinium Chymicum: Chemical Essays Acquired from Nature & Manual Experience*  
 Book One, Chapter I (p. 1)  
 Heptangle Books. Gillette, New Jersey, USA. 1983

**Bent, Henry Albert**  
 No biographical data available

Chemistry is the central subject in a liberal arts curriculum. It stands between the traditional humanities on the one hand and modern physics on the other hand.  
*Chemical and Engineering News*, March 12, 1984 (p. 44)

**Bernal, John Desmond** 1901–71  
 Irish-born physicist and x-ray crystallographer

Chemistry, far more than physics, was the dominant science of the nineteenth century. This is so, in spite of the fact that the major physical discoveries found their development and application in the steam engine at the beginning and electric power at the end of the century. With chemistry, however, there was a far larger number of new processes that could be turned more immediately to profitable use, and this afforded directly and indirectly for the training and employment of an ever-increasing number of chemists. Indeed from the beginning of the century and increasingly till its end the chemists were the most numerous of the newly differentiated groups of scientists.  
*Science and Industry in the Nineteenth Century* (pp. 70–72)  
 Indiana University Press. Bloomington, Indiana, USA. 1953

...the old chemistry was largely a matter of memory, a set of cookery recipes that had, for no apparent reason but to worry the student, to be learnt by heart.  
 In H.N. Parton  
*Science Is Human*  
 Science and the Liberal Arts (p. 17)  
 University of Otago Press. Dunedin, New Zealand. 1972

**Berthelot, Marcellin** 1827–1907  
 French chemist

Chemistry creates its objects.  
 In Jean-Marie Lehn  
*Supramolecular Chemistry: Concepts and Perspectives: A Personal Account Built upon the George Fisher Baker Lectures in Chemistry at Cornell University (and the Lezione Lincee, Accademia Nazionale dei Lincei, Roma*  
 Chapter 10.3 (p. 206)  
 VCH. Weinheim, Germany. 1995

**Berzelius, Jöns Jacob** 1779–1848  
 Swedish chemist

Of all the sciences contributing to medicine, chemistry is the primary one, and, apart from the general light it throws on the entire art of healing, it will soon bestow on some of its branches a perfection such as one never could have anticipated.  
 In J. Erik Jorpes  
*Jac. Berzelius* (p. 7)  
 University of California Press. Berkeley, California, USA. 1970

**Biggs, Noah** fl. 1651  
 English medical practitioner

I praise God who hath been so bountiful to me as to call me to the practise of Chymistry, out of the dregs of other Professions: Since Chymistry hath principles not drawn from fallacious reasonings, but such as are known by nature, & conspicuou by fire; and she prepareth the Intellect to penetrate, not the upper deck or surface of things, but the deep hold, the concentrick and hidden things of nature, and maketh an investigation into the America of nature...  
*The Vanity of the Craft of Physick* (p. 57)  
 Printed for Edward Blackmore. London, England. 1651

**Black, Joseph** 1728–99  
 Scottish chemist and physician

Chemistry is not yet a science. We are very far from the knowledge of first principles. We should avoid every thing that has the pretensions of a full system. The whole of chemical science should, as yet, be analytical, like Newton's Optics, in the form of a general law, at the very end of our induction, as the reward of our labour.  
*Lectures on the Elements of Chemistry* (Volume 1) (p. 547)  
 Mundell & Son. Edinburgh, Scotland. 1803

**Boerhaave, Herman** 1668–1738  
 Dutch chemist, physician, and botanist

But if anyone shall still retain a doubt of the worth and abilities of chymistry, to reward those who cultivate it: let him consider the practice and procedure of the happiest philosopher the world ever yet cou'd boast, the great Sir Isaac Newton: who, when he demonstrates the laws, the actions, and the powers of bodies, from a consideration of their effects, always produces chymical experiments for his vouchers; and when, to solve other phenomena, he makes use of these powers, his refuge is to chymistry.  
 In Arnold Thackray  
*Atoms and Powers: An Essay on Newtonian Matter — Theory and the Development of Chemistry*  
 Chapter 2 (p. 8)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1970

Chemistry is an Art, that teaches us how to perform certain physical operations, by which bodies that are discernible

by the senses, or that may be rendered so, and that are capable of being contained in vessels, may by suitable instruments be so changed, that particular determin'd effects may be thence produced, and the causes of those effects understood by the effects themselves, to the manifold improvement of various Arts.

*Elements of Chemistry*

Part II, Which Delineates the Theory (p. 19)

Printed for J. and J. Pemberton. London, England. 1735

### Boyle, Robert 1627–91

English natural philosopher and theological writer

For I observed, that of late Chymistry begins, as indeed it deserves, to be cultivated by Learned Men who before dispis'd it, and to be pretended to by many who never cultivated, that they may be thought not to ignore it...

*The Sceptical Chymist*

A Preface, Introductory (p. A2)

Dawsons of Pall Mall. London, England. 1965

### Bredwell, Stephen

English physician

I say in like manner, the art of Chimistrie is in it selfe the most noble instrument of naturall knowledges; but through the ignorance and impietie, partly of those that most audaciously professe it without skill and partly of them that impudently condemne that they knowe not, it is of all others most basely despised and scornfully rejected.

In John Gerarde

*The Herball or Generall Historie of Plantes*

Prefatory letter

Bonham & I. Norton. London, England. 1597

### Bridges, Robert Seymour 1844–1930

English poet

From Universal Mind the first-born atoms draw  
their function, whose rich chemistry the plants trans-  
mute to make organic life, whereon animals feed  
to fashion sight and sense and give service to man,  
who sprung from them is conscient in his last degree  
of ministry unto God, the Universal Mind,  
whither all effect returneth whence it first began.

*The Testament of Beauty*

Book IV, l. 116–122

Oxford University Press, Inc. Oxford, England. 1930

### Buchanan, Robert Williams 1841–1901

English poet and novelist

He read the great stone Book whereon is writ  
The riddle of the world from age to age;  
Knew the fair marvels of the Zodiac,  
The stars and their processions; had by heart  
The elemental truths of chemistry...

And zealously, within a mental maze,

As dense as that which covered Rosamond,

His teacher guarded him against the creeds.

*The Complete Poetical Works of Robert Buchanan* (Volume 2)

Justinian; Or, The New Creed, l. 256–263

Chatto & Windus. London, England. 1901

### Buchner, Edward 1860–1917

German chemist

We must never, therefore, let ourselves fall into the way of thinking “ignorabimus” (“We shall never know”), but must have every confidence that the day will dawn when even those processes of life which are still a puzzle today will cease to be inaccessible to us natural scientists.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1907

Cell-Free Fermentation (p. 119)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

It is difficult, however, for a person to be comprehensible and at the same time remain scientific, so I must ask you to bear with me.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1907

Cell-Free Fermentation (p. 103)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

### Meredith, Owen (Edward Robert Bulwer-Lytton, 1<sup>st</sup> Earl Lytton) 1831–91

English statesman and poet

“Friend, I believe in miracles? “ said he,

“And I believe in chemistry as well...”

*Glenaveril; or, the Metamorphoses*

Volume II, Book The Fourth The Guardians, Canto ii. John Steel, l. 463–464

D. Appleton & Company. New York, New York, USA. 1885

Chemistry, Soldier, trust me, is a science

Which now-a-days we sceptred students need

To study more than your rough art of war.

*Chronicles and Characters* (Volume 2)

The Duke's Laboratory, l. 234–236

Chapman & Hall. London, England. 1868

### Byron, George Gordon, 6<sup>th</sup> Baron Byron 1788–1824

English Romantic poet and satirist

No Chemistry for them unfolds her gases,

No Metaphysics are let loose in lectures,

No Circulating Library amasses

Religious novels, moral tales, and strictures

Upon the living manners, as they pass us;

No Exhibition glares with annual pictures;

They stare not on the stars from out their attics,

Nor deal (thank God for that!) in Mathematics.

*The Complete Poetical Works of Byron*

Beppo: A Venetian Story, l. 617–624

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

### Cady, Varian

No biographical data available

I think that I shall never see

A test as hard as Chemistry,

A test that makes you stir and squirm

And wonder if you'll pass this term,

A test that makes you tear your hair  
And wish you were not sitting there,  
A test that turns your hair to snow  
Because it asks you what you don't know.  
Tests are flunked by fools like me  
Especially when in Chemistry.

(Chemis)TREES

*Industrial and Engineering Chemistry: News Edition*, Volume 12, Number 22, 20 November 1934 (p. 419)

### **Caglioti, Luciano**

Italian chemist

Chemistry has invaded our lives, has provided us with new foods and new materials, has replaced wood and metal with less expensive products, has enabled low-income classes to acquire things that otherwise would have been inaccessible.

*The Two Faces of Chemistry*

Preface (p. xv)

The MIT Press. Cambridge, Massachusetts, USA. 1983

Chemistry... is one of the broadest branches of science, if for no other reason that, when we think about it, everything is chemistry.

*The Two Faces of Chemistry*

Preface (p. xv)

The MIT Press. Cambridge, Massachusetts, USA. 1983

### **Chakrabarti, C. L.**

No biographical data available

Analytical chemistry, like Cleopatra's beauty, is of infinite variety.

*Journal of Chemical Education*, Volume 47, 1970 (p. 58)

### **Chaptal, Jean-Antoine-Claude**

No biographical data available

How immense is the empire of chemistry! It embraces in its studies all the phenomena which nature presents to our view, in the infinite variety of her productions, and all the processes of the arts for which we are indebted to human ingenuity.

*Chemistry Applied to Arts and Manufacturing*

Book I (pp. 2–3)

R. Phillips. London, England. 1807

### **Collingwood, Robin George** 1889–1943

English historian and philosopher

Egregious blunder! A beginner in physics or chemistry does not know what matter is, and if he thinks he does it is the duty of his teacher to disabuse him; but he knows what physics or chemistry is; it is the stuff in this red textbook, or the stuff old So-and-So teaches, or the stuff we have on Tuesday mornings.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*

Part I, Chapter I, aphorism I.42 (p. 3)

At The Clarendon Press. Oxford, England. 1942

### **Cram, Donald J.** 1919–2001

American chemist

The chemistry of the day, to get done, had to be driven by the thought that it is the most important thing in the world, but the chemistry of the paper, thesis, or monograph requires perspective, context, and balanced judgment.

*From Design to Discovery*

Personal Notes (p. 3)

American Chemical Society. Washington, D.C. 1990

### **Cullen, William** 1710–90

Scottish physician and chemist

Chemistry is the art of separating mixt bodies into their constituent parts and of combining different bodies or the parts of bodies into new mixts for the purposes of philosophy and arts, that is, for the purposes of philosophy by explaining the composition of bodies, the nature of mixture and the properties of bodies thereon depending, and for the purposes of arts by producing several artificial substances more suitable to the intention of various arts than any natural productions are.

In A.L. Donovan

*Philosophical Chemistry in the Scottish Enlightenment*

Chapter 6 (p. 98)

At The University Press. Edinburgh, Scotland. 1975

### **Curie, Marie Skłodowska** 1867–1934

French physical chemist

... we have here an entirely separate kind of chemistry for which the current tool we use is the electrometer, not the balance, and which we might well call the chemistry of the imponderable.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1911

Radium and the New Concepts in Chemistry (p. 211)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

### **Dana, James Dwight** 1813–95

American geologist

Science has no explanation for the origin of Life. The living organism instead of being a product of physical or chemical forces, controls these forces for its highest forms.

*Manual of Geology. Treating of the Principles of the Science with Special Reference to American Geological History*

Ivison, Blakeman, Taylor & Co. New York, New York, USA. 1880

### **Davy, Sir Humphry** 1778–1829

English chemist

It may be said of modern chemistry, that its beginning is pleasure, its progress knowledge and its object truth and utility.

*Consolations in Travel; or The Last Days of a Philosopher*

Dialogue V (p. 251)

John Murray. London, England. 1830

Chemistry relates to those operations by which the intimate nature of bodies is changed, or by which they acquire new properties. This definition will not only apply to the effects of mixture, but to the phenomena of electricity, and in short to all the changes which do not merely depend upon the motion or division of masses of matter.

*Consolations in Travel; or the Last Days of a Philosopher*  
Dialogue V (pp. 247–248)  
John Murray. London, England. 1830

Chemistry is that part of Natural Philosophy which relates to those intimate actions of bodies upon each other, by which their appearances are altered, and their individuality destroyed.

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 5)  
Press of the Royal Institution of Great Britain. London. 1802

...at no very distant period the whole science [chemistry] will be capable of elucidation by mathematical principles.

*Elements of Chemical Philosophy*  
Part I, Volume I, Introduction (p. 60)  
Printed for J. Johnson & Company. London, England. 1812

**de Balzac, Honoré** 1799–1850  
French novelist

You are dressed so coquettishly to talk about chemistry.

*The Quest of the Absolute* (p. 73)  
The Macmillan Company. New York, New York, USA. 1901

Modern chemistry is...much, and yet little. Much has been accomplished, for chemistry has learned to shrink before no difficulties; little, because what has been accomplished is as nothing compared with what remains to do.

*The Quest of the Absolute* (p. 76)  
The Macmillan Company. New York, New York, USA. 1901

**de Unamuno, Miguel** 1864–1936  
Spanish philosopher and writer

...chemistry ought to be not for chemists alone.

*The Tragic Sense of Life*  
Chapter XII (p. 356)  
Princeton University Press. Princeton, New Jersey, USA. 1972

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

A formidable array of bottles and test-tubes, with the pungent cleanly smell of hydrochloric acid, told me that he had spent his day in the chemical work which was so dear to him. "Well, have you solved it?" I asked as I entered. "Yes. It was the bisulphate of baryta."

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
A Case of Identity (p. 413)  
Wings Books. New York, New York, USA. 1967

**du Fresnoy, Nicholas Langlet** 1674–1755  
French historian of alchemy

It is necessary to note that there are two kinds of chemistry; the one wise and reasonable, even necessary for the extraction of useful remedies from all things in nature...: the other is that foolish and senseless chemistry which is nevertheless the older of the two.... The first has been given the name of Chemistry, and the second that of Alchemy.

In Allen G. Debus  
*The French Paracelsians*  
Chapter 6 (p. 203)  
Cambridge University Press. Cambridge, England. 1991

**Duffy, Carol Ann** 1955–  
Scottish poet, playwright, and writer

The words you spoke were frenzied prayers to chemistry....

*From the Other Country*  
Dream of a Lost Friend, 1. 9  
Anvil Press Poetry. London, England. 1990

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

In chemistry, our theories are crutches; to show that they are valid, they must be used to walk.... A theory established with the help of twenty facts must explain thirty, and lead to the discovery of ten more.

*Lecons de philosophie chimique* (p. 60)  
Publisher data not available

**Duncan, Robert** 1919–88  
American poet

Chemistry having its equations beyond our range of in-equation.

*Bending the Bow*  
Orders Passage 24, 1. 75–76  
New Directions. New York, New York, USA. 1968

**Edgeworth, Maria** 1767–1849  
English writer

...chemistry is a science particularly suited to women, suited to their talents and their situation. Chemistry is not a science of parade, it affords occupation and infinite variety; it demands no bodily strength, it can be pursued in retirement, it applies immediately to useful and domestic purposes; and whilst the ingenuity of the most intensive mind may be exercised, there is no danger of inflaming the imagination; the judgment is improved, the mind is intent upon realities, the knowledge that is acquired is exact, and the pleasure of the pursuit is a sufficient reward for the labour.

*Letters for Literary Ladies to Which Is Added an Essay on the Noble Science of Self-Justification*  
Answer to the Preceding Letter (pp. 39–40)  
Joseph Milligan. Georgetown, D.C. 1810



**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

‘Tis a short sight to limit our faith in laws to those of gravity, of chemistry, of botany, and so forth.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Worship (p. 1065)

The Library of America. New York, New York, USA. 1983

Chemistry takes to pieces, but it does not construct.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

The Conduct of Life

Chapter VII (p. 282)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Chemistry began by saying it would change the baser metals into gold. By not doing that it has done much greater things.

*Journals of Ralph Waldo Emerson 1824–1832*

January 22, 1830 (p. 288)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Faraday, Michael** 1791–1867

English physicist and chemist

Chemistry is necessarily an experimental science: its conclusions are drawn from data, and its principles supported by evidence derived from facts.... Hence the importance of multiplying facts by every possible means, while engaged in such pursuits; and hence Chemistry is necessarily an experimental science.

*Chemical Manipulation*

Introduction

Printed and Published by W. Phillips. London, England. 1827

It is the great beauty of our science, CHEMISTRY, that advancement in it, whether in a degree great or small, instead of exhausting the subjects of research, opens the doors to further and more abundant knowledge, overflowing with beauty and utility, to those who will be at the easy personal pains of understanding its experimental investigations.

*Experimental Researches in Electricity* (Volume 1)

Seventh Series, 871 (p. 257)

Richard and John Edward Taylor. London, England. 1839–1855

**Farber, Eduard** 1892–1969

Galician chemist

The evolution of chemistry is a drama written and enacted by the great chemists.

*Great Chemists*

Preface (p. ix)

Interscience. New York, New York, USA. 1961

**Fischer, Emil** 1852–1919

German chemist

The circle within which the individual research worker, especially as an experimenter, can distinguish himself is continually shrinking in size. Consequently the progress

of science today is not so much determined by brilliant achievements of individual workers, but rather by the planned collaboration of many observers.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1902

Syntheses in the Purine and Sugar Group (p. 35)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

...the veil behind which Nature has so carefully concealed her secrets is being lifted where the carbohydrates are concerned. Nevertheless, the chemical enigma of Life will not be solved until organic chemistry has mastered another, even more difficult subject, the proteins, in the same way as it has mastered the carbohydrates.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1902

Syntheses in the Purine and Sugar Group (p. 34)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Flory, Paul J.** 1910–85

American physical chemist

...to hold that all chemistry follows deductively from physics and dismiss the matter therewith is to overlook the central role of science in erecting constructs for representation of physical reality in terms rational to the human mind...to present chemistry as a deductive science is to conceal the historical foundations and conceptual framework of the science of molecules and molecular behavior. This viewpoint could conceivably lead ultimately to denial of the rightful existence of chemistry as a separate discipline.

*The Science of Molecules*

*Chemical Engineering News*, Volume 52, Number 30, 1974 (p. 25)

**Fownes, George** 1815–49

English chemist

The Science of Chemistry has for its object the study of the nature and the properties of all the materials which enter into the composition or structure of the earth, the sea, and the air...The highest efforts of Chemistry are constantly directed to the discovery of the general laws or rules which regulate the formation of chemical compounds, and determine the action of one substance upon another. These laws are deduced from careful observation and comparison of the properties and relations of vast numbers of individual substances; — and by this method alone. The science is entirely experimental, and all its conclusions the result of skilful and systematic experimental investigations.

*A Manual of Elementary Chemistry, Theoretical and Practical*

Introduction (p. 37)

Henry C. Lea. Philadelphia, Pennsylvania, USA. 1870

**Glaser, Christophe** 1615–78

Swiss chemist

They that have any true knowledge of this Noble Art, are without doubt fully persuaded of the usefulness of it; for

it is the key which alone can unlock to all Naturalists the door of Nature's secrets...

*The Compleat Chymist; or a New Treatise of Chymistry*

Chapter II (p. 3)

Printed for John Starkey. London, England. 1677

### **Haber, Fritz** 1868–1934

German physical chemist

Nitrogen bacteria teach us that Nature, with her sophisticated forms of the chemistry of living matter, still understands and utilizes methods which we do not as yet know how to imitate. Let it suffice that in the meantime improved nitrogen fertilization of the soil brings new nutritive riches to mankind and that the chemical industry comes to the aid of the farmer who, in the good earth, changes stones into bread.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1918

The Synthesis of Ammonia from Its Elements (p. 339)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

### **Halbach, Mary Jayne**

No biographical data available

I think that I shall never see

A study as muddled as chemistry,

A study hidden in ponderous books,

Where only a chemist ever looks!

A study written in secret code —

Just numerous equations by the load!

Chemistry was and is and will be —

But I'll never know what it means to me!

Sentiment of a Would-Be Chemistry Student

*Industrial and Engineering Chemistry: News Edition*, Volume 10, Number 20, 20 October 1932 (p. 257)

### **Haldane, John Burdon Sanderson** 1892–1964

English biologist

Chemistry is not haunted by the phlogiston theory as Christianity is haunted by the theory of a God with a craving for bloody sacrifices.

*Possible Worlds and Other Papers*

Chapter XXXI (p. 243)

Harper & Brothers Publishers. New York, New York, USA. 1928

### **Hinshelwood, Sir Cyril** 1897–1967

English chemist

What the Society is and must continue above all else to be is a fellowship of those who share the love of chemistry, that most splendid child of intellect and art. Chemistry provides not only a mental discipline, but an adventure and an aesthetic experience. Its followers seek to know the hidden causes which underlie the transformations of our changing world, to learn the essence of the rose's colour, the lilac's fragrance, and the oak's tenacity, and to understand the secret paths by which the sunlight and the air create these wonders.

Centenary Celebration of the Chemical Society

*Journal of the Chemical Society of London*, 1947 (p. 1277)

### **Hoffer, Eric** 1902–83

American longshoreman and philosopher

The chemistry of dissatisfaction is as the chemistry of some marvelously potent tar. In it are the building stones of explosives, stimulants, poisons, opiates, perfumes and stench.

*The Passionate State of Mind, and Other Aphorisms*

No. 14

Harper and Brothers. New York, New York, USA. 1955

### **Hoffmann, Roald** 1937–

Polish-born American chemist

These chemicals we desire and fear (chemists call them compounds or molecules, once they are reasonably pure) are not the largest (the realm of astronomy), nor the smallest (part of physics). They are squarely, nicely in the middle, on our human scale. Which is why we care about them, not as distanced, hypothetical constructs, but in this world. Those molecules, of pharmaceutical or pollutant, are of just the right size to interact, for better or for worse, with the molecules of our bodies.

*The Same and Not the Same*

Preface (p. xiv)

Columbia University Press. New York, New York, USA. 1995

Atoms are nice, atoms are fundamental, but they're not chemistry. Chemistry is about molecules, the fixed but transformable way in which atoms get together for a while.

*Chemistry Imagined: Reflections on Science*

Smithsonian Institution Press. 1993

### **Hofmann, A. W.**

No biographical data available

Organic chemistry before Kekulé spread his wings was like a merrily splashing torrent; there were so many stones in the water that one could still cross it without getting wet. Today, the torrent has become a deep and massive stream; the eye can hardly see the opposite bank, and proud, richly loaded fleets rock gently on its broad surface.

In W.H. Brock, O.T. Benfey and S. Stark

Hofmann's Benzene Tree at the Kekulé Festivities

*Journal of Chemical Education*, Volume 68, 1991

### **Holmes, Harry N.**

No biographical data available

While you yawn comfortably in your easy chair, chemistry wages desperate battles on many fronts — against man's insect enemies, yet dominant on earth; against disease bacteria that have from time to time threatened to exterminate the race of men; against the frowns and mysteries of Nature.

*Out of the Test Tube*

Preface (p. ix)

Emerson Books, Inc. New York, New York, USA. 1941

### Horne, R. A.

No biographical data available

If you bemoan technological compartmentalization, take hope! Consider environmental chemistry. Man is a chemical mote aswim in a chemical soup. All the changes about him, all the changes within him are chemical. Everything he sees and touches, everything he does, and the effect of what he does are chemical. If there is anything in the real world that does not fit under the rubric of environmental chemistry, then I am at a loss to find it.

*The Chemistry of Our Environment*

Preface (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1978

### Huxley, Thomas Henry 1825–95

English biologist

Looking back through the prodigious vista of the past, I find no record of the commencement of life, and therefore I am devoid of any means of forming a definite conclusion as to the conditions of its appearance. Belief, in the scientific sense of the word, is a serious matter, and needs strong foundations. To say, therefore, in the admitted absence of evidence, that I have any belief as to the mode in which existing forms of life originated, would be using words in a wrong sense. But expectation is permissible where belief is not; and if it were given to me to look beyond the abyss of geologically recorded time to the still more remote period when the Earth was passing through physical and chemical conditions which it can no more see again than a man can recall his infancy, I should expect to be a witness of the evolution of living protoplasm from not-living matter.

*Collected Essays* (Volume 8)

Biogenesis and Abiogenesis (p. 256)

Macmillan & Company Ltd. London, England. 1904

Medicine was the foster-mother of Chemistry, because it has to do with the preparation of drugs and the detection of poisons; of Botany, because it enabled the physician to recognise medicinal herbs; of Comparative Anatomy and Physiology, because the man who studied Human Anatomy and Physiology for purely medical purposes was led to extend his studies to the rest of the animal world.

*Collected Essays* (Volume 3)

*Science and Education*

Universities: Actual and Ideal (p. 213)

Macmillan & Company Ltd. London, England. 1904

### Janssen, Johannes 1829–81

Roman Catholic German historian

Chemistry is the true and living anatomy...

Translated by A.M. Christie

*History of the German People at the Close of the Middle Ages*

Volume XIV, Chapter VI (p. 5)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1909

...the doctor must be a chemist also, and medicine and chemistry cannot be separated from each other.

Translated by A.M. Christie

*History of the German People at the Close of the Middle Ages*

Volume XIV, Chapter VI (p. 7)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1909

### Jefferson, Thomas 1743–1826

3<sup>rd</sup> president of the United States

If you are obliged to neglect any thing, let it be your chemistry. It is the least useful and the least amusing to a country gentleman of all the ordinary branches of science.

In E.M. Betts and J.A. Bear, Jr. (eds.)

*The Family Letters of Thomas Jefferson*

Letter

January 3, 1809, to Thomas Jefferson Randolph (p. 377)

### Kant, Immanuel 1724–1804

German philosopher

...chemistry can become nothing more than a systematic art or experimental doctrine, but never a science proper...

Translated by James Ellington

*Metaphysical Foundations of Natural Science*

Preface (p. 7)

The Bobbs-Merrill Company, Inc. Indianapolis, Indiana, USA. 1970

### Keosian, J.

No biographical data available

The materialist theory of the origin of life from inanimate beginnings recognizes the role of chance in the interactions of matter in the universe, but views the overall developments as in no way accidental; on the contrary, it is looked upon as inevitable, almost inexorable, outcome of the emergence and operation of natural laws.

In D.J. Depew and B.H. Weaver (eds.)

*Molecular Evolution: Prebiological and Biological*

The Origin of Life Problem – A Brief Critique (p. 14)

Plenum Press. New York, New York, USA. 1972

### Klaproth, Martin Heinrich 1743–1817

German chemist

No science has ever made more rapid progress in a shorter time than chemistry.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 316)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

### Knight, David

No biographical data available

Now that God has given us chemistry let us enjoy it.

*Ideas in Chemistry: A History of the Science*

Chapter 1 (p. 12)

Athlone. London, England. 1992

Chemistry seems in our day more a business of questions difficult to answer than of questions difficult to ask.

*Ideas in Chemistry: A History of the Science*

Chapter 13 (p. 171)

Athlone. London, England. 1992

Chemistry can thus be seen as a kind of scientific cookery, its ideas only of interest to those involved in it and perhaps their wives, biographers or psychiatrists...

*Ideas in Chemistry: A History of the Science*

Chapter 1 (p. 1)

Athlone. London, England. 1992

### **Kornberg, Arthur** 1918–

American biochemist

Life, after all, is only chemistry, in fact, a small example of chemistry observed on a single, mundane planet.

*International Journal of Quantum Chemistry*, Volume 53, 1995

### **Kunckel, Johann** 1630?–1703

German alchemist

Chemistry is without contradiction one of the most useful arts and it would be no exaggeration to call it the mother or the instructress of other arts; she alone can teach us to interpret the Sacred Scriptures; she alone teaches us the work of God; and it is thanks to her that we understand the Creation and the material world; Physics and medicine are her dependents; and again, she serves as the foundation for the science of animals and vegetables.

In Allen G. Debus

*The Chemical Philosophy* (Volume 2)

Chapter 7 (p. 464 & 467).

Science History Publications. New York, New York, USA. 1977

### **Latham, Peter Mere** 1789–1875

English physician

Sagacious observers and experimenters have, in these later days, gone nigh to show that there is a chemistry within us which is cooperative with life; that making good its work, it gives to our bodies the materials of their health; and that doing its work faultily, it suffers noxious things to form, which become the elements of their diseases.

In William B. Bean

*Aphorisms from Latham* (p. 89)

Prairie Press. Iowa City, Iowa, USA. 1962

Let no man who is making his entrance into the medical profession henceforth ever neglect chemistry. Chemistry was once thought to be conversant only with the physiology of external nature; but every day is bringing us to look more and more to chemistry to explain the physiology of our own bodies.

In William B. Bean

*Aphorisms from Latham* (p. 89)

Prairie Press. Iowa City, Iowa, USA. 1962

Chemical experiment and clinical observation, leading each other by the hand, proceed together, and arrive at the seminal principal of the disease.

In William B. Bean

*Aphorisms from Latham* (p. 93)

Prairie Press. Iowa City, Iowa, USA. 1962

### **Lavoisier, Antoine Laurent** 1743–94

French chemist

This science [chemistry] still has many chasms, which interrupt the series of facts, and often render it extremely difficult to reconcile them with each other: It has not, like the elements of geometry, the advantage of being a complete science, the parts of which are all closely connected together: Its present progress, however, is so rapid, and the facts, under the modern doctrine, have assumed so happy an arrangement, that we have ground to hope, even in our own times, to see it approach near to the highest state of perfection of which it is susceptible.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xx)

Printed for William Creech. Edinburgh, Scotland. 1790

...as chemistry advances towards perfection by dividing and subdividing, it is impossible to say where it will end; and these things we at present suppose simple may soon be found quite otherwise.

*Elements of Chemistry in a New Systematic Order*

Part II, Section I (p. 177)

W. Creech. Edinburgh, Scotland. 1790

### **Le Fèvre, Nicholas**

No biographical data available

Chymistry is the true Key of Nature.

In Allen G. Debus

*The French Paracelsians*

Chapter 4 (p. 126)

Cambridge University Press. Cambridge, England. 1991

Chymistry is nothing else but the Art and Knowledge of Nature it self; that it is by her means we examine the Principles out of which natural bodies do consist and are compounded; and by her are discovered unto us the causes and sources of their generations and corruptions, and of all the changes and alterations to which they are liable:.... [Further] it is known, that the ancient Sages have taken from Chymistry, the occasions and true motives of reasoning upon natural things, and that their monuments and writings do testify this Art to be of no fresher date than Nature it self.

*A Compleat Body of Chymistry*

The Preface (p. 1)

Printed for O. Pully. London, England. 1640

### **Le Noble, William J.**

No biographical data available

It may sound like a lot of work to keep up with organic chemistry, and it is; however, those who haven't the time to do it become subject to decay in the ability to teach and contribute to the Science — a sort of first-order process the half-life of which can't be much more than a year or so.

*Highlights of Organic Chemistry*

Chapter 3 (p. 112)

Marcel Dekker, Inc. New York, New York, USA. 1974

### Lederman, Leon 1922–

American high-energy physicist

I started out as a molecules kid. In high school and early college I loved chemistry, but I gradually shifted toward physics, which seemed cleaner — odorless, in fact.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 5)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### Lehn, Jean-Marie 1939–

French chemist

The essence of chemistry is not only to discover but to invent, and, above all, to create. The book of chemistry is not only to be read but to be written! The score of chemistry is not only to be played but to be composed!

In Ehud Keinan and Israel Schecheter (eds.)

*Chemistry for the 21<sup>st</sup> Century*

Chapter 1, Section 1.3 (p. 7)

Wiley-VCH. Weinheim, Germany. 2001

### Lemaire, Eugene

No biographical data available

Chemistry respects nothing.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1906*

The Role of Chemistry in Painting (p. 453)

Government Printing Office. Washington, D.C. 1907

### Lemery, Nicolas 1645–1715

French chemist

Chymistry is an Art that teaches how to separate the different substances which are found in Mixt Bodies...

*A Course of Chemistry*

Of Chemistry in General (p. 1)

London, England. 1675

### Levi, Primo 1919–87

Italian writer and chemist

To botch an analysis was worse: perhaps because unconsciously one realized that the judgment of men (in this case the professors) is arbitrary and debatable, while the judgment of things is always inexorable and just: this law is the same for all.

*Other People's Trades*

The Mark of the Chemist (p. 99)

Summit Books. New York, New York, USA. 1989

This salt [stannous chloride], in itself, is odorless, but it reacts in some manner with the skin, perhaps reducing the keratin's disulfide bridges and giving off a persistent metallic stench that for several days announces to all that you are a chemist.

*The Periodic Table*

Tin (p. 188)

Schocken Books. New York, New York, USA. 1984

[The therapy] was found pretty soon, drawing on good inorganic chemistry, that distant Cartesian island, a lost paradise, for us organic chemists, bunglers, "students of gunk"...

*The Periodic Table*

Chromium (p. 157)

Schocken Books. New York, New York, USA. 1984

There was no need to get from Caselli the other raw material, the partner of zinc, that is, sulfuric acid: it was there in abundance in every corner. Concentrated, of course: and you had to dilute it with water; but watch out! it is written in all the treatises, one must operate in reverse, that is, pour the acid in the water and not the other way around, otherwise that innocuous-looking oil is prone to wild rages: this is known even to the kids in *liceo*.

*The Periodic Table*

Zinc (p. 33)

Schocken Books. New York, New York, USA. 1984

The lab is a place for the young, and returning there you feel young again: with the same longing for adventure, discovery, and the unexpected that you have at seventeen.

*The Periodic Table*

Uranium (p. 198)

Schocken Books. New York, New York, USA. 1984

It [the fact the fossils of wooden tools are rare] should remind us that wood, like all organic substances, is stable only in appearance. Its mechanical virtues go hand in hand with an intrinsic chemical weakness. In our atmosphere rich in oxygen, wood is stable more or less like a billiard ball placed on a horizontal shelf edged by a border no thicker than a sheet of tissue paper. It can remain there for a long time, but the tiniest push, or even a faint breath of air, will be enough to make it go past the barrier and drop to the ground. In short, wood is anxious to oxidize, that is, to destroy itself.

*Other People's Trades*

Stable/Unstable

Summit Books. New York, New York, USA. 1989

In this place, too, nobody wasted many words teaching us how to protect ourselves from acids, caustics, fires, and explosions; it appeared that the Institute's rough and ready morality counted on the process of natural selection to pick out those among us most qualified for physical and professional survival. There were few ventilation hoods; each student, following his text's prescriptions,

in the course of systematic analysis, conscientiously let loose into the air a good dose of hydrochloric acid and ammonia, so that a dense, hoary mist of ammonium chloride stagnated permanently in the lab, depositing minute scintillating crystals on the windowpanes.

*The Periodic Table*

Iron (p. 39)

Schocken Books. New York, New York, USA. 1984

...for me chemistry represented an indefinite cloud of future potentialities which enveloped my life to come in black volutes torn by fiery flashes, like those which had hidden Mount Sinai. Like Moses, from that cloud I expected my law, the principle of order in me, around me, and in the world...I would watch the buds swell in spring, the mica glint in the granite, my own hands, and I would say to myself:

*The Periodic Table*

Hydrogen (pp. 22–23)

Schocken Books. New York, New York, USA. 1984

...all honor to the pickax and its modern equivalents; they are still the most important intermediaries in the millennial dialogue between the elements and man...

*The Periodic Table*

Carbon (p. 226)

Schocken Books. New York, New York, USA. 1984

### Lewes, G. H.

No biographical data available

Physics treat of Masses acting at sensible distances. Chemistry treats of Molecules acting at insensible distances.

In G.H. Lewes

*Comte's Philosophy of the Sciences*

Section XI (p. 113)

Henry C. Bohn. London, England. 1853

### Lewis, Gilbert Newton 1875–1946

American chemist

The fact is that physical chemistry no longer exists. The men who have been called physical chemists have developed a large number of useful methods by which the concrete problems of inorganic chemistry, organic chemistry, biochemistry, and technical chemistry may be attacked, and as the applications of these methods grow more numerous, it becomes increasingly difficult to adhere to our older classification.

In J.W. Servos

*Physical Chemistry Ostwald to Pauling: The Making of Science in America*

Chapter 7 (p. 310)

Princeton University Press. Princeton, New Jersey, USA. 1990

I have attempted to give you a glimpse...of what there may be of soul in chemistry. But it may have been in vain. Perchance the chemist is already damned and the guardian the blackest. But if the chemist has lost his soul,

he will not have lost his courage and as he descends into the inferno, sees the rows of glowing furnaces and sniffs the homey fumes of brimstone, he will call out: "Asmodeus, hand me a test tube."

In Derek A. Davenport

Gilbert Newton Lewis: 1875–1946

*Journal of Chemical Education*, Volume 61, 1984 (p. 2)

### Lewis, Sinclair 1885–1951

American novelist

Organic chemistry! Puzzle chemistry! Stink chemistry! Drug-store chemistry! Physical chemistry is power, it is exactness, it is life.

*Arrowsmith*

Chapter II, Section III (p. 14)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

### Libby, Willard F.

No biographical data available

Chemistry is increasingly important to the peaceful atom. In fact, in the next few years, the chemist may be the most important contributor.

Address

Manufacturing Chemists' Association, Inc., November 25, 1998, New

York

### Lichtenberg, Georg Christoph 1742–99

German physicist and satirical writer

He who understands nothing but chemistry doesn't even understand chemistry.

In Philip Ball

*Designing the Molecular World: Chemistry at the Frontier*

Introduction (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 1994

### Little, Arthur D.

No biographical data available

Chemistry is a creative science...and the first chapter of its Book of Genesis is not yet written.

In David H. Killeffer

*Chemical Engineering*

Chapter 10 (p. 130)

Doubleday & Company, Inc. Garden City, New York, USA. 1967

### Loos, Anita 1889–1981

American screenwriter, playwright, and author

There's nothing colder than chemistry.

*Kiss Hollywood Good-by*

Chapter 21 (p. 193)

The Viking Press. New York, New York, USA. 1974

### Meredith, Owen (Edward Robert Bulwer-Lytton, 1<sup>st</sup> Earl Lytton) 1831–91

English statesman and poet

"Friend, I believe in miracles?" said he,

"And I believe in chemistry as well..."

*Glenaveril; or, the Metamorphoses*

Volume II, Book The Fourth The Guardians, Canto ii. John Steel, l. 463–464

D. Appleton & Company. New York, New York, USA. 1885

Chemistry, Soldier, trust me, is a science

Which now-a-days we sceptred students need

To study more than your rough art of war.

*Chronicles and Characters* (Volume 2)

The Duke's Laboratory, l. 234–236

Chapman & Hall. London, England. 1868

### Mackenzie, Colin

No biographical data available

The Science of Chemistry is the knowledge of the relations of those phenomena, or changes, which take place in the sensible qualities of bodies, as results of the action of one species of matter on another.

*One Thousand Experiments in Chemistry*

Introduction (p. v)

Printed for Sir Richard Phillips & Company. London, England. 1821

### Mann, Thomas 1875–1955

German-born American novelist

Soon or late, division must yield “units” which, even though in composition, were not organized, and which mediated between life and absence of life; molecular groups, which represented the transition between vitalized organization and mere chemistry.

*The Magic Mountain*

Chapter V

Research (p. 283)

Alfred A. Knopf. New York, New York, USA. 1966

### Mayo, William J. 1861–1939

American physician

Life is largely a matter of chemistry.

The Advancement of Learning in Medicine Through Biochemistry

*Industrial and Engineering Chemistry: News Edition*, Volume 20, 1928

### Melville, Herman 1819–91

American novelist

In physical chemistry, as in other sciences, progress usually occurs by a series of rather discontinuous steps separated by periods of consolidation. Thus certain topics and branches of a subject become popular fields of activity once the pioneering work has defined the field of endeavor. Thereafter papers flow in ever-increasing numbers.

High Polymers

*Transactions of The Faraday Society*, Volume 49, 1953

### Mendeleev, Dmitry 1834–1907

Russian chemist

In sciences like chemistry, which treat of ideas as well as of the substances of nature, experience demonstrates at every step that the work of the past has availed much and that without it it would be impossible to advance “into the ocean of the unknown.”

*Principles of Chemistry* (Volume 1)

Preface (p. viii)

Longmans, Green & Company. London, England. 1891

### Mittasch, Alwin 1869–1953

German chemist

Chemistry without catalysis, would be a sword without a handle, a light without brilliance, a bell without sound.

In R.E. Oesper

Alwin Mittasch

*Journal of Chemical Education*, Volume 25, 1948 (pp. 531–532)

### Muir, M. M. Pattison 1848–1931

British chemist and author

The purpose of chemistry seems to have changed much from time to time. At one time chemistry might have been called a theory of life, and at another time a department of metallurgy: at one time a study of combustion, and at another time an aid to medicine, at one time an attempt to define a single word, the word element, and at another time the quest for the unchanging basis of all phenomena. Chemistry has appeared to be sometimes a handicraft, sometimes a philosophy, sometimes a mystery, and sometimes a science.

*A History of Chemical Theories and Laws*

Introduction (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1906

The more I try to understand chemistry, the more I am convinced that the methods, achievements, and aims of the science can be realized only by him who has followed the gradual development of chemical ideas.

*A History of Chemical Theories and Laws*

Preface (p. v)

John Wiley & Sons, Inc. New York, New York, USA. 1906

Chemistry is a universal science: it was founded by many whose memories are forgotten. The foundations of chemistry are laid deep in the experiences, the hopes, the visions of mankind.

*A History of Chemical Theories and Laws*

Part I, Chapter I (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1906

### Nernst, Walther 1864–1941

German physicist and chemist

...generally speaking it is better, where possible in natural science, to study objects of research independently of the accidents of their historical development.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1920

Studies in Chemical Thermodynamics (p. 354)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

### Newman, Joseph S. 1892–1960

American poet

Thus man, in essence, seems to be

A problem based on chemistry.

*Poems for Penguins, and Other Lyrical Lapses*

Biochemistry

Greenburg. New York, New York, USA. 1941

**Olah, George A.** 1927–

Hungarian chemist

Humanity's drive to uncover the secrets of life processes and to use this knowledge to improve human existence has led to spectacular advances in the biological and health sciences. Chemistry richly contributes to these advances by helping to increase our understanding of processes at the molecular level, and it provides many of the methods and techniques of biotechnology. However, chemistry is not just an adjunct of biology and biotechnology. It is and always will be a central science in its own right.

Editorial

*Science*, Volume 270, Number 5241, December 1, 1995 (p. 1417)

**Oparin, Alexander Ivanovich** 1894–1980

Russian biochemist

It has now become quite clear that the origin of life was not the result of some "happy chance" as was thought till quite recently, but a necessary stage in the evolution of matter. The origin of life is an inalienable part of the general process of the development of the universe and, in particular, the development of the earth.

In R. Buvet and C. Ponnampertua (eds.)

*Chemical Evolution and the Origin of Life*

Problem of the Origin of Life: Present State and Prospects (pp. 3–4)

North-Holland Publishing Company. Amsterdam, Netherlands. 1971

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Professional chemists look askance at physiological chemistry, and physiological chemists criticize pretty sharply the work of some clinical chemists, but there can be no doubt of the value to the physicians of a very thorough training in methods and ways of organic chemistry.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Internal Medicine as a Vocation (p. 137)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

...the physician without physiology and chemistry flounders along in an aimless fashion, never able to gain any accurate conception of disease, practising a sort of pop-gun pharmacy, hitting now the malady and again the patient, he himself not knowing which.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Teaching and Thinking (p. 121)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Ostwald, Friedrich Wilhelm** 1853–1932

Latvian-born German chemist

I have fortunately been proved wrong in that prediction demonstrates how far I underestimated that as science

progressively developed and as its nature and attributes became more and more familiar, mankind's appreciation and acceptance of scientific progress has steadily accelerated.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1909

On Catalysis (p. 151)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Packe, Christopher** 1604–1670

German-Dutch chemist

The Art of Chymistry, (Honoured Sir) although in its speculations most Noble and Delectable to a Philosophic Mind, and in its Practice highly Inservient, and Beneficial to Mankind; yet hath it not escaped Obloquies, the false Imputations of Detractors, and Calumniators, who either through Ignorance, Idleness, or Envoy (or all of the cojoined) have made a false Representation of this most Noble Art to the World, and endeavored to set Mankind at the greatest distance from that which is its highest interest to court.

In Johann Glauber

Translated by Christopher Packe

*The Works of the Highly Experienced and Famous Chymist, John Rudolph Glauber to The Honoured, and Truly Learned, Edmond Dickenson, M.D.* (p. 2)

Printed by Thomas Wilbourn. London, England. 1689

**Pallister, William Hales** 1877–1946

Canadian physician

This is the quest for you and me,  
Are men twigs on the chemis-tree?

When X is life, and time is T,

Sp is space, and vast force is E,

When Y is thought, dimension D:

Does  $X = C_{50}O_{100}O_{250}N_{250}S_{50} + P?$

*Poems of Science*

Protoplasm (p. 75)

Playford Press. New York, New York, USA. 1931

**Pauling, Linus** 1901–94

American chemist

There is more to chemistry than an understanding of general principles. The chemist is also, perhaps even more, interested in the characteristics of individual substances — that is, of individual molecules.

In Mary Jo Nye

*Before Big Science*

Chapter 6 (p. 188)

Prentice-Hall International. London, England. 1996

Every aspect of the world today — even politics and international relations — is affected by chemistry.

*Chemical Engineering News*, 16 April 1984

Chemistry is wonderful! I feel sorry for people who don't know anything about chemistry. They are missing an important source of happiness.



In Barbara Marinacci (ed.)

*Linus Pauling in His Own Words*

Chapter 2 (p. 43)

Simon & Schuster. New York, New York, USA. 1885

**Plath, Sylvia** 1932–63

American poet and novelist

I knew chemistry would be worse, because I'd seen a big chart of the ninety-odd elements hung up in the chemistry lab, and all the perfectly good words like gold and silver and cobalt and aluminum were shortened to ugly abbreviations with difficult decimal numbers after them. If I had to strain my brain with any more of that stuff I would go mad.

*The Bell Jar*

Chapter Three (p. 37)

Faber & Faber Ltd. London, England. 1966

**Plummer, Andrew**

Scottish chemist

Chemistry is an art that has furnished the world with a great number of useful facts, and has thereby contributed to the improvement of many arts; but these facts lie scattered in many different books, involved in obscure terms, mixed with many falsehoods, and joined to a great deal of false philosophy; so that it is no great wonder that chemistry has not been so much studied as might have been expected with regard to so useful a branch of knowledge, and that many professors are themselves but very superficially acquainted with.

In A.L. Donovan

*Philosophical Chemistry in the Scottish Enlightenment*

Chapter 3 (p. 39)

At The University Press. Edinburgh, Scotland. 1975

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Physics and chemistry are not very different, and there seems to be no great difference in the kind of things to which they apply, except that chemistry, as it is usually understood, becomes inapplicable, at very high temperatures and also, perhaps, at very low ones. It therefore would not be very surprising if the hopes, held for a long time, that chemistry can be reduced to physics, were to come true, as indeed they seem to be doing...by a reduction I mean, of course, that all the findings of chemistry can be fully explained by (that is to say, deduced from) the principles of physics.

*Objective Knowledge: An Evolutionary Approach*

Chapter 8 (p. 290)

Clarendon Press. Oxford, England. 1972

**Prelog, V.**

No biographical data available

Chemistry takes a unique position among the natural sciences for it deals not only with material from natural

sources but creates the major parts of its objects by synthesis. In this respect, as stated many years ago by Maccollin Bertholt, chemistry resembles the arts; the potential of creativity is terrifying.

Chirality in Chemistry

*Science*, Volume 193, Number 4247, 2 July, 1976 (p. 18)

**Primas, Hans** 1928–

No biographical data available

The most important task of contemporary theoretical chemistry is to stimulate the mutual understanding of the various branches of chemistry and its neighboring sciences.

*Chemistry, Quantum Mechanics and Reductionism*

Chapter 1, Section 1.2 (p. 2)

Springer-Verlag. Berlin, Germany. 1983

**Protheroe, Chester F.**

No biographical data available

I sing to you of chemistry,  
Of test tubes and of stinks;  
Of things that burn and those that don't,  
And those that clog up sinks;  
Oh hydrogen and oxygen,  
The water that they make,  
And hydrogen peroxide —  
Unstable — do not shake;  
Of chemical equations,  
Of valence and other joys:  
How are your mathematics?  
Oh, bright-faced girls and boys!

Reader's Column

*Chemistry*, Volume 40, Number 3, March 1967 (p. 42)

**Prout, William** 1785–1850

English physician and chemist

Chemistry forms the connecting link between that kind of knowledge which is founded on quantity, and those kinds of knowledge which rest solely on experience. Now so far as the logic of quantity is applicable, so far are we certain of our conclusions. But when this logic cannot be applied, our conclusions are no longer such as must be, but are only for the most part such as may be.

In Ida Freund

*The Study of Chemical Composition*

Chapter XIX (p. 592)

At The University Press. Cambridge, England. 1904

**Raine, Kathleen Jessie** 1908–2003

English poet and critic

Chemistry dissolves the goddess in the alembic,  
Venus, the white queen, the universal matrix,  
Down to the molecular hexagons and carbon-chains.

*The Collected Poems of Kathleen Raine*

The Human Form Divine (p. 86)

Counterpoint. Washington, D.C. 2001

**Ramsay, Sir William** 1852–1916  
English chemist

...I am leaving the regions of fact, which are difficult to penetrate, but which bring in their train rich rewards, and entering the regions of speculation, where many roads lie open, but where a few lead to a definite goal.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1904

The Rare Gases of the Atmosphere (p. 77)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Reis, Johann Philipp** 1834–74  
German physicist

Chemistry is the dirty part of physics.

Quoted in R. Oesper

*The Human Side of Scientists* (p. 116)

University of Cincinnati. Cincinnati, Ohio, USA. 1975

**Richards, Ellen Henrietta Swallow** 1842–1911  
American environmental chemist

...some sort of false logic has crept into our schools, for the people whom I have seen doing housework or cooking know nothing of botany or chemistry, and the people who know botany and chemistry do not cook or sweep. The conclusion seems to be, if one knows chemistry she must not cook or do housework.

In Caroline L. Hunt

*The Life of Ellen H. Richards*

Chapter 10 (p. 179)

Whitcomb & Barrow. Boston, Massachusetts, USA. 1912

**Richards, Theodore William** 1868–1928  
American chemist

The importance of accurate knowledge in a case of this sort was foreseen long ago by Plato, who perhaps drew his inspiration from yet more ancient knowledge, coming from wise men of the Far East. As I have often quoted, he said: "If from any art that which concerns weighing and measuring and arithmetic is taken away, how little is left of that art!" The implication of this wise saying as regards the study of atomic weights is clear; any increase in the accuracy of the determination of these quantities must of necessity add greatly to our insight into the profound mysteries with which chemistry has to deal.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1914

Atomic Weights (p. 282)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

Chemistry has not grown spontaneously to its present state; it is a product of human mentality. The science which we know today is but an echo of the eternal and incomprehensible "music of the spheres" as heard and recorded by the minds of individual men.

In Bernard Jaffe

*New World of Chemistry*

Preface (p. vi)

Silver, Burdett & Company. New York, New York, USA. 1935

**Richet, Charles** 1850–1935  
French physiologist

If the progress of chemistry consisted only in producing still more noxious gases capable of destroying a regiment in a few minutes, then chemistry would be an accursed science.

*The Natural History of a Savant*

Chapter II (p. 13)

J.M. Dent & Sons Ltd. London, England. 1927

**Sabatier, Paul** 1854–1941  
French chemist

Theories cannot claim to be indestructible. They are only the plough which the ploughman uses to draw his furrow and which he has every right to discard for another one, of improved design, after the harvest.

*Nobel Lectures, Chemistry 1901–1921*

Nobel lecture for award received in 1912

The Method of Direct Hydrogenation by Catalysis (pp. 230–231)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

...any branch of science may be completely revolutionized at any time by a discovery necessitating a radically new approach to the subject. Chemistry today is essentially different from chemistry in the eighteenth century. The fundamental notions are different, the methods are different, the scope is indescribably larger, and the contents are infinitely more varied. We may safely assume that the chemistry of the twenty-fifth century will be as unlike that of the present as that, in turn, is unlike that of the fifteenth century.

*The Study of the History of Science* (pp. 7–8)

Harvard University Press. Cambridge, Massachusetts, USA. 1936

**Scheele, Carl Wilhelm** 1742–1786  
Swedish chemist

It is the object and chief business of chemistry to skillfully separate substances into their constituents, to discover their properties, and to compound them in different ways.

How difficult it is, however, to carry out such operations with the greatest accuracy, can only be unknown to one who either has never undertaken this occupation, or at least has not done so with sufficient attention.

*The Discovery of Oxygen*

Part II, Chemical Treatise on Air and Fire, Section I

Oliver & Boyd. Edinburgh, Scotland. 1923

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

THE DEVIL: ...in the arts of life man invents nothing; but in the arts of death he outdoes Nature herself, and produces by chemistry and machinery all the slaughter of plague, pestilence and famine.

*Man and Superman: A Comedy and a Philosophy*

Act III (pp. 83–84)

The Heritage Press. New York, New York, USA. No date

Not love: we know better than that. Let's call it chemistry.... Well, you're attracting me irresistibly — chemically.

*You Never Can Tell*

Act II (p. 70)

University of Nebraska Press. Lincoln, Nebraska, USA. 1961

**Shelley, Mary** 1797–1851

English Romantic writer

Chemistry is that branch of natural philosophy in which the greatest improvements have been and may be made...

*Frankenstein*

Chapter 3 (p. 40)

Running Press. Philadelphia, Pennsylvania, USA. 1990

**Silver, Brian L.**

Israeli professor of physical chemistry

Chemistry handles the visible cloth from which the universe is made.

*The Ascent of Science*

Part Four, Chapter 13 (p. 166)

Solomon Press Book. New York, New York, USA. 1998

**Smith, Betty** 1896–1972

American writer

Francie came away from her first chemistry lecture in a glow. In one hour she found out that everything was made up of atoms which were in continual motion. She grasped the idea that nothing was ever lost or destroyed. Even if something was burned up or rot away, it did not disappear from the face of the earth; it changed into something else — gases, liquids, and powders. Everything, decided Francie after that first lecture, was vibrant with life and there was no death in chemistry. She was puzzled as to why learned people didn't adopt chemistry as a religion.

*A Tree Grows in Brooklyn*

Chapter XLIX (p. 389)

Everybody's Vacation Publishing Company, Inc. New York, New York, USA. 1943 (Harper & Brothers)

**Smith, Walter Chalmers** 1824–1908

Scottish poet and preacher

But women who have lost their Faith  
Are angels who have lost their wings,  
And always have a nasty breath  
Of chemistry, and horrid things  
That go off when a lecturer rings  
His bell.

*Obrig Grange*

Book Third, Editorial, Loquitur Mater Domina, 1. 185–190

James Maclehose. Glasgow, Scotland. 1933

**Snow, Charles Percy** 1905–80

English writer and government administrator

The future of chemistry rests and must rest, with physics.

In H. Wright

*University Studies* (p. 125)

I. Nicholson & Watson. London, England. 1933

**Teeple, John E.** 1874–1931

American chemist

Chemistry is a science, a branch of knowledge, and there is no law to prevent anyone who has the least bit of chemical information — such, for instance, as the chemical symbol for water — from calling himself a chemist.

*Journal of Industrial and Engineering Chemistry*, Volume 17, Number 7

**Thomson, J. Arthur** 1861–1933

Scottish biologist

Chemistry is mainly the science of the different kinds of matter, their transformations, affinities, and interactions. It is par excellence the science of molecules and atoms.

*Introduction to Science*

Chapter IV (p. 106)

William & Norgate. London, England. 1916

**Thomson, Thomas**

No biographical data available

Chemistry, unlike other sciences, sprang originally from delusions and superstition, and was at its commencement exactly on a level with magic and astrology.

*The History of Chemistry*

Introduction (p. 1)

Henry Colburn & Richard Benley. London, England. 1830

Chemistry is a science, the object of which is to ascertain the ingredients that enter into the composition of bodies, to examine the nature of these ingredients, the manner in which they combine, and the properties resulting from their combination.

*A New System of Chemistry*

Definition (p. 1)

Printed for Thomas Dobson. Philadelphia, Pennsylvania, USA. 1800

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Verily, chemistry is not a splitting of hairs when you have got half a dozen raw Irishmen in the laboratory.

*The Writings of Henry David Thoreau* (Volume 4)

Cape Cod

Chapter X (p. 264)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Townson, Robert** 1763–1827  
Australian scholar and scientist

Chemistry of late years has made a most rapid progress and every branch of knowledge within its reach has been advanced by it. Mineralogy should be the first to speak its eulogium as the small tribute of gratitude for great favours.... Chemistry has done much for Mineralogy: it has raised it from a frivolous amusement to a sublime science; and still continuing its enlightening aid, will in time, with the progress of science, bring to light many things that now lie concealed, and unveil of the hidden mysteries of nature.

*Philosophy of Mineralogy*

Chapter IX (p. 114)

Printed for the author. London, England. 1798

**Trevor, J. E.**

No biographical data available

If chemistry be in its ultimate nature, an energy science, chemists obviously must study those energy transformations which constitute its phenomena.

*The Achievements and Aims of Physical Chemistry*, Volume XVI, Number 8, August 1894 (p. 519)

**van Helmont, Jean-Baptista** 1579–1644  
Flemish chemist

I praise my bountiful God, who hath called me into the Art of the fire, out of the dregs of other professions. For truly Chymistry...prepares the understanding to pierce the secrets of nature, and causeth a further searching out in nature, than all other Sciences being put together: and it pierceth even unto the utmost of real truth.

*Oriatrike or Physick Refined* (p. 462)

Printed for L. Loyd. London, England. 1662

**van't Hoff, Jacobus Henricus** 1852–1911  
Dutch physical and organic chemist

This is physical chemistry, formerly a colony, now a great, free land.

In Diana Kormos Barkan

*Walther Nernst and the Transition to Modern Physical Science*

Chapter I (p. 1)

Cambridge University Press. Cambridge, England. 1999

**von Euler, Hans** 1873–1964  
Swedish biochemist

Any scientific problem must be attacked by research into detail; the natural scientist did not win his victories until he left meditation on the great riddles of the world and began a careful study of special problems; our knowledge — of more general associations and of far-reaching laws — has grown out of the results of such research.

*Nobel Lectures, Chemistry 1922–1941*

Nobel lecture for award received in 1929

Fermentation of Sugars and Fermentative Enzymes (p. 144)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**von Liebig, Justus** 1803–73  
German organic chemist

It is an indisputable requirement in organic chemistry that we refrain from stripping the phenomena, not yet clarified, of the charm that lies precisely in their obscurity.

In Rolf Huisgen

*The Adventure Playground of Mechanisms and Novel Reactions* (p. xx)

American Chemical Society. Washington, D.C. 1994

**von Meyer, Ernst**  
German chemist

The main problem of chemistry, the investigation of the true composition of compounds, necessarily carries along with itself the constant endeavor to elaborate and perfect the means employed for arriving at this end.

*A History of Chemistry from Earliest Times to the Present Day*

Chapter VI (p. 358)

Macmillan & Company Ltd. London, England. 1891

**von Schelling, Friedrich Wilhelm Joseph** 1775–1854

German philosopher

Chemistry itself is a science which advances securely upon the beaten path of experience, even when it does not turn back to first principles. But a science which in itself is so rich, and which has lately made such great progress towards system, surely deserves to be led back to such principles.

Translated by Errol E. Harris and Peter Heath

*Ideas for a Philosophy of Nature as Introduction to the Study of this Science*

Chapter 8 (p. 237)

Cambridge University Press. Cambridge, England. 1988

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian and sociologist

He was a practical electrician but fond of whiskey, a heavy, red-haired brute with irregular teeth. He doubted the existence of the Deity but accepted Carnot's cycle, and he had read Shakespeare and found him weak in chemistry.

*The Door in the Wall, and Other Stories*

Lord of the Dynamos

Chapter 7

M. Kennerley. New York, New York, USA. 1911

**Werner, Alfred** 1866–1919  
German chemist

Chemistry must become the astronomy of the molecular world.

In George B. Kauffman

*Alfred Werner: Founder of Coordination Chemistry* (p. iii)

Springer-Verlag. Berlin, Germany. 1966

**Whewell, William** 1794–1866  
English philosopher and historian

The common operations of chemistry give rise in almost every instance to products which bear no resemblance to the materials employed. Nothing can be so false as to expect that the qualities of the elements shall be still discoverable in an unaltered form in the compound.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 1)

Part I, Book VI (p. 399)

John W. Parker. London, England. 1847

### **Wieland, Heinrich O.** 1877–1957

German chemist

The problem is not very attractive from the experimental viewpoint. There is no nitrogen, which adds interest and variety to the treatment of alkaloids. Only carbon, hydrogen and a little oxygen, all in the traditional combination, which does not lead us to expect any surprising results. The task would appear to be a long and unspeakably wearisome trek through an arid desert of structure. True, the wanderer in this apparently so unattractive region finds friendly landscapes at all stages of his journey, and the large quantity of substances bringing him nearer his goal accumulates around him like dear companions, although, clothed in the plain garment of colourlessness, they do not stand out either in their appearance or in their properties.

*Nobel Lectures, Chemistry 1922–1941*

Nobel lecture for award received in 1927

The Chemistry of the Bile Acids (p. 96)

Elsevier Publishing Company. Amsterdam, Netherlands. 1966

### **Wiley, Harvey W.**

No biographical data available

There is no branch of our science which is to be crowned king and leader. Chemistry is a pure democracy, and all are equal therein.

Address of Welcome, World's Chemical Congress

*The Journal of the American Chemical Society*, Volume XV, Number 6, June 1893 (p. 304)

### **Wurtz, Charles Adolphe** 1817–84

French organic chemist

Chemistry is a French science; it was founded by Lavoisier of immortal memory.

Translated by Henry Watts

*History of Chemical Theory from the Age of Lavoisier to the Present*

Introduction (p. 1)

Macmillan & Company Ltd. London, England. 1869

## CHEMISTRY INSTRUMENTATION

### **Glaser, Christophe** 1615–78

Swiss chemist

To perform Chymical Operations, one must be very well provided with necessary Instruments and Vessels; for there being but few things that can be prepared in an open

naked fire, one is obliged to put ones matter into some convenient Vessel, which is to be placed with dexterity upon the fire, and that is to be governed differently, according to the Artist's skill and intention.

*The Compleat Chymist; or a New Treatise of Chymistry*

Chapter VII (pp. 19–20)

Printed for John Starkey. London, England. 1677

## CHEMOTHERAPY

### **Domagk, Gerhard** 1895–1964

German bacteriologist and pathologist

I consider it my first duty in the development of chemotherapy to cure those diseases which have hitherto been incurable, so that in the first place those patients are helped who can be helped in no other way.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1939

Further Progress in Chemotherapy of Bacterial Infections (p. 525)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## CHEYNE–STOKES RESPIRATION

### **Hippocrates** 460 BCE–377 BCE

Greek physician

Philiscus...too to bed on the first day of acute fever....

About the middle of the sixth day he died. The respiration throughout, like that of a person recollecting himself.

*In Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

Of the Epidemics

Fourteen Cases of Disease, Case I (p. 50)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CHILDBIRTH

### **Mitchell, Margaret** 1900–49

American author

Death and taxes and childbirth! There's never any convenient time for any of them!

*Gone With the Wind*

Part Four, Chapter XXXVIII (p. 668)

The Macmillan Company. New York, New York, USA. 1936

## CHITIN

### **Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

Not blood nor flesh nor hair nor feathers, not the chlorophyll or cellulose of the plants, is stranger than the stuff called chitin.

*An Almanac for Moderns*

August Twenty-First (p. 165)

G.P. Putnam's Sons. New York, New York, USA. 1935

**CHOICE**

**Juster, Norton** 1929–  
American architect and author

Just because you have a choice, it doesn't mean that any of them has to be right.

*The Phantom Tollbooth*

Chapter 14 (pp. 175–176)

Alfred A. Knopf. New York, New York, USA. 1989

**Poynting, John Henry** 1852–1914  
English physicist

If our mental experience convinces us that we have freedom of choice, we are obliged to believe that in mind there is territory which the physicist can never annex. Some of his laws may still hold good, but somewhere or other his scheme must cease to give a true account.

*Collected Scientific Papers*

Physical Law and Life, 1903 (p. 698)

At The University Press. Cambridge. 1920

**CHOLERA**

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

He died from fear of cholera.

*Note-Book of Anton Chekhov* (p. 68)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Flaubert, Gustave** 1821–90  
French novelist

Cholera: You catch it from eating melons. The cure is lots of tea with rum in it.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Inge, William Ralph** 1860–1954  
English religious leader and author

If...an outbreak of cholera might be caused either by an infected water supply or by the blasphemies of an infidel mayor, medical research would be in confusion.

*Outspoken Essays (Second Series)*

Confessio Fidei (p. 3)

Longmans, Green & Company. New York, New York, USA. 1922

**Kipling, Rudyard** 1865–1936  
British writer and poet

When the cholera comes — as it will past a doubt —

Keep out of the wet and don't go on the shout,

For the sickness gets in as the liquor dies out,

An' it crumples the young British soldier.

Crum-, crum-, crumples the soldier...

*Collected Verse of Rudyard Kipling*

The Young British Soldier

Doubleday, Page & Company. Garden City, New York, USA. 1915

**CHROMOSOME**

**Conklin, Edwin Grant** 1863–1952  
American zoologist

What molecules and atoms and electrons are to the physicist and chemist, chromosomes and genes are to the biologist.

A Generation's Progress in the Study of Evolution

*Science*, Volume 80, Number 2068, August 17, 1934 (p. 151)

**Newman, Joseph S.** 1892–1960  
American poet

All living protoplasmic cells

That make up frogs or pimpernels

Or men or hippopotami

Have portions known as nuclei.

Within these microscopic homes

There lurk our fateful chromosomes,

Those strange hereditary factors

That make us good or bad actors,

That shape our lips and chins and eyebrows

And predetermine fools and highbrows.

*Poems for Penguins, and Other Lyrical Lapses*

Heredity

Greenburg. New York, New York, USA. 1941

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

But the term code-script is, of course, too narrow. The chromosome structures are at the same time instrumental in bringing about the development they foreshadow. They are law-code and executive power — or, to use another simile, they are architect's plan and builder's craft — in one.

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*

Chapter II, Section 12 (p. 21)

At The University Press. Cambridge, England. 1945

**Stoller, Robert** 1925–91  
American psychoanalytic theorist and researcher

What to the unempathic scientist is a chromosome is the heavy hand of immutable destiny to the victims: on receiving the genetic information, the patient may feel transformed into a freak, no longer fully human. Those who feel this is an exaggeration have not treated people afflicted with depression, hopelessness, or psychosis as a result of learning such a truth.

In Michael A. Sperber and Lissy F. Jarvik

*Psychiatry and Genetics: Psychosocial, Ethical and Legal Considerations*

Genetics, Constitution, and Gender Disorder (p. 54)

Basic Books, Inc. New York, New York, USA. 1976

**CHRONOLOGY**

**Lamb, Charles** 1775–1834  
English essayist and critic

Your now is not my now; and again, your  
then is not my then; but my now may be your then, and  
*vice versa*.

Whose head is competent to these things?

In E.V. Lucas (ed.)

*The Works of Charles and Mary Lamb* (Volume 5)

Letter 236

To Barron Field, August 31, 1817

## CIRCLE

**Browne, Sir Thomas** 1605–82

English author and physician

Circles and right lines limit and close all bodies, and the  
mortal right-lined circle must conclude and shut up all.

*Hydriotaphia*

Chapter V (p. 74)

Printed for Hen. Brome. London, England. 1658

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English writer

A small circle is quite as infinite as a large circle.

*Orthodoxy*

Chapter II (p. 33)

John Lane Company. New York, New York, USA. 1918

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The eye is the first circle; the horizon which it forms is  
the second; and throughout nature this primary figure is  
repeated without end. It is the highest emblem in the ci-  
pher of the world.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Circles (p. 403)

The Library of America. New York, New York, USA. 1983

**Pope, Alexander** 1688–1744

English poet

As the small pebble stirs the peaceful lake;  
The centre mov'd, a circle straight succeeds,  
Another still, and still another spreads.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle IV, l. 364

Houghton Mifflin Company. New York, New York, USA. 1903

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

KNELLER: Just what such blockheads would believe. The  
circle is a dead thing like a straight line: no living hand can  
draw it: you make it by twirling a pair of dividers.

*The Complete Plays of Bernard Shaw*

In Good King Charles's Golden Days, Act I (p. 1358)

Odhams Press. London, England. 1950

**Soddy, Frederick** 1877–1956

English chemist

Four circles to the kissing come,  
The smaller are the benter.

The bend is just the inverse of

The distance from the centre.

Though their intrigue left Euclid dumb

There's now no need for rule of thumb.

Since zero bend's a dead straight line

And concave bends have minus sign,

The sum of squares of all four bends

Is half the square of their sum.

The Kiss Precise

*Nature*, Volume 137, Number 3477, June 20, 1936 (p. 1021)

## CIRCULATION

**Harvey, William** 1578–1657

English physician

...since all living things are warm, all dying things cold,  
there must be a...seat and fountain, a kind of home and  
hearth, where the cherisher of nature, the original of the  
native fire, is stored and preserved; whence heat and life  
are dispensed to all parts as from a fountain head; whence  
sustenance may be derived; and upon which concoction  
and nutrition, and all vegetative energy may depend.  
Now, that the heart is this place, that the heart is the prin-  
ciple of life...I trust no one will deny.

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in  
Animals*

Chapter 15 (p. 296)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...I frequently and seriously bethought me, and long re-  
volved in my mind, what might be the quantity of blood  
which was transmitted, in how short a time its passage  
might be effected, and the like; and not finding it possi-  
ble that this could be supplied by the juices of the in-  
gested aliment without the veins on the one hand becom-  
ing drained, and the arteries on the other getting ruptured  
through the excessive charge of blood, unless the blood  
should somehow find its way from the arteries into the  
veins, and so return to the right side of the heart; I began  
to think there might not be a MOTION, AS IT WERE,  
IN A CIRCLE.

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*  
Chapter 8 (p. 285)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CIRCUMCISION

**Freeland, E. Harding**

No biographical data available

It has been urged as an argument against the universal  
adoption of circumcision that the removal of the protective

covering of the glans tends to dull the sensitivity of that exquisitely sensitive structure and thereby diminishes sexual appetite and the pleasurable effects of coitus. Granted that this be true, my answer is that, whatever may have been the case in days gone by, sensuality in our time needs neither whip nor spur, but would be all the better for a little more judicious use of curb and bearing-rein. —

Circumcision as a Preventative of Syphilis and Other Disorders  
*The Lancet*, Volume 2, 29 December 1900 (pp. 1869-1871)

### **Johnson, Athol A. W.**

No biographical data available

In cases of masturbation we must, I believe, break the habit by inducing such a condition of the parts as will cause too much local suffering to allow of the practice to be continued. For this purpose, if the prepuce is long, we may circumcise the male patient with present and probably with future advantages; the operation, too, should not be performed under chloroform, so that the pain experienced may be associated with the habit we wish to eradicate.

On an Injurious Habit Occasionally Met with in Infancy and Early Childhood

*The Lancet*, Volume 1, 7 April 1860 (pp. 344–345)

### **Sayer, Lewis L.**

No biographical data available

Hip trouble is from falling down, an accident that children with tight foreskins are specially liable to, owing to the weakening of the muscles produced by the condition of the genitals.

Circumcision for the Cure of Enuresis

*Journal of the American Medical Association*, Volume 7, 1887 (pp. 631–633)

### **Taylor, A. W.**

No biographical data available

Not infrequently marital unhappiness would be better relieved by circumcising the husband than by suing for divorce.

Circumcision—Its Moral and Physical Necessities and Advantages

*Medical Record*, Volume 56, 1899 (p. 174)

## CITY

### **Abbey, Edward** 1927–89

American nature writer

We must save the city. It is essence and substance of us all—we cannot lose it without diminishing our stature as a nation, without a fatal wound.

*The Journey Home: Some Words in Defense of the American West*  
Chapter 9 (p. 101)

E.P. Dutton & Company. New York, New York, USA. 1977

## CIVILIZATION

### **Beston, Henry** 1888–1968

American writer

Our fantastic civilization has fallen out of touch with many aspects of nature, and with none more completely than with night.

*The Outermost House*

Chapter VIII (p. 168)

Rinehart & Company. New York, New York, USA. 1928

### **Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Civilization is but a filmy fringe on the history of man.

*The Evolution of Modern Medicine*

Chapter I (p. 2)

Yale University Press. New Haven Connecticut, USA. 1921

## CLARITY

### **Bronk, Detlev W.** 1897–1975

American biologist

Science, like art, music and poetry, tries to reduce chaos to the clarity and order of pure beauty.

In Max Levin

Our Debt to Hughlings Jackson

*Journal of the American Medical Association*, Volume 191, Number 12,  
March 22, 1965 (p. 996)

### **Einstein, Albert** 1879–1955

German-born physicist

In the interest of clearness, it appeared to me inevitable that I should repeat myself frequently, without paying the slightest attention to the elegance of the presentation.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Preface (p. 3)

Pi Press. New York, New York, USA. 2005

### **Sober, Elliott** 1948–

American philosopher of science and evolutionary theorist

A science may fall short of perfect clarity in different ways. One is relatively benign. A science may move forward, sideways, and backwards as if in a fog that sometimes lifts a little then resettles.... But a science enveloped by fog has at least one consolation. A fog does not foster the illusion of clarity; the lack of visibility is patent. More insidious than the fog is the mirage. Fogs are seen for what they are. Mirages are trickier, engendering the mistaken conviction that things are as they seem.

The Nature of Selection: Evolutionary Theory in Philosophical Focus

Introduction (p. 1)

The MIT Press. Cambridge, Massachusetts, USA. 1984



## CLASSIFICATION

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

Are our systems the inventions of naturalists, or only their reading of the Book of Nature? and can that book have more than one reading? If these classifications are not mere inventions, if they are not an attempt to classify for our own convenience the objects we study, then they are thoughts which, whether we detect them or not, are expressed in Nature, — then Nature is the work of thought, the production of intelligence carried out according to plan, therefore premeditated, — and in our study of natural objects we are approaching the thoughts of the Creator, reading His conceptions, interpreting a system that is His and not ours.

*Methods of Study in Natural History*

Chapter I (pp. 13–14)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

Are these divisions artificial or natural? Are they the devices of the human mind to classify and arrange our knowledge in such a manner as to bring it more readily within our grasp and facilitate further investigations, or have they been instituted by the Divine Intelligence as the categories of his mode of thinking?

*Essay on Classification*

Chapter I, Section I (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1962

...believing, as I do, that classification, rightly understood, means simply the creative plan of God as expressed in organic forms, I feel the importance of attempting at least to present it in a popular guise, divested, as far as possible, of technicalities. I would therefore ask the indulgence of my readers for such scientific terms and details cannot well be dispensed with, begging them to remember that a long and tedious road may bring us suddenly upon a glorious prospect, and that a clearer mental atmosphere and a new intellectual sensation may well reward us for a little weariness in the outset.

*Methods of Study in Natural History*

Chapter IV (p. 42)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Ought we, for instance (to give an illustration of what I mean), to begin by discussing each separate species — man, lion, ox, and the like — taking each kind in hand independently of the rest, or ought we rather to deal first with the attributes which they have in common in virtue of some common element of their nature, and proceed from this as a basis for the consideration of them separately?

In *Great Books of the Western World* (Volume 8)

*On the Parts of Animals*

Book I, Chapter 1 (p. 161)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bain, Alexander** 1818–1903  
Scottish philosopher and psychologist

The number of trials necessary to arrive at a new construction, is commonly so great, that, without something of an affection, or fascination, for the subject, one grows weary of the task. The patient thought of the naturalist desirous of rising to new classifications, grows out of his liking for the subject, which makes it to him a sweet morsel rolled under the tongue, and gives an enjoyment even to fruitless endeavors.

*The Sense and the Intellect* (3<sup>rd</sup> edition) (p. 593)

D. Appleton & Company. New York, New York, USA. 1868

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

It is not obviously silly to classify flowers by their colors; after all, the bluer flowers do tend to be associated with the colder climates and greater heights. There is nothing wrong with the system in advance. It simply does not work as conveniently and as instructively as Linnaeus's classification by family likenesses.

*The Common Sense of Science*

Chapter IV, Section 4 (p. 48)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Childe, V. Gordon** 1892–1957  
Australian-English archaeologist

To interpret the objects he collects, to classify them and even to describe them correctly, an archaeologist ought ideally to be able to make them.

*A Short Introduction to Archaeology*

Chapter Five (p. 105)

Frederick Muller Ltd. London, England. 1956

**Darwin, Charles Robert** 1809–82  
English naturalist

From the most remote period in the history of the world organic beings have been found to resemble each other in descending degrees, so that they can be classed in groups under groups. This classification is not arbitrary like the grouping of the stars in constellations. The existence of groups would have been of simple significance, if one group had been exclusively fitted to inhabit the land, and another the water; one to feed on flesh, another on vegetable matter, and so on; but the case is widely different, for it is notorious how commonly members of even the same subgroup have different habits.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XIV (p. 208)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

But what is classification but the perceiving that these objects are not chaotic, and are not foreign, but have a law which is also the law of the human mind?

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

The American Scholar (p. 56)

The Library of America. New York, New York, USA. 1983

**Gladilin, V. N.**

No biographical data available

There is no problem in archaeology today which is more important than the classification of archaeological materials.

*150 let Odesskomu arkheologicheskomu museju*

Printsipy Klassifikatsii Rannepaleoliticheskikh Izdelij Tezisy Dokladov Konferentsii, Kiev, 1975 (p. 13)

**Graton, L. C.**

No biographical data available

The purpose of classification is not to set forth final and indisputable truths but rather to afford stepping stones towards better understanding.

In Fred M. Bullard

*Volcanoes of the Earth*

Chapter 4 (p. 30)

University Texas Press. Austin, Texas, USA. 1984

**Hopwood, Arthur Tindell** 1897–1969

English scientist

The urge to classify is a fundamental human instinct; like the predisposition to sin, it accompanies us into the world at birth and stays with us to the end.

The Development of Pre-Linnaean Taxonomy

*Proceedings of the Linnaean Society of London*, Volume 170, 1959 (p. 230)

**Hull, David L.**

No biographical data available

If contemporary philosophers of science agree on anything, it is that scientific classification cannot be theoretically neutral. Nor can there be any prescribed order in which theoretical combinations are introduced into a classification. One cannot begin by producing a theoretically neutral classification, and then only later add theoretical interpretations.

*Philosophy of Science Association 1978*

The Principles of Biological Classification: The Use and Abuse of Philosophy, Volume 2

**James, William** 1842–1910

American philosopher and psychologist

The first steps in most of the sciences are purely classificatory. Where facts fall easily into rich and intricate series (as plants and animals and chemical compounds do), the

mere sight of the series fill the mind with a satisfaction *sui generis*; and a world whose real materials naturally lend themselves to serial classification is *pro tanto* a more rational world, a world with which the mind will feel more intimate, than with a world in which they do not. By the pre-evolutionary naturalists, whose generation has hardly passed away, classifications were supposed to be ultimate insights into God's mind, filling us with adoration of his ways. The fact that Nature lets us make them was a proof of the presence of his Thought in her bosom.

*The Principles of Psychology* (Volume 2)

Necessary Truths — Effects of Experience, Classificatory Series (p. 647)

Harvard University Press. Cambridge, Massachusetts, US. 1981

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–

1829

French biologist

Thus, among living bodies, nature, as I have already said, definitely contains nothing but individuals which succeed one another by reproduction and spring from one another; but the species among them have only a relative constancy and are only invariable temporarily.

Nevertheless, to facilitate the study and knowledge of so many different bodies it is useful to give the name of species to any collection of like individuals perpetuated by reproduction without change, so long as their environment does not alter enough to cause variations in their habits, character and shape.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter III (p. 44)

The University of Chicago Press. Chicago, Illinois, USA. 1984

Throughout nature, wherever man strives to acquire knowledge he finds himself under the necessity of using special methods, 1st, to bring order among the infinitely numerous and varied objects which he has before him; 2<sup>nd</sup>, to distinguish, without danger of confusion, among this immense multitude of objects, either groups or those in which he is interested, or particular individuals among them; 3<sup>rd</sup>, to pass on to his fellows all what he has learnt, seen and thought on the subject. Now the methods which he uses for this purpose are what I call the artificial devices in natural science, — devices which we must beware of confusing with the laws and acts of nature herself.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter I (p. 19)

The University of Chicago Press. Chicago, Illinois, USA. 1984

It was no doubt indispensable to break up the productions of nature into groups, and to establish different kinds of divisions among them such as classes, orders, families and genera. It was, moreover, necessary to fix what are

called species, and to assign special names to these various sorts of objects. This is required on account of the limitations of our faculties; some such means are necessary for helping us to fix the knowledge which we gain from that prodigious multitude of natural bodies which we can observe in their infinite diversity.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter I (p. 20)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Morris, Henry** 1918–2006  
American creationist

If an evolutionary continuum existed, as the evolution model should predict, there would be no gaps, and thus it would be impossible to demark specific categories of life. Classification requires not only similarities, but differences and gaps as well, and these are much more amenable to the creation model.

*Scientific Creationism*

Chapter IV (p. 72)

Creation-Life Publishers. San Diego, California, USA. 1974

**Olson, S. L.**

No biographical data available

...the present classification of birds amounts to little more than superstition and bears about as much relationship to a true phylogeny of the Class Aves as Greek mythology does to the theory of relativity.

The Museum Tradition in Ornithology — A Response to Ricklefs

*The Auk*, Volume 98, January 1981 (p. 193)

**Rouse, Irving**

No biographical data available

Classification, like statistics, is not an end in itself but a technique by means of which to attain specific objectives, and so it must be varied with the objective.

The Classification of Artifacts in Archaeology

*American Antiquity*, Volume 25, January 1960 (p. 313)

A good archaeologist is distinguished from a bad one by his ability to make valid classificatory judgments.

*Introduction to Prehistory: A Systematic Approach*

Chapter 2, Section 7 (p. 46)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Smiles, Samuel**

No biographical data available

A place for everything and everything in its place.

*Thrift*

Chapter 5 (p. 66)

John Murray. London, England. 1888)

**Tennyson, Alfred (Lord)** 1809–92

English poet

What is it? A learned man

Could give it a clumsy name.

Let him name it who can,

The beauty would be the same.

*Alfred Tennyson's Poetical Works*

Maude, Part II, Section II, Stanza II

Oxford University Press, Inc. London, England. 1953

**The Bible**

The man gave names to all cattle, to the birds of the air, and to every wild animal...

*The Revised English Bible*

Genesis 2:20

Oxford University Press, Inc. Oxford, England. 1989

**Washington, Henry S.** 1867–1934

American petrologist, geologist, and geochemist

We can classify rocks, for petrological purposes, exactly, definitely, and strictly only by creating arbitrary divisions, cutting them up by sharp planes and putting them into man-devised pigeon-holes, as was done in the quantitative classification or as seems necessary in any modification of it. Such a classification is a pis-aller, a makeshift, a classification of convenience; it may or may not correspond to the evolution of igneous rocks as it really is.

Deccan Salts and Plateau Basalts

*Bulletin of Geological Society of America*, Volume 33, Number 4,

November 2, 1922 (p. 801)

## CLIMATE CHANGE

### American Geophysical Union

...There is no known geologic precedent for the transfer of carbon from the Earth's crust to atmospheric carbon dioxide in quantities comparable to the burning of fossil fuels without simultaneous changes in other parts of the carbon cycle and climate system. This close coupling between atmospheric carbon dioxide and climate suggests that a change in one would in all likelihood be accompanied by a change in the other.

Climate Change and Greenhouse Gases, American Geophysical Union Report, 1999

Quoted in David Hafemeister

*Physics of Societal Issues. Calculations on National Security, Environment, and Energy* (p. 199)

Springer. New York, New York, USA. 2007

**Crichton, Michael** 1942–

American novelist

[I]n this elastic anything-goes world where science — or non-science — is the hand maiden of questionable public policy, we arrive at last at global warming. It is not my purpose here to rehash the details of this most magnificent of the demons haunting the world. I would just remind you of the now-familiar pattern by which these

things are established. Evidentiary uncertainties are glossed over in the unseemly rush for an overarching policy, and for grants to support the policy by delivering findings that are desired by the patron. Next, the isolation of those scientists who won't get with the program, and the characterization of those scientists as outsiders and "skeptics" in quotation marks — suspect individuals with suspect motives, industry flunkies, reactionaries, or simply anti-environmental nut-cases. In short order, debate ends, even though prominent scientists are uncomfortable about how things are being done.

Lecture

Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

**Gore, Al** 1948–

45<sup>th</sup> vice-president of the United States and environmentalist

Climate does naturally change. By studying tree rings, lake sediments, ice cores, and other natural features that provide a record of past climates, scientists know that changes in climate, including abrupt changes, have occurred throughout history. But these changes all took place with natural variations in carbon dioxide levels that were smaller than the ones we are now causing. Cores taken from deep in the ice of Antarctica show that carbon dioxide levels are higher now than they have been at any time in the last 650,000 years, which means we are outside the realm of natural climate variation. More CO<sub>2</sub> in the atmosphere means warming temperatures.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 312)

Rodale. New York, New York, USA. 2006

The age-old rhythm of the Earth's seasons — summer, fall, winter, and spring — is...changing as some parts of the world heat up more rapidly than others.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 152)

Rodale. New York, New York, USA. 2006

...the more we understand about climate change, the more it looks as if [the United States] may be the real culprit. The United States emits about a quarter of the world's greenhouse gases, while the entire continent of Africa is culpable for only about 5% of it. ...We helped manufacture the suffering in Africa, and we have a moral obligation to try to fix it.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 117)

Rodale. New York, New York, USA. 2006

**Hafemeister, David** 1934–

American physicist

Few scientists debate the fact that Earth is getting warmer. Seventeen of the eighteen warmest years in the 20<sup>th</sup> century occurred after 1980. The IPCC determined that Earth's surface temperature rose 0.6°C (+/- 0.2

°C) during the 20<sup>th</sup> century. Half this increase occurred since the mid-1970s to reach the highest temperatures in a millennium.

*Physics of Societal Issues. Calculations on National Security, Environment, and Energy* (p. 197)

Springer. New York, New York, USA. 2007

Until alternate energy becomes competitive, natural gas and coal will be the bridging fuels that will supply portable energy as petroleum becomes expensive and less plentiful. And the burning of fossil fuels will probably double CO<sub>2</sub> levels during the next century, causing an unknown amount of climate change.

*Physics of Societal Issues. Calculations on National Security, Environment, and Energy* (pp. 249–250)

Springer. New York, New York, USA. 2007

## **Intergovernmental Panel on Climate Change (IPCC)**

It is *very likely* that heat waves will be more intense, more frequent and longer lasting in a future warmer climate. Cold episodes are projected to decrease significantly in a future warmer climate. Almost everywhere, daily minimum temperatures are projected to increase faster than daily maximum temperatures, leading to a decrease in diurnal temperature range. Decreases in frost days are projected to occur almost everywhere in the middle and high latitudes, with a comparable increase in growing season length.

In S. Solomon, D. Qin, et al. (eds.)

*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

Cambridge University Press. Cambridge, UK, and New York, New York, USA.

If greenhouse gas concentrations could be reduced, global temperatures would begin to decrease within a decade, although sea level would continue to rise due to thermal expansion for at least another century.

In S. Solomon, D. Qin, et al. (eds.)

*Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*

Cambridge University Press. Cambridge, UK, and New York, New York, USA.

**Jevons, William Stanley** 1835–82

English economist and logician

Climate, indeed, is a subject upon which the most extravagant and unreasonable statements are made. Not only do many men, even of much scientific information, imagine that within the short scope of their own recollection they can detect a permanent change in weather or some phenomenon, which would involve a connected change over all the regions of the earth, but they even assert that man's muscular strength and mental ingenuity can affect such changes. The clearing away of trees they say will

render a climate dry; extensive reservoirs of water may increase the moistures of the atmosphere.

*Waugh's Australian Almanac, for 1859*

Some Data Concerning the Climate of Australia and New Zealand (p. 79)

Sydney, Australia. 1859

**Sagan, Carl** 1934–96

American astronomer and science writer

The inadvertent side effects of technology can challenge the environment on which our very lives depend. That means that we must understand science and technology; we must anticipate long-term consequences in a very clever way — not just the bottom line on the profit-and-loss column for the corporation for this year, but the consequences for the nation and the species 10, 20, 50, 100 years in the future.

Wonder and Skepticism

*Skeptical Inquirer*, Jan/Feb 1995 (p. 24)

**Stewart, R. W.** d. 2005

Canadian oceanographer

...one can imagine a gambler's die lying on the floor of a truck running over a rough road; the die is stable on any of its six faces so that in spite of bounding and vibration the same face usually remains up — until a particularly big bump jars it so that it lands with a different face up, whereupon it is stable in its new position.... Perhaps in recent years we have been bouncing along with, say, a four showing. Perhaps 200 years ago the die flipped over to three for a moment, then flipped back to four. It could one day jounce over to a snake eye and bring in a new ice age!

The Atmosphere and the Ocean

*Scientific American*, Volume 221, Number 3, September 1969 (p. 86)

**Weiner, Jonathan** 1953–

American fiction and non-fiction writer

It is amazing that chemicals measured in parts per million, billion, trillion, should matter to a planet. Yet, together with carbon dioxide, all these trace gases will shape Earth's next one hundred years and beyond. We are turning up the planet's thermostat a little more each year, committing the planet to a higher and higher temperature.

*The Next One Hundred Years*

Chapter 4 (p. 51)

Bantam Books. New York, New York, USA. 1990

**Wohlforth, Charles** 1963–

American journalist and writer

Choosing shorts or long underwear on a particular day is about weather; the ratio of shorts to long underwear in the drawer is about climate.

*The Whale and the Supercomputer: On the Northern Front of Climate Change*

Chapter 6 (p. 150)

North Point Press. New York, New York, USA. 2004

## CLINICIAN

**Addis, Thomas** 1881–1949

English-born American physician

A clinician is complex. He is part craftsman, part practical scientist, and part historian; so his several classifications involve, in varying degree, all these elements. It is only if we look at him when he is working with his patients that we find him pragmatic and utilitarian. His only design is to bring relief, and he is not at all scrupulous about how he does it.

*Glomerular Nephritis: Diagnosis and Treatment*

Chapter 5 (p. 120)

The Macmillan Company. New York, New York, USA. 1948

**Feinstein, Alvin R.**

No biographical data available

Unlike other types of scientific equipment, a clinician is not easily tested, compared, or calibrated in the act of getting clinical evidence. He can markedly improve the scientific quality of his performance, however, if he is willing to recognize the importance of what he does, to acknowledge himself as the apparatus to be improved, and to revise many minor and some major aspects of the way he works.

*Clinical Judgment* (p. 308)

Williams & Wilkins. Baltimore. 1967

**Peabody, Francis Weld** 1881–1927

American physician

One of the essential qualities of the clinician is interest in humanity, for the secret of the care of the patient is in caring for the patient.

*The Care of the Patient*

The Care of the Patient (p. 48)

Harvard University Press. Cambridge, Massachusetts, USA. 1928

## CLITORIS

**Culpeper, N.**

No biographical data available

The Clytorus is a sinewy and hard body, full of spongy and black matter within, as the side ligaments of the Yard are, in form it represents the Yard of a Man, and suffers erection and falling as doth that; this is that which causes lust in Women, and gives delight in copulation, for without this, a Woman neither desires copulation, or hath pleasure in it, or conceives by it.

*A Directory for Midwives, or a Guide for Women in Their Conception,*

*Bearing, and Suckling Their Children* (p. 22)

Peter & Edward Cole. London, England. 1660

## CLONE

**Ehlers, Vernon** 1934–  
American politician

Human life is sacred. The good Lord ordained a time-honored method of creating human life, commensurate with substantial responsibility on the part of the parents, the responsibility to raise a child appropriately. Creating life in the laboratory is totally inappropriate and so far removed from the process of marriage and parenting that has been instituted upon this planet that we must rebel against the very concept of human cloning. It is simply wrong to experiment with the creation of human life in this way.

Human Cloning

*Congressional Record-House*, Volume 143, Number 26, 4 March 1997 (p. H 713)

## COCAINE

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

...whether it was the Beaune which I had taken with my lunch, or the additional exasperation produced by the extreme deliberation of his manner, I suddenly felt that I could hold out no longer.

“Which is it to-day,” I asked, “morphine or cocaine?”

He raised his eyes languidly from the old black-letter volume which he had opened.

“It is cocaine,” he said, “a seven-per-cent solution. Would you care to try it?”

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Sign of the Four, Chapter 1 (p. 610)

Wings Books. New York, New York, USA. 1967

## COD LIVER OIL

**Crichton-Browne, Sir James** 1840–1938  
English physician

Oleum Jecoris Aselli, or cod-liver oil, was introduced into medical practice in this country, by Dr., afterwards Professor John Hughes Dennett, of Edinburgh in 1841. It had long been used by the Laplanders as a delicacy, in the Shetland Islands in place of butter, and in Holland it had been recommended as a cure for gout and rheumatism, but its first employment as a medical agent amongst us followed on the publication of Dr. Bennett’s treatise on the subject.

*From the Doctor’s Notebook*

Oleum Jecoris Aselli (p. 39)

Duckworth. London, England. 1937

## COHERENCE

**Donne, John** 1572–1631  
English poet and divine

‘Tis all in peeces, all cohaerence gone.

*Anatomic of the World* (pp. 202–203)

N. Douglas. London, England. 1926

## COINCIDENCE

**Raymo, Chet** 1936–  
American physicist and science writer

Coincidence is the evidence of the True Believer.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Six (p. 107)

Walker & Company. New York, New York, USA. 1998

## COLD

**Benchley, Robert** 1889–1945  
American humorist and critic

If you think you have caught a cold, call a good doctor.  
Call in three doctors and play bridge.

*Benchley — or Else!*

How to Avoid Colds (p. 166)

Harper. New York, New York, USA. 1947

**Chamfort, Nicolas** 1741–94  
French ironist and maker of maxims

The threat of a neglected cold is for doctors what the threat of purgatory is for priests — a gold mine.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#1092 (p. 61)

Harper & Row, Publishers. New York, New York, USA. 1969

**Crichton-Browne, Sir James** 1840–1938  
English physician

At a meeting of a medical society, it was said of the common cold that it was three days coming, three days staying, and three days going. A French physician, quoted by Sir St. Clair Thompson, said that the common cold, if left to itself, ran for a fortnight, but if medically treated, lasted only fourteen days.

*The Doctor’s After Thoughts* (p. 235)

E. Benn Ltd. London, England. 1932

**Simmons, Charles** 1798–1856  
American clergy and litterateur

Zealously nurse a cold with warm weather, and light and scanty food, till well cured, or repentance will be upon you.

*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 87)

Robert Dick. Toronto, Ontario, Canada. 1853

The best way to cure a cold is, not to catch another.  
*Laconic Manual and Brief Remarker Containing Over a Thousand*

*Subjects Alphabetically and Systematically Arranged* (p. 87)  
Robert Dick. Toronto, Ontario, Canada. 1853

## COLD FUSION

### Beam, Alex

No biographical data available

Cold fusion, the most delectable scientific nonevent since Kohoutek's Comet, is fizzling fast. As reports debunking the improbable breakthrough pour in from labs around the country, "fusion in a jar" is looking like a latter-day Veg-O-Matic, the kitchen appliance that works when you see it on TV but not when you get it home.

Cold Fusion, We Hardly Knew Ye  
*The Boston Globe*, May 3, 1989 (p. 77)

## COLEOPTERIST

### Crowson, Roy Albert 1914–99

English biologist

If and when the day comes when pure science is once again generally appreciated as a self-justifying intellectual adventure of mankind, then the coleopterists should be able to step forward and claim their share of its glory.

*The Biology of the Coleoptera*  
Chapter 21 (p. 691)  
Academic Press. London, England. 1981

## COLLECTING

### Darwin, Charles Robert 1809–82

English naturalist

The passion for collecting which leads a man to be a systematic naturalist, a virtuoso, or a miser, was very strong in me, and was clearly innate, as none of my sisters or brothers ever had this taste.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II (p. 26)  
D. Appleton & Company. New York, New York, USA. 1896

I was very fond of collecting eggs, but I never took more than a single egg out of a bird's nest, except on one single occasion, when I took all, not for their value, but from a sort of bravado.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II (p. 28)  
D. Appleton & Company. New York, New York, USA. 1896

### Durrell, Gerald M. 1925–95

British naturalist, zookeeper, and author

One of the chief charms of collecting is its uncertainty. One day you will go out loaded down with nets and bags for the sole purpose of catching bats, and you will arrive

back in camp with a python in the nets, your bags full of birds, and your pockets full of giant millipedes.

*The Overloaded Ark*  
Chapter 5 (p. 92)  
The Viking Press. New York, New York, USA. 1953

## COLONIZATION

### Bernal, John Desmond 1901–71

Irish-born physicist and x-ray crystallographer

...once acclimatized to space living, it is unlikely that man will stop until he has roamed over and colonized most of the sidereal universe, or that even this will be the end. Man will not ultimately be content to be parasitic on the stars but will invade them and organize them for his own purposes.

*The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational Soul*  
Chapter II (pp. 27–28)  
Indiana University Press. Bloomington, Indiana, USA. 1969

### Hoyle, Sir Fred 1915–2001

English mathematician, astronomer, and writer

Colonization of the galaxy is impossible because it was deliberately arranged to be so.

*The Intelligent Universe*  
Chapter 6 (p. 155)  
Holt, Rinehart & Winston. New York, New York, USA. 1983

### Moore, Patrick 1923–

English amateur astronomer

I cannot believe that it will ever be feasible to send a manned space-ship out beyond the Solar System; my lack of faith in space-warps, time-warps, freezing techniques, and cosmical Noah's Arks is profound, though I am well aware that others do not agree.

*The Next Fifty Years In Space*  
Chapter 10 (p. 129)  
William Luacombe Publisher Ltd. London, England. 1976

### Wiley, Jr., John P.

No biographical data available

With the rest of our solar system inhospitable to life as we know it and with travel to the stars problematical, man must lie in the bed he is making on Earth for the foreseeable future.

Space: A Barrier to the Species  
*Natural History*, Volume 79, Number 1, January 1970 (p. 73)

## COLOR

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

The world is not made up to the eye of figures, that is, only half; it is also made of color. How that element

washes the universe with its enchanting waves!.... It is the last stroke of Nature; beyond color she cannot go.

*The Complete Works of Ralph Waldo Emerson (Volume 7)*

Society and Solitude

Success

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

## COMBINATORICS

**Chadwick, John** 1920–98

English linguist

This method of deduction...is often called “combinatory”. Its usefulness is not exhausted at this stage, but it does even at the outset lead to some valuable conclusions...

*The Decipherment of Linear B*

Cambridge University Press. Cambridge, England. 1958

**Dieudonné, Jean** 1906–92

French mathematician and educator

We have not begun to understand the relationship between combinatorics and conceptual mathematics.

*A Panorama of Pure Mathematics: As Seen by N. Bourbaki*

Academic Press. New York, New York, USA. 1982

**Hoban, Russell**

American fantasy writer

More and more I’m aware that the permutations are not unlimited.

*Turtle Diary*

Jonathan Cape. London, England. 1975

**Jones, Richard G.**

No biographical data available

...Lord of sequence and design.

*The Hymn book of the Anglican Church of Canada and the United Church of Canada*

God of Concrete, God of Steel.

Anglican Church of Canada and the United Church of Canada. Toronto, Ontario, Canada. 1971

**Kanigel, Robert** 1946–

Scientific journalist

...combinatorics, a sort of glorified dice-throwing...

*The Man Who Knew Infinity: A Life of the Genius Ramanujan*

Chapter Seven (p. 250)

Charles Scribner’s Sons. New York, New York, USA. 1991

**Pinker, Steven** 1954–

Canadian-born American cognitive scientist and author

Journalists say that when a dog bites a man, that is not news, but when a man bites a dog, that is news.... Thanks to the mathematics of combinatorics, we will never run out of news.

*How the Mind Works*

Chapter 2 (p. 118)

W.W. Norton & Company, Inc. New York, New York, USA. 1997

**Segerstrale, Ullica** 1952–

Finish-born American sociologist and author

While [Maynard Smith] believed that a Marxist in science could take a lot of different positions, he saw the need for “some kind of substitute for Hegelian dialectics...some kind of concept that in dynamical systems there are going to be sudden breaks and thresholds and transformations, and so on”. He added that, in his opinion, “today we really do have a mathematics for thinking about complex systems and things which undergo transformations from quantity into quality”. Here he saw Hopf bifurcations and catastrophe theory as really nothing other than a change of quantity into quality in a dialectical sense.

*Defenders of the Truth: The Battle for Science in the Sociobiology Debate and Beyond*

Oxford University Press, Inc. Oxford 2000

**von Neumann, John** 1903–57

Hungarian-born mathematician

**Morgenstern, Oskar** 1902–77

German-born American economist

The emphasis on mathematical methods seems to be shifted more towards combinatorics and set theory — and away from the algorithm of differential equations which dominates mathematical physics.

*Theory of Games and Economic Behavior*

Chapter 4.8.3 (p. 45)

Princeton University Press. Princeton, New Jersey, USA. 1947

## COMET

### Author undetermined

...obviously, then, comet Kohoutek promises to be the celestial extravaganza of the century.

A Comet for Christmas

*Newsweek*, November 5, 1973 (p. 109)

### Babylonian Inscription

A comet arose whose body was bright like the day, while from its luminous body a tail extended, like the sting of a scorpion.

In John Brandt and Robert Chapman

*Introduction to Comets*

Chapter 1 (p. 4)

Cambridge University Press. Cambridge, England. 1981

**Byron, George Gordon,**

**6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

The angels all were singing out of tune,  
And hoarse with having little else to do,  
Excepting to wind up the sun and moon,  
Or curb a runaway young star or two,  
Or wild colt of a comet, which too soon



Broke out of bounds o'er the ethereal blue,  
Splitting some planet with its beautiful tail,  
As boats are sometimes by a wanton whale.

*The Complete Poetical Works of Byron*

The Vision of Judgment

Houghton Mifflin Company, Boston, Massachusetts, USA. 1933

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Guardian and friend of the moon, O Earth, whom the  
comets forget not,

Yea, in the measureless distance wheel around and again  
they behold thee!

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

Hymn to the Earth

The Clarendon Press, Oxford, England. 1912

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

These foreign planets, with their tails and their beards,  
have a terrible menacing countenance, it may be they are  
sent to affront us...

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 173)

Printed for Peter Wilson. Dublin, Ireland. 1761

We think ourselves unhappy when a comet appears; but it  
is the comet itself which is unfortunate.

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 175)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Dick, Thomas** 1600–80

Scottish theologian and philosopher

Whatever opinions we may adopt as to the physical con-  
stitution of comets, we must admit that they serve some  
grand and important purpose in the economy of the uni-  
verse; for we cannot suppose that the Almighty has created  
such an immense number of bodies, and set them in rapid  
motion according to established laws, without an end wor-  
thy of his perfection, and, on the whole, beneficial to the  
inhabitants of the system through which they move.

*The Sidereal Heavens and Other Subjects Connected with Astronomy, as  
Illustrative of the Character of the Deity and of an Infinity of Worlds*  
Chapter XX (p. 342)

Worthington. New York, New York, USA. 1884

...what I conceive to be one of the main designs of the  
Creator in the formation of such a vast number of splendid  
bodies is, that they may serve as habitations for myriads  
of intelligent beings.... If this position be admitted, then  
we ought to contemplate the approach of a comet, not as  
an object of terror or harbinger of evil, but as a splendid  
world, of a different construction from ours, conveying  
millions of happy beings to survey a new region of the  
Divine empire...

*The Sidereal Heavens and Other Subjects Connected with Astronomy, as  
Illustrative of the Character of the Deity and of an Infinity of Worlds*

Chapter XX (p. 345)

Worthington. New York, New York, USA. 1884

**Donne, John** 1572–1631

English poet and divine

Who vagrant transitory comets sees,

Wonders because they're rare; but a new star

Whose motion with the firmament agrees,

Is miracle; for there no new things are.

In A.J. Smith (ed.)

*The Complete English Poems*

To the Countess of Huntingdon (p. 169)

St. Martin's Press. New York, New York, USA. 1971

**Editor of the Louisville Journal**

That comet is a gay deceiver! He promised to jostle the  
earth, but has only jilted her. The rogue has told a tale  
instead of showing one.

*Prenticeana* (p. 213)

Derby & Jackson. New York, New York, USA. 1859

**Flammarion, Camille** 1842–1925

French astronomer and author

Between the solar world and the stars strange forms rush  
disheveled through celestial space, appearing to throw a  
bridge for our mind across the fathomless abyss, and to  
place us in communication with other universes. Let us  
observe these comets in passing, but let us take care not  
to be delayed too long by these fantastic creatures, the  
sirens of the sidereal ocean, whose revelations concerning  
immensity are full of charms, and whose hands, extended  
towards the inaccessible horizons, seem to show us from  
afar the mysterious dreams of Infinity.

*Popular Astronomy: A General Description of the Heavens*

Book IV, Chapter IX (p. 474)

Chatto & Windus. London, England. 1894

**Grassi, Horatio** 1583–1654

Jesuit astronomer

The vain comet which by its light has disturbed the earth  
and the heavens begins its harmless journey. With that  
light bestowed upon it by the creator it shrewdly propiti-  
ates the adverse celestial torches by its equal fire. May  
this comet which alters the heavens with its ready advan-  
tage teach me the nature of the stars.

*On the Three Comets of the Year MDCXVIII* (p. 2)

Rome. 1619

Have you seen the fleeting comet with its terrifying tail?  
Behold how with its fearsome beard it is carried sky-  
high. But no longer need you fear that stellar body with  
its menacing rays, nor is there harm in those stars which  
delight us by their appearance. Tell me, does this phan-  
tom glitter as a better and more favorable omen and does  
its false light surpass that true fire of the stars?

*On the Three Comets of the Year MDCXVIII* (p. 2)

Rome. 1619

**Halley, Edmond** 1656–1742  
English astronomer and mathematician

We have reason to suspect that there are a great many more comets, which being at remote distances from the Sun, and being obscure and without a tail, may for that reason escape our observation.

*Transactions of the Royal Society of London*, Volume 24, 1706 (p. 882)

Now we know

The sharply veering ways of comets, once

A source of dread, no longer do we quail

Beneath appearances of bearded stars.

In Florian Cajori

*Sir Isaac Newton's Mathematical Principles of Natural Philosophy and His System of the World* (p. xiv)

University of California Press. Berkeley, California, USA. 1934

Aristotle's opinion...that comets were nothing else than sublunary vapors or airy meteors...prevailed so far amongst the Greeks, that this sublimest part of astronomy lay altogether neglected; since none could think it worthwhile to observe, and to give an account of the wandering and uncertain paths of vapours floating in the Aether.

In David Gregory

*The Elements of Astronomy, Physical and Geometrical*

A Synopsis of the Astronomy of Comets, Volume 2, 1715

Printed for John Morphew. London, England. 1715

Hitherto I have consider'd the Orbits of Comets as exactly Parabolic; upon which supposition it wou'd follow, that Comets being impell'd towards the Sun by Centripetal Force, would descend as from space infinitely distant, and by their so falling acquire such a Velocity, as that they may again fly off into the remotest parts of the Universe, moving upwards with a perpetual tendency, so as never to return again to the Sun. But since they appear frequently enough, and since some of them can be found to move in a Hyperbolic Motion, or a Motions swifter than what a Comet might acquire by its Gravity to the Sun, 'tis highly probable they rather move in a very Excentric Elliptic Orbits, and make their returns after long periods of Time: For so their number will be determinate, and perhaps, not so very great.

In David Gregory

*The Elements of Astronomy, Physical and Geometrical*

A Synopsis of the Astronomy of Comets, Volume 2, 1715

Printed for John Morphew. London, England. 1715

...wherefore if according to what we have already said, it [the comet] should return again about the year 1758, candid posterity will not refuse to acknowledge that this was first discovered by an Englishman.

In David Gregory

*The Elements of Astronomy, Physical and Geometrical*

A Synopsis of the Astronomy of Comets, Volume 2, 1715

Printed for John Morphew. London, England. 1715

**Harris, John** 1666?–1719  
English natural philosopher

The Affairs of Comets, Sir, with their grisly Beards and Horrid Tails, fright me almost our of my Wits...

*Astronomical Dialogues Between a Gentleman and a Lady* (p. 138)

Printed by T. Wood for Benj. Cowse. London, England. 1719

**Hellman, C. Doris** 1910–73

Translator and editor

I cannot think a comet is a sudden fire, but I rank it among Nature's permanent creations.

*The Comet of 1577: Its Place in the History of Astronomy* (p. 31)

Columbia University Press. New York, New York, USA. 1944

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

There is beyond question some profound secret and mystery of nature concerned in the phenomenon of their tails. In no respect is the question as to the materiality of the tail more forcibly pressed on us for consideration than in that of the enormous sweep which it makes round the sun in perihelion, in the manner of a straight and rigid rod, in defiance of the law of gravitation, nay, even of the received laws of motion...

*Outlines of Astronomy*

Part I, Chapter XI (599) (p. 375)

Longman, Brown, Green & Longmans. London, England. 1849

By far the most wonderful and mysterious bodies of our system are the comets. Their number is immense, their variety of aspect infinite, their magnitude astounding.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Humbolt's Kosmos (p. 298)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

It is for the most part after thus passing the sun that they shine forth in all their splendor, and that their tails acquire their greatest length and development, thus indicating plainly the action of the sun's rays as the exciting cause of that extraordinary emanation.

*Outlines of Astronomy*

Part I, Chapter XI (561) (p. 346)

Longman, Brown, Green & Longmans. London, England. 1849

**Hildebrand, Wolfgang**

No biographical data available

When 'er a comet doth appear,

Come mishap, want, sorrow, and fear;

And never hath a comet's sheen

Without great evil yet been seen.

These dire ill-fortunes do ensue

When a comet appears to view —

In Bruno H. Burgel

*Astronomy for All* (p. 257)

Cassell & Company Ltd. London, England. 1911

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The Comet! He is on his way,  
And singing as he flies;  
The whizzing planets shrinks before  
The specter of the skies.

*The Complete Poetical Works of Oliver Wendell Holmes*

The Comet, Stanza 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Hopkins, Gerard Manley** 1844–89

English poet and Jesuit priest

I am like a slip of comet,  
Scarce worth discovery, in some corner seen  
Bridging the slender difference of two stars,  
Come out of space, or suddenly engender'd  
By heady elements, for no man knows:  
But there she sights the sun she grows and sizes  
And spins her skirts out, while her central star  
Shakes its cocooning mists; and so she comes  
To fields of light; millions of traveling rays  
Pierce her; she hangs upon the flame-cased sun,  
And sucks the light as full as Gideon's fleece:  
But then her tether calls her; she falls off,  
And as she dwindles shreds her smock of gold  
Amidst the sisting planets, till she comes  
To single Saturn, last and solitary;  
And then goes out into the cavernous dark.

In Norman H. MacKenzie (ed.)

*The Poetical Works of Gerard Manley Hopkins*

After Observing Tempel's Comet in 1864 (p. 40)

Clarendon Press. Oxford, England. 1990

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

But indeed all the whole story of Comets and Planets,  
and the Production of the World, is founded upon such  
poor and trifling grounds, that I have often wonder'd how  
an ingenious man could spend all that pains in making  
such fancies hang together.

*The Celestial Worlds Discover'd; or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions* (p. 160)

Printed for Timothy Childe. London, England. 1698

**Joyce, James** 1882–1941

Irish-born author

Would the departed never nowhere nohow reappear? Ever  
he would wander, selfcompelled, to the extreme limit  
of his cometary orbit, beyond the fixed stars and variable  
suns and telescopic planets, astronomical waifs and strays,  
to the extreme boundary of space, passing from land to  
land, among peoples, amid events. Somewhere imperceptibly  
he would hear and somehow reluctantly, uncompelled, obey  
the summons of recall. Whence, disappearing from the  
constellation of the Northern Crown he would somehow  
reappear reborn above delta in the

constellation of Cassiopeia and after incalculable eons of  
peregrination return an estranged avenger, a wrecker of  
justice on malefactors, a dark crusader, a sleeper awakened,  
with financial resources (by supposition) surpassing those  
of Rothschild or the silver king.

*Ulysses* (p. 712)

Random House, Inc. New York, New York, USA. 1946

**Kraus, Karl** 1874–1936

Austrian essayist and poet

If the earth had any idea of how afraid the comet is of  
contact with it.

In Harry Zohn (ed.)

*Half-Truths & One-and-a-Half Truths*

Lord, Forgive Them (p. 109)

The University of Chicago Press. Chicago, Illinois, USA. 1990

**Lee, Oliver Justin** 1881–1964

American astronomer

Dynamically it is quite possible that great numbers of  
comets were once well-behaved members of the solar  
system and that they have been bullied and kicked around  
gravitationally by the great planets and by possible dark  
bodies in space that they have become the pariahs they  
are.

*Measuring Our Universe: From the Inner Atom to Outer Space*

Chapter 7 (p. 93)

Ronald Press Company. New York, New York, USA. 1950

**Levy, David H.** 1948–

Canadian astronomer and science writer

Comets are like cats: they have tails, and they do precisely  
what they want.

*Comets: Creators and Destroyers*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1998

**Lubbock, Sir John** 1834–1913

English banker, author, and scientist

Comets may almost be regarded as the ghosts of heavenly  
bodies.

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter X (p. 402)

The Macmillan Company. New York, New York, USA. 1893

**Maunder, Edward Walter** 1851–1928

English astronomer

Comets cannot be homes of life; they are not sufficiently  
condensed; indeed, they are probably but loose congeries  
of small stones. But even if comets were of planetary size  
it is clear that life could not be supported on them; water  
could not remain in the liquid state on a world that rushed  
from one such extreme of temperature to another.

*Are the Planets Inhabited?*

Chapter IX (pp. 119–120)

Harper & Brothers. London, England. 1913

**Milton, John** 1608–74

English poet

Satan stood

Unterrifi'd, and like a comet burn'd

That fires the length of Ophiuchus huge

In th' Arctic sky...

In *Great Books of the Western World* (Volume 32)*Paradise Lost*

Book II, l. 707–710

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**National Geographic Society**

Comets are the nearest thing to nothing that anybody can be and still be something.

*National Geographic Society*

Concerning the comet of 31 March 1955

**Nicholson, Norman** 1914–87

English poet

It's here at last. Eyes in the know

Had spotted it two years ago,

A microscopic smut on film.

...

Anxious astronomers protest:

Give them a month, and they'll know just what

The frozen core is made of, test

The fluorescence tailing from it,

Fanned out in the solar wind.

*Collected Poems*

Comet Come (p. 431)

Faber &amp; Faber Ltd. London, England. 1994

**Noyes, Alfred** 1880–1958

English poet

It was a comet, made of mortal sins...

*The Torch Bearers: Watchers of the Sky*

Tycho Brahe, III (p. 61)

Frederick A. Stokes Company Publishers. New York, New York, USA.

1922

**Nye, Bill** 1850–96

American journalist

The comet is a kind of astronomical parody on the planet. Comets look some like planets, but they are thinner and do not hurt so hard when they hit anybody as a planet does. The comet was so called because it had hair on it, I believe, but late years the bald-headed comet is giving just as good satisfaction everywhere.

*Remarks*

Skimming the Milky Way (p. 125)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Paré, Ambroise** 1510–90

French surgeon

The comet was so horrible and frightful...that some [people] died of fear and others fell sick. It appeared as a star

of excessive length and the color of blood; at its summit was seen the figure of a bent arm holding a great sword in its hand, as if about to strike. On both sides...were seen a great number of axes, knives and spaces colored with blood, among which were a great number of hideous human faces with beards and bristling hair.

In William H. Jefferys and R. Robert Robbins

*Discovering Astronomy*

Physician (p. 12)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1995

**Peltier, Leslie C.** 1900–80

American comet hunter

Time has not lessened the age-old allure of the comets. In some ways their mystery has only deepened with the years. At each return a comet brings with it the questions which were asked when it was here before, and as it rounds the sun and backs away toward the long, slow night of its aphelion, it leaves behind with us those questions, still unanswered.

To hunt a speck of moving haze may seem a strange pursuit, but even though we fail the search is still rewarding, for in no better way can we come face to face, night after night, with such a wealth of riches as old Croesus never dreamed of.

*Starlight Nights*

Chapter 27 (p. 231)

Harper &amp; Row, Publishers. New York, New York, USA. 1965

I had watched a dozen comets, hitherto unknown, slowly creep across the sky as each one signed its sweeping flourish in the guest book of the Sun.

*Starlight Nights*

Chapter 6 (p. 43)

Harper &amp; Row, Publishers. New York, New York, USA. 1965

**Sagan, Carl** 1934–96

American astronomer and science writer

These are the snows of yesteryear, the pristine remnants of the origin of the solar system, waiting frozen in the interstellar dark.

*Comet*

Chapter I (p. 4)

Random House, Inc. New York, New York, USA. 1985

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

Some day there will arise a man who will demonstrate in what region of the heavens comets take their way.

In Michael Rowan-Robinson

*Our Universe: An Armchair Guide* (p. 1)

W.H. Freeman &amp; Company. New York, New York, USA. 1990

If one of these fires of unusual shape have made its appearance, everybody is eager to know what it is. Blind to all other celestial bodies, each asks about the new-comer; one is not quite sure whether to admire or to

fear it. Persons there are who seek to inspire terror by forecasting its grave import.

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*  
Book VII, Chapter I (p. 272)  
Macmillan & Company Ltd. London, England. 1910

...how many other bodies besides [these comets] move in secret, never dawning upon human eyes? Nor is it for man that God has made all things.

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*  
Book VII, Chapter XXX (p. 305)  
Macmillan & Company Ltd. London, England. 1910

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

When beggars die, there are no comets seen:  
The heavens themselves blaze forth the death of princes.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume One)  
Julius Caesar  
Act II, Scene ii, l. 30–31  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Hung by the heavens with black, yield day to night!

Comets, importing change of time and states,  
Brandish your crystal tresses in the sky.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume One)  
The First Part of King Henry the Sixth  
Act I, Scene i, l. 1–3  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Shelley, Percy Bysshe** 1792–1822

English poet

Thou too, O Comet, beautiful and fierce,  
Who drew the heart of this frail Universe  
Towards thine own; till, wrecked in that convulsion,  
Alternating attraction and repulsion,  
Thine went astray, and that was rent in twain;  
Oh, float into our Azure heaven again!

*The Complete Poetical Works of Percy Bysshe Shelley*  
Epipsychidion, l. 367–372  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### **Swift, Jonathan** 1667–1745

Irish-born English writer

...the earth very narrowly escaped a brush from the tail of the last comet, which would have infallibly reduced it to ashes...

In *Great Books of the Western World* (Volume 36)  
*Gulliver's Travels*  
Part III, Chapter II (p. 98)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Tasso, Torquato** 1544–95

Italian poet

As shaking terrors from his blazing hair,  
A sanguine comet gleams through dusky air.

Translated by Edward Fairfax

*Jerusalem Delivered*, l. 581  
The Colonial Press. New York, New York, USA. 1901

### **Thomson, James** 1700–48

Scottish poet

Lo! from the dread immensity of space  
Returning, with accelerated course,  
The rushing comet to the sun descends;  
And as he shrinks below the shading earth,  
With awful train projected o'er the heavens,  
The guilty nations tremble.

*Seasons*  
Summer, l. 1705–10  
Printed by John Mycall. Newburyport, Massachusetts, USA. 1790

### **Tolstoy, Leo** 1828–1910

Russian writer

...this bright comet which, having traveled in its orbit with inconceivable velocity through immeasurable space, seemed suddenly — like an arrow piercing the earth — to remain fixed in a chosen spot, vigorously holding its tail erect, shining and displaying its white light amid countless other scintillating stars.

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
Book VIII, Chapter XXII (p. 341)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Turner, H. H.**

No biographical data available

Of all the meteors in the sky  
There's none like Comet Halley.

We see it with the naked eye  
And periodically.  
Halley's Comet  
*The Mathematical Gazette*, Volume VI, Number 91, March 1911 (p. 53)

### **Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

I came in with Halley's Comet in 1835. It is coming again next year (1910), and I expect to go out with it. It will be the greatest disappointment of my life if I don't go out with Halley's Comet. The Almighty has said, no doubt: "Now here are these two unaccountable freaks; they came in together, they must go out together."

In Albert Bigelow Paine  
*Mark Twain: A Biography* (Volume 4)  
Chapter CCLXXXII (p. 1511)  
Harper & Brothers Publishers. New York, New York, USA. 1912

### **Virgil** 70 BCE– 19 BCE

Roman epic, didactic, and idyllic poet

Of, too, when wind is toward, the stars thou'lt see  
From heaven shoot headlong, and through murky night  
Long trails of fire white-glistening in their wake...

In *Great Books of the Western World* (Volume 13)

*The Georgics*

Book I, l. 365–366

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

Since scientific knowledge, although frequently blended with vague and superficial views, has been more extensively diffused through wider circles of social life, apprehensions of the possible evils threatened by comets have acquired more weight, as their direction has become more definite.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Aerolites (p. 110)

Harper & Brothers, Publishers. New York, New York, USA. 1869

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

That, science said, would be all. The green clouds would whirl and vanish, and there might be thunderstorms. But through the attenuated wisps of comet shine, the old sky, the old stars, would reappear, and all would be as it had been before.

*Seven Famous Novels by H.G. Wells*

In the Days of the Comet

Book I, Chapter 5 (pp. 774–775)

Alfred A. Knopf. New York, New York, USA. 1934

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Year of comets and meteors transient and strange — lo!  
even here one equally transient and strange!

As I flit through you hastily, soon to fall and be gone,  
what is this chant?

What am I but one of you meteors?

*Complete Poetry and Collected Prose*

Year of the Meteor

The Library of America. New York, New York, USA. 1982

**Winchell, Alexander** 1824–91

American geologist

Comets are facts of observation; there is no mistake as to the real existence of such bodies, whatever they may be. They always excite our admiration. They are full of wonder. They come from the unsearchable depths of space, and after shining in our heavens a few weeks, disappear in the unsearchable depths.

*Walks and Talks in the Geological Field*

Chapter XXXVI (p. 208)

Chautauqua Press. New York, New York, USA. 1890

**Young, Edward** 1683–1765

English poet and dramatist

Hast thou n'er seen the Comet's flaming Flight?

Th' illustrious Stranger passing, Terror sheds

On gazing Nations, from his fiery Train

Of length enormous; takes his ample Round

Thro' Depths of Ether; coasts unnumber'd Worlds,  
Of more than solar Glory; doubles wide  
Heavens's mighty Cape; and then revisits Earth,  
From the long Travel of a thousand Years.

*Night Thoughts*

Night IV, l. 706–713

Printed by R. Nobels for R. Edwards. London, England. 1797

## COMMON SENSE

**Ackoff, Russell Lincoln** 1919–

American operations research and systems scientist

...common sense...has the very curious property of being more correct retrospectively than prospectively. It seems to me that one of the principal criteria to be applied to successful science is that its results are almost always obvious retrospectively; unfortunately they seldom are prospectively. Common sense provides a kind of ultimate validation after science has completed its work; it seldom anticipates what science is going to discover.

In Anthony de Reuck, Maurice Goldsmith and Julie Knight (eds.)

*Decision Making in National Science Policy*

Operational Research and National Science Policy, Discussion (p. 96)

**Arnauld, Antoine** 1612–94

French philosopher, lawyer, and mathematician

Common sense is not really so common.

*The Art of Thinking: Port-Royal Logic*

First Discourse (p. 9)

The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1964

**Atkins, Peter William** 1940–

English physical chemist and writer

...common sense drives us to accept quantum theory in place of classical physics as more consistent with common sense.... When they are inspected, the explanations of classical physics fall apart, and they are seen to be mere superficial delusions, like film-sets.

*Creation Revisited: The Origin of Space, Time and the Universe*

Chapter Three (p. 53)

W.H. Freeman & Company. Oxford, England. 1992

**Barfield, Owen** 1898–1997

British philosopher, critic, and anthroposophist

And common sense today assumes that it is the outer world that is real and permanent, while the inner experience we call consciousness, or subjectivity, or our own or our self, is a fleeting unreality to which it somehow gives birth from time to time.

*History, Guilt, and Habit*

Chapter 2 (p. 47)

Wesleyan University Press. Middletown, Connecticut, USA. 1979

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

This is precisely what common sense is for, to be jarred into uncommon sense. One of the chief services which mathematics has rendered the human race in the past century is to put “common sense” where it belongs, on the topmost shelf next to the dusty canister labeled “discarded nonsense.”

*Mathematics: Queen and Servant of Science*

Mathematical Truth (pp. 17–18)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

### **Belloc, Hilaire** 1870–1953

French-born poet and historian

The double analysis kills the single analysis, and the treble kills the double, until at last a sufficiency of statistics comes very near to common sense.

*The Silence of the Sea*

On Statistics (p. 174)

Sheed & Ward. New York, New York, USA. 1940

### **Bennett, Arnold** 1867–1931

English novelist and playwright

And then he knew that something within him more powerful than his common-sense would force him to stake that five-franc piece. He glanced furtively at the crowd to see whether anyone was observing him. Number Well, it having been decided to bet, the next question was, how to bet? Now, Henry had read a magazine article concerning the tables at Monte Carlo, and, being of a mathematical turn, had clearly grasped the principles of the game. He said to himself, with his characteristic caution: “I’ll wait till red wins four times running, and then I’ll stake on the black.”

(“But surely,” remarked the logical superior person in him, “you don’t mean to argue that a spin of the ball is affected by the spins that have preceded it? You don’t mean to argue that, because red winds four times, or forty times, running, black is any the more likely to win at the next spin?”)

“You shut up!” retorted the human side of him crossly....)

*A Great Man*

Chapter XXV (pp. 245–246)

George H. Doran Company. New York, New York, USA. 1911

### **Bialac, Richard N.**

No biographical data available

Statistics are no substitute for common sense.

In Paul Dickson

*The Official Explanations* (p. B–14)

Delacorte Press. New York, New York, USA. 1980

### **Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

The world makes sense all right; it makes common sense.... But common sense is not what we put into the

world. It is what we find there.

*The Common Sense of Science*

Chapter V, Section 7 (p. 78)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

### **Chatfield, Christopher**

English statistician

“Common sense” is not common but needs to [be] learnt systematically.... A “simple analysis” can be harder than it looks.... All statistical techniques, however sophisticated, should be subordinate to subjective judgment.

The Initial Examination of Data

*Journal of The Royal Statistical Society*, Series A, Volume 148, 1985

### **Compton, Karl Taylor** 1887–1954

American educator and physicist

We cannot get far by trying to impose an engineering education, however excellent it may be, on a young man of mediocre ability or one temperamentally unfitted for technical or administrative work. The idea reminds me of an experience which my sister had...in India. She had engaged a native electrician to install some new fixtures in her house, but he seemed particularly stupid and kept coming to her for instructions. Finally, in exasperation she said to him: “Why do you come asking questions all the time? Why don’t you use your common sense?” “Madam,” he replied gravely, “common sense is a rare gift of God. I have only a technical education.”

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

*During the Years 1930–1949* (p. 51)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA.

1955

### **Crofton, M. W.**

British mathematician

There is no more remarkable feature in the mathematical theory of probability than the manner in which it has been found to harmonize with, and justify, the conclusions to which mankind have been led, not by reasoning, but by instinct and experience, both of the individual and of the race. At the same time it has corrected, extended, and invested them with a definiteness and precision of which these crude, though sound, appreciations of common sense were till then devoid.

*Encyclopædia Britannica* (9th Edition)

Probability

J.M. Stoddart & Co. Philadelphia, Pennsylvania, USA. 1911

### **Cross, Hardy** 1885–1959

American professor of civil and structural engineering

Common sense is only the application of theories which have grown and been formulated unconsciously as a result of experience.

*Engineers and Ivory Towers*

For Man’s Use of God’s Gifts (p. 107)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Dewey, John** 1859–1952  
American philosopher and educator

...unless the materials involved can be traced back to the material of common sense concern there is nothing whatever for scientific concern to be concerned with.

Common Sense and Science

*The Journal of Philosophy*, Volume XLV, Number 8, April 18, 1948 (p. 206)

**Dickens, Charles** 1812–70  
English novelist

I don't profess to be profound; but I do lay claim to common sense.

*David Copperfield*

Chapter VIII (p. 113)

Oxford University Press, Oxford, England. 1981

**Einstein, Albert** 1879–1955  
German-born physicist

...common sense is nothing more than a deposit of prejudices laid down in the mind before you reach eighteen.

In Eric T. Bell

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 42)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Goldenweiser, Alexander** 1880–1940  
American anthropologist

...the physician would be even worse off than he is, if not for the occasional emergence of common sense which breaks through dogmas with intuitive freshness, or those flashes of insight for which talented diagnosticians are noted, or finally, an opportunity to make a biographical study of a patient, a luxury few physicians can enjoy and few patients can afford.

With the subject of the uniqueness of particulars, is ushered in intuitive mind as it functions in religion, art, and other forms of imaginative creativeness.

*Robots or Gods*

Chapter IV (p. 62)

Alfred A. Knopf, New York, New York, USA. 1931

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Son, that phrase is self-contradictory; "sense" is never "common".

*Time Enough for Love*

Prelude, Chapter II (p. 47)

G.P. Putnam's Sons, New York, New York, USA. 1973

**Henderson, Lawrence** 1878–1942  
American biochemist

It is a strange irony that the principles of science should seem to deny the necessary conviction of common sense.

*The Order of Nature*

Chapter V (p. 92)

Harvard University Press, Cambridge, Massachusetts, USA. 1917

**Hofstadter, Douglas** 1945–  
American cognitive scientist and author

...consider the very roots of our ability to discern truth. Above all (or perhaps I should say "underneath all"), common sense is what we depend on — that crazily elusive, ubiquitous faculty we all have, to some degree or other... If we apply common sense to itself over and over again, we wind up building a skyscraper. The ground floor of this structure is the ordinary common sense we all have, and the rules for building new floors are implicit in the ground floor itself. However, working it all out is a gigantic task, and the result is a structure that transcends mere common sense.

Pretty soon, even though it has all been built up from common ingredients, the structure of this extended common sense is quite arcane and elusive. We might call the quality represented by the upper floors of this skyscraper "rare sense"; but it is usually called "science". And some of the ideas and discoveries that have come out of this originally simple and everyday ability defy the ground floor totally.

*Metamagical Themas: Questing for the Essence of Mind and Pattern*

Section II, Chapter 5 (p. 93, 94)

Basic Books, Inc. New York, New York, USA. 1985

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Science is a first-rate piece of furniture for a man's upper chamber, if he has common sense on the ground-floor.

*The Poet at the Breakfast-Table*

Chapter V (p. 120)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1895

**Howe, E. W.** 1853–1937  
American novelist and newspaper and magazine editor

What is common sense? That which attracts the least opposition: that which brings most agreeable and worthy results.

*Sinner Sermons: A Selection of the Best Paragraphs of E.W. Howe* (p. 7)

Girard, Kansas, USA. 1926

**Huxley, Thomas Henry** 1825–95  
English biologist

Science is, I believe, nothing but trained and organized common sense, differing from the latter only as a veteran may differ from a raw recruit: and its methods differ from those of common sense only as far as the guardsman's cut and thrust differ from the manner in which a savage wields a club.

*Collected Essays* (Volume 3)

*Science and Education*

On the Educational Value of the Natural History of Science (p. 45)

Macmillan & Company Ltd. London, England. 1904

**James, William** 1842–1910  
American philosopher and psychologist



Common-sense contents itself with the unreconciled contradiction, laughs when it can, and weeps when it must, and makes, in short, a practical compromise, without trying a theoretical solution.

*Collected Essays and Reviews*

German Pessimism (p. 17)

Longmans, Green & Company. New York, New York, USA. 1920

**Keynes, John Maynard** 1883–1946

British economist

We know that the probability of a well-established induction is great, but, when we are asked to name its degree, we cannot. Common sense tells us that some inductive arguments are stronger than others, and that some are very strong. But how much stronger or how strong we cannot express.

*A Treatise on Probability*

Chapter XXI (p. 259)

Harper & Row, Publishers. New York, New York, USA. 1962

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

One sees in this essay that the theory of probabilities is at bottom only common sense reduced to a calculus; it makes us appreciate with exactitude that which exact minds feel by a sort of instinct without being able oft-times to give a reason for it.

*A Philosophical Essay on Probabilities*

Chapter XVIII (p. 196)

Dover Publications, Inc. New York, New York, USA. 1951

**Latham, Peter Mere** 1789–1875

English physician

A small overweight of knowledge is often a sore impediment to the movement of common sense.

In William B. Bean

*Aphorisms from Latham* (p. 37)

Prairie Press. Iowa City, Iowa, USA. 1962

**Lehrer, Keith** 1936–

American philosopher

The overthrow of accepted opinion and the dictates of common sense are often essential to epistemic advance. Moreover, an epistemic adventurer may arrive at beliefs that are not only new and revelatory, but also better justified than those more comfortably held by others. The principle of the conservation of accepted opinion is a roadblock to inquiry, and, consequently, it must be removed.

*Knowledge*

Chapter 7 (p. 184)

Clarendon Press. Oxford, England. 1974

**Luria, Salvador Edward** 1912–91

Italian-American microbiologist

Significant advances in science often have a peculiar quality: they contradict obvious, commonsense opinions.

*A Slot Machine, a Broken Test Tube: An Autobiography*

The Science Path: IV, Looking Back (p. 116)

Harper & Row, Publishers. New York, New York, USA. 1984

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Common sense is not wrong in the view that it is meaningful, appropriate and necessary to talk about the large objects of our daily experience.... Common sense is wrong only if it insists that what is familiar must reappear in what is unfamiliar.

*Science and the Common Understanding*

Chapter 5 (pp. 74–75)

Simon & Schuster. New York, New York, USA. 1953

...distrust all the philosophers who claim that by examining science they come to the results in contradiction with common sense. Science is based on common sense; it cannot contradict it.

In University of Denver

*Foundations for World Order*

The Scientific Foundations for World Order (p. 51)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Common-sense nerve fibers are seldom medullated before forty — they are never seen even with a microscope before twenty.

*Sir William Osler: Aphorisms from His Bedside Teachings and Writings*

(p. 283)

Charles C. Thomas. Springfield. 1961

**Pope, Alexander** 1688–1744

English poet

Good sense, which only is the gift of Heaven,  
And through no science, fairly worth the seven.

*The Complete Poetical Works*

Moral Essays, Ep. IV, l. 43

Houghton Mifflin & Company. New York, New York, USA. 1903

**Roosevelt, Franklin Delano** 1882–1945

32<sup>nd</sup> president of the United States

It is common sense to take a method and try it. If it fails, admit it frankly and try another. But above all, try something.

Speech

Oglethorpe University, May 22, 1932

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Common sense starts with the notion that there is matter where we can get sensations of touch, but not elsewhere. Then it gets puzzled by wind, breath, clouds, etc., whence it is led to the conception of “spirit” — I speak etymologically. After “spirit” has been replaced by “gas,” there is a further stage, that of the aether.

*The Analysis of Matter*

Chapter XIII (p. 121)  
Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

Common sense, however it tries, cannot avoid being surprised from time to time. The aim of science is to save it from such surprises.

In Jean-Pierre Luminet  
*Black Holes* (p. 182)  
Cambridge University Press. New York, New York, USA. 1992

The supposition of common sense and naive realism, that we see the actual physical object, is very hard to reconcile with the scientific view that our perception occurs somewhat later than the emission of light by the object; and this difficulty is not overcome by the fact that the time involved, like the notorious baby, is a very little one.

*The Analysis of Matter*  
Chapter XV (p. 155)  
Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

It used to be supposed by empiricists that the justification of such inference rests upon induction. Unfortunately, it can be proved that induction by simple enumeration, if conducted without regard to common sense, leads very much more often to error than the truth. And if a principle needs common sense before it can be safely used, it is not the sort of principle than can satisfy a logician. We must, therefore, look for a principle other than induction if we are to accept the broad outlines of science, and of common sense in so far as it is not refutable. This is a very large problem.

*My Philosophical Development*  
Chapter I (p. 11)  
George Allen & Unwin Ltd. London, England. 1975

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

...one of the most marked characteristics of science is its critical quality, which is just what common-sense lacks. By common-sense is usually meant either the consensus of public opinion, of unsystematic everyday thinking, the untrustworthiness of which is notorious, or the verdict of uncritical sensory experience, which has so often proved fallacious. It was “common-sense” that kept the planets circling around the earth; it was “common-sense” that refused to accept Harvey’s demonstration of the circulation of the blood.

*Introduction to Science*  
Chapter II (p. 39)  
Williams & Norgate Ltd. London, England. 1916

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

There is absolutely no common sense; it is common non-sense.

*The Writings of Henry David Thoreau* (Volume 4)  
Paradise (to Be) Regained (p. 298)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Titchener, Edward Bradford** 1867–1927  
English-born American psychologist

...common sense is the very antipodes of science.  
*Systematic Psychology: Prolegomena*  
Chapter I (p. 48)  
Cornell University Press. Ithaca, New York, USA. 1972

**Veblen, Thorstein** 1857–1929  
Norwegian-American sociologist and economist

...enlightened common-sense sticks by the opaque truth and refuses to go behind the returns given by the triangle of facts.

*The Place of Science in Modern Civilisation and Other Essays*  
The Place of Science in Modern Civilisation (p. 4)  
The Viking Press. New York, New York, USA. 1942

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

...the anxious precision of modern mathematics is necessary for accuracy...it is necessary for research. It makes for clearness of thought and for fertility in trying new combinations of ideas. When the initial statements are vague and slipshod, at every subsequent stage of thought, common sense has to step in to limit applications and to explain meanings. Now in creative thought common sense is a bad master. Its sole criterion for judgment is that the new ideas shall look like the old ones, in other words it can only act by suppressing originality.

*An Introduction to Mathematics*  
Chapter 11 (p. 116)  
Oxford University Press, Inc. New York, New York, USA. 1958

**Wolpert, Lewis** 1929–  
American biologist

...one of the strongest arguments for the distance between common sense and science is that the whole of science is totally irrelevant to people’s day-to-day lives.

*The Unnatural Nature of Science*  
Chapter I (p. 16)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

## COMMUNITY

**Greenspoon, David Harry**  
No biographical data available

We are community, within and without — that is, our bodies are, in a sense, communities of microorganisms, and our biosphere is an intricate mesh of interacting communities. It’s only natural to want to extend this and create an interplanetary community. There is beauty and inspiration in the vision of humanity’s spreading into the galaxy, leaving the cradle, becoming who-knows-what.

*Venus Revealed*  
Chapter 6 (p. 337)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

## COMPARISON

**Bramah, Ernest** 1869–1942

English author

How is it possible to suspend topaz in one cup of the balance and weigh it against amethyst in the other; or who in a single language can compare the tranquillizing grace of a maiden with the invigorating pleasure of witnessing a well-contested rat-fight.

*Kai Lung's Golden Hours*

258

G.H. Doran Company. New York, New York, USA. 1923

**Levy, Matthys**

No biographical data available

**Salvadori, Mario**

No biographical data available

When we compare our tiny corner of the universe to the infinite majesty of the whole, our innate, unjustified pride should naturally vanish. Yet, if we realize that, small as we are, we have been able to penetrate the mystery of the universe, establish its history, analyze its composition and draw its map; and that, moreover, we might even soon be able to predict its behavior to the end of time; and finally that, unfazed by our smallness, we have explored our little home, discovering in the process the origin of earthquakes and volcanoes, we are entitled to a complacent smile, a smile wisely tempered by the comparison of our mortality to the apparent never-ending life of the universe.

*Why the Earth Quakes*

Chapter 15 (pp. 191–192)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1995

## COMPLEXITY

**Forrester, Jay Wright** 1918–

American computer engineer and systems theorist

...complex systems are counterintuitive. That is, they give indications that suggest corrective action which will often be ineffective or even adverse in its results.

*Urban Dynamics*

Chapter 1 (p. 9)

MIT Press. Cambridge, Massachusetts, USA. 1969

**Reeves, Hubert** 1932–

Canadian astrophysicist

But shouldn't the simple have already potentially encompassed the complex? Where were the seeds of complexity during the first three minutes of the universe?

*Atoms of Silence*

Chapter 4 (p. 46)

The MIT Press. Cambridge, Massachusetts, USA. 1984

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

A more complete study of the movements of the world will oblige us, little by little, to turn it upside down; in other words, to discover that if things hold and hold together, it is only by reason of complexity, from above.

*The Phenomenon of Man*

Book One, Chapter I, Section 1 (p. 43)

Harper &amp; Brothers Publishers. New York, New York, USA. 1959

**Watts, Alan Wilson** 1915–73

American philosopher

The natural world seems a marvel of complexity, requiring a vastly intricate intelligence to create and govern it, just because we have represented it to ourselves in the clumsy "notation" of thought.

*Nature, Man, and Woman*

Part I, Chapter 2 (p. 62)

Vintage Books. New York, New York, USA. 1970

## COMPOUND

**Baeyer, Adolf von** 1835–1917

German research chemist

I have never stuck stubbornly to a particular point of view if it could no longer be reconciled with the facts. ...

I went for a ride, so to speak, through a pleasant countryside among the compounds and enjoyed the view. One day it looked this way, and perhaps the next day it looked different. So why should one stick stubbornly to one particular point of view.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 141)

W.A. Benjamin. New York, New York, USA. 1965

**Fittag, R.**

No biographical data available

We are now forced to increase the number of compounds, not merely in order to prepare new substances, but to discover natural laws.

In W. Mansfield Clark

*The Determination of Hydrogen Ions*

Chapter IV (p. 67)

The Williams &amp; Wilkins Company. Baltimore, Maryland, USA. 1928

**Pirsig, Robert M.** 1928–

American writer

Why, for example, should a group of simple, stable compounds of carbon, hydrogen, oxygen and nitrogen struggle for billions of years to organize themselves into a professor of chemistry?

*Lila: An Inquiry into Morals*

Chapter 11 (p. 140)

Bantam Books. New York, New York, USA. 1991

**Proust, J. L.** 1755–1826  
French chemist

We must recognize an invisible hand which holds the balance in the formation of compounds. A compound is a substance to which Nature assigns fixed ratios, it is, in short, a being which Nature never creates other than balance in hand, *pondere et mensur.*

*Annales of Chimie*, Volume 32, 1799 (p. 26)

## COMPREHENSION

**Atkins, Peter William** 1940–  
English physical chemist and writer

Comprehension is moving across the face of the Earth, like the sunrise.

*Creation Revisited: The Origin of Space, Time and the Universe*

Chapter Seven (p. 157)

W.H. Freeman & Company. Oxford, England. 1992

**D'Alembert, Jean Le Rond** 1717–83  
French mathematician

To someone who could grasp the universe from one unified viewpoint, the entire creation would appear as a unique fact and a great truth.

In Cornelius Lanczos

*Albert Einstein and the Cosmic World Order*

Chapter 6 (p. 107)

Interscience Publishers. New York, New York, USA. 1965

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

In the end what we comprehend about the universe is precisely that which we put into the universe to make it comprehensible.

*The Relativity Theory of Protons and Electrons* (p. 328)

Cambridge University Press. Cambridge, England. 1936

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

A strong sense of unease and dissatisfaction always goes with lack of comprehension. Laymen feel it too; how can we otherwise account for the relief they feel when they learn that some odd and disturbing phenomenon can be explained? It cannot be the explanation itself that brings relief, for it may easily be too technical to be widely understood. It is not the knowledge itself, but the satisfaction of knowing that something is known.

*Advice to a Young Scientist*

Chapter 2 (p. 7)

Basic Books, Inc. New York, New York, USA. 1979

## COMPUTER

**Crichton, Michael** 1942–  
American novelist

This fascination with computer models is something I understand very well. Richard Feynman called it a disease. I fear he is right.

Lecture

Aliens Cause Global Warming, California Institute of Technology,

January 17, 2003

**Hawking, Stephen William** 1942–  
English theoretical physicist

At present, computers are a useful aid in research, but they have to be directed by human minds. If one extrapolates their recent rapid rate of development, however, it would seem quite possible that they will take over altogether in theoretical physics. So maybe the end is in sight for theoretical physicists, if not for theoretical physics.

*Black Holes and Baby Universes and Other Essays*

Chapter Seven (p. 68)

Bantam Books. New York, New York, USA. 1987

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

What a satire, by the way, is that machine [Babbage's engine] on the mere mathematician! A Frankenstein-monster, a thing without brains and without heart, too stupid to make a blunder; that turns out results like a corn-sheller, and never grows any wiser or better, though it grind a thousand bushels of them!

*The Autocrat of the Breakfast-Table*

Chapter I (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Klein, Felix** 1849–1925  
German mathematician

If the activity of a science can be supplied by a machine, that science cannot amount to much, so it is said; and hence it deserves a subordinate place. The answer to such arguments, however, is that the mathematician, even when he is himself operating with numbers and formulas, is by no means an inferior counterpart of the errorless machine...

Translated by E.R. Hedrick and C.A. Noble

*Elementary Mathematics from an Advanced Standpoint*

Part First, Chapter II (p. 22)

Dover Publications. New York, New York, USA. 1939

## Mathematical Sciences Education Board

Calculators and computers should be used in ways that anticipate continuing rapid change due to technological developments. Technology should be used not because it is seductive, but because it can enhance mathematical learning by extending each student's mathematical power.

*Everybody Counts: A Report to the Nation on the Future of Mathematics Education*

Change (p. 84)

National Academy Press. Washington, D.C. 1989

**COMPUTING**

**Hamming, Richard W.** 1915–98  
Mathematician

The purpose of computing is insight, not numbers.  
*Numerical Methods for Scientists and Engineers* (p. v)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1962

**CONCEPT**

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

It is more important to have a clear understanding of general principles, without, however, thinking of them as fixed laws, than to load the mind with a mass of detailed technical information which can readily be found in reference books or card indexes.

*The Art of Scientific Investigation*  
Chapter One (p. 4)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Due to the contrast between the principles underlying the ordinary description of natural phenomena and the element of discontinuity characteristic for the quantum theory, we must be prepared that every concept used in accounting for the experimental evidence will have only restricted validity when dealing with atomic phenomena.

In E. Rudinger (ed.)  
*Niels Bohr: Collected Works* (Volume 6) (p. 69)  
North-Holland. Amsterdam, Netherlands. 1985

**Bridgman, Percy Williams** 1882–1961  
American physicist

...the concept is synonymous with the corresponding set of operations.

*The Logic of Modern Physics*  
Chapter I (p. 5)  
The Macmillan Company. New York, New York, USA. 1928

**Cassirer, Ernst** 1874–1945  
German philosopher

But what are concepts save formulation and creations of thought, which, instead of giving us the true forms of objects, show us rather the forms of thought itself? Consequently all schemata which science evolves in order to classify, organize and summarize phenomena of the real world turn out to be nothing but arbitrary schemes — dry fabrics of the mind, which express not the nature of things, but the nature of mind.

Translated by Susanne K. Langer  
*Language and Myth*  
Chapter 1 (p. 7)  
Harper & Brothers Publishers. New York, New York, USA. 1946

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

The initial incommunicability of truth, scientific or otherwise, shows that we think in grooves, and that it is painful for us to be torn away from the womblike security of accepted concepts.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Part II  
The Exquisiteness of Minute Differences (p. 86)  
Rockefeller University Press. New York, New York, USA. 1978

Great concepts require great names.  
*Essays on Nucleic Acids*  
Chapter 11 (p. 183)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1963

**Conant, James Bryant** 1893–1978  
American educator and scientist

...a useful concept may be a barrier to the acceptance of a better one if long-entrenched in the minds of scientists.

*On Understanding Science*  
Chapter III (p. 74)  
Yale University Press. New Haven, Connecticut, USA. 1947

**Egler, Frank E.** 1911–96  
American botanist and ecologist

A concept is nothing more than an idea, a mental creation, which makes comprehensible a certain group of facts.

*The Way of Science*  
Science Concepts (p. 21)  
Hafner Publishing Company. New York, New York, USA. 1970

**Einstein, Albert** 1879–1955  
German-born physicist

In the attempt to achieve a conceptual formulation of the confusingly immense body of observational data, the scientist makes use of a whole arsenal of concepts which he imbibed practically with his mother's milk; and seldom if ever is he aware of the eternally problematic character of his concepts.

*Concepts of Space: The History of Theories of Space in Physics*  
Preface (p. xi)  
Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968  
Polish physicist

Physical concepts are free creations of the human mind, and are not, however it may seem, uniquely determined by the external world.

*The Evolution of Physics*  
One Clew Remains (p. 31)  
Simon & Schuster. New York, New York, USA. 1961

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Even if we realize that the meaning of a concept is never defined with absolute precision, some concepts form an integral part of scientific methods, since they represent for the time being the final result of the development of human thought in the past, even in a very remote past; they may even be inherited and are in any case the indispensable tools for doing scientific work in our time.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter V (p. 92)

Harper &amp; Row, Publishers. New York, New York, USA. 1958

...words are not so clearly defined as they seem to be at first sight and...they have only a limited range of applicability.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter X (p. 168)

Harper &amp; Row, Publishers. New York, New York, USA. 1958

**Riemann, Bernhard** 1826–66

German mathematician

Science is the attempt to comprehend nature by means of concepts.

In C.J. Keyser

*The Hibbert Journal*, Volume 3, 1904–1905 (pp. 312–313)

**Talbot, Michael** 1953–92

American physicist

We have dreamed the world. Our concepts of time and space, the very structure of the universe, are more intimately related to the problems and phenomenon of consciousness than we have seriously suspected.

*Mysticism and the New Physics* (p. 2)

Routledge &amp; Kegan Paul. London, England &amp; Henley. 1981

**Taylor, E. S.** 1903–91

American aircraft engine pioneer

It is necessary to have a concept before it can be analyzed.

Report on Engineering Design

*Journal of Engineering Education*, Volume 51, Number 8, April 1961 (p. 649)

**von Bertalanffy, Ludwig** 1901–72

Austrian biologist

Behind the logical thesis that all concepts in science are reducible to physical concepts, there lies a meta-physical motive, although this would be sternly denied by the representatives of logical positivism. This motive is that the world, as pictured in physics, is the ultimate reality. The world consists of those elementary particles called atoms, electrons, protons, neutrons, and the like; and the things observed, whether stars and crystals, plants and animals, or brains and mental

life, are aggregates or the outcome of those ultimate realities.

*The Scientific Monthly*, November 1953 (p. 236)

**Wheeler, John Archibald** 1911–

American theoretical physicist and educator

I have great hesitation in trying to formulate some unifying concepts out of my own field, and still more reluctance in speaking about their application to other fields of human knowledge.

*At Home in the Universe*

A Septet of Sibyls: Aids in the Search for Truth (p. 3)

The American Institute of Physics. Woodbury, New York, USA. 1994

**CONCEPTION****Millikan, Robert Andrews** 1868–1953

American physicist

We can still look with a sense of wonder and mystery and reverence upon the fundamental elements of the physical world as they have been partially revealed to us in this century. The childish mechanical conceptions of the nineteenth century are now grotesquely inadequate.

*Evolution in Science and Religion*

Chapter I (p. 27)

Yale University Press. New Haven, Connecticut, USA. 1927

**CONCHOLOGY****Garstang, Walter** 1868–1949

English embryologist and amateur poet

Echinospira sets this riddle to the students of Conchology

To make them pay attention to the doctrines of Morphology:

And this is how he poses it: “The Ammonite’s old shell From time to time was portioned off, to make it fit him well.

“The smaller shell around his hump was “visceral,” like mine;

His outer shell also agrees: it’s “pallial” in fine.

We differ in this: his inner shell was fixed by suture, While mine is truly portable, and useful for the future!

So let us sing in fitting terms an entente cordiale, Observing in its proper place the torsion viscerales: My outer shell’s a “relic” of my Ammonitic traits, My inner is a tribute to my clever modern ways!

*Larval Forms, and Other Zoological Verses*

Echinospira’s Double Shell, Stanzas 2–4 (p. 42)

The University of Chicago Press. Chicago, Illinois, USA. 1985

**CONCLUSION****Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

These practical results — for so we venture to call the general conclusions last presented — although they are purely scientific deductions from general principles, may satisfy the most obstinate supporters of the matter-of-fact side of all questions, of the advantages of scientific illustrations in the daily walks of life, and also justify the course which has been followed with so much success by the Coast Survey, in combining the strictest scientific methods with its practical operation.

*Annual Report of the Superintendent of the Coast Survey, Showing the Progress of that Work During the Year Ending November, 1851*

Extracts from the Report of Professor Agassiz to the Superintendent of the Coast Survey, on the Examination of the Florida Reefs, Keys, and Coast (pp. 159–160)

Printed by Robert Armstrong. Washington, D.C. 1852

**Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

It may seem rash indeed to draw conclusions valid for the whole universe from what we can see from the small corner to which we are confined. Who knows that the whole visible universe is not like a drop of water at the surface of the earth? Inhabitants of that drop of water, as small relative to it as we are relative to the Milky Way, could not possibly imagine that beside the drop of water there might be a piece of iron or a living tissue, in which the properties of matter are entirely different.

*Space and Time*

Note IV (p. 227)

Dover Publications, Inc. New York, New York, USA. 1960

**Charlie Chan**

Fictional character

Hasty conclusion like toy balloon. Easy to blow up, easy to pop.

*Charlie Chan at the Race Track*

Film (1936)

Hasty conclusion like gunpowder. Easy to explode.

*Charlie Chan in Paris*

Film (1935)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

However experienced the observer, I do not think we ought to put implicit trust in a result which strains his skill to the utmost until it has been verified by others working independently. Therefore you should for the present make the usual reservations in accepting these conclusions. But science is not just a catalogue of ascertained facts about the universe; it is a mode of progress, sometimes tortuous, sometimes uncertain. And our interest in science is not merely a desire to hear the latest facts added to the collection; we like to discuss our hopes and fears, probabilities and expectations.

*Stars and Atoms*

Lecture II (p. 53)

Yale University Press. London, England. 1927

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

He that will not verify his conclusions as far as possible by mathematics, as it were bringing the ingots of common sense to be assayed and coined at the mint of sovereign science, will hardly realize the full value of what he holds, will want a measure of what it will be worth in however slightly altered circumstances, a means of conveying and making it current.

*Mathematical Psychics*

Part I (p. 3)

C. Kegan Paul & Company. London, England. 1881

**Gregory, Sir Richard Arman** 1864–1952

Scientific writer and journalist

There is a common impression that the conclusions arrived at by men of science are of the nature of beliefs, and have, therefore, no firmer basis than that of conviction. Nothing could be farther from the truth.

*Discovery: The Spirit and Service of Science*

Chapter V (p. 92)

Macmillan & Company Ltd. London, England. 1918

**Hume, David** 1711–76

Scottish philosopher and historian

The principal difficulty in the mathematics is the length of inferences and compass of thought, requisite to the forming of any conclusion.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section VII, Part I (p. 471)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

Scientific men should not rush to conclusions, but keep their minds open for such time as may be necessary.

In Eric Temple Bell

*The Search for Truth*

Chapter XVIII (p. 277)

George Allen & Unwin Ltd. London, England. 1935

**Somerville, Mary** 1780–1872

English mathematician

Great discoveries generally lead to a variety of conclusions...

*The Connexion of the Physical Sciences* (9<sup>th</sup> edition)

Section IV (p. 32)

John Murray. London, England. 1858

English poet

A large number of incorrect conclusions are drawn because the possibility of chance occurrences is not fully

considered. This usually arises through lack of proper controls and insufficient repetitions. There is the story of the research worker in nutrition who had published a rather surprising conclusion concerning rats. A visitor asked him if he could see more of the evidence. The researcher replied, "Sure, there's the rat."

*An Introduction to Scientific Research*

Chapter 3 (p. 34)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

## CONDUCTOR

### Rudberg, Eric Gustaf

Swedish physicist

If the Easter pilgrims in Piazza San Pietro were to represent the carriers in a metal, then an insulator would resemble the Antarctic with one solitary traveler. In the abundance of carriers there is an enormous gap between conductors and insulators.

*Nobel Lectures, Physics 1942–1962*

Presentation speech for Nobel Prize for physics in 1956

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## CONFIDENCE

### Burroughs, Edgar Rice 1875–1950

American writer

I do not think that I am ever overconfident. I am merely wholly confident, and I maintain that there is all the difference in the world there.

*Llana of Gathol*

Book IV, Chapter 9

Ballantine Books. Tarzana, California, USA. 1948

### Curie, Marie Skłodowska 1867–1934

Polish-born French physicist and chemist

Life is not easy for any of us. But what of that? We must have perseverance and above all confidence in ourselves. We must believe that we are gifted for something and that this thing, at whatever cost, must be attained.

In *Eve Curie*

*Madame Curie*

Chapter XII (p. 158)

The Literary Guild of America, Inc. New York, New York, USA. 1937

## CONFUSION

### Darwin, Charles Robert 1809–82

English naturalist

I am in thick mud; the orthodox would say in fetid abominable mud. I believe I am in much the same frame of mind as an old gorilla would be in if set to learn the first book of Euclid...yet I cannot keep out of the question.

*The Correspondence of Charles Darwin*

Letter to Asa Grey (p. 369)

Cambridge University Press. Cambridge, England. 1994

### Galilei, Galileo 1564–1642

Italian physicist and astronomer

At times also I have been put to confusion and driven to despair of ever explaining something for which I could not account, but which my senses told me to be true.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

First Day (p. 131)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Hammer, P. C.

American science editor

...the filling of minds with technical concepts without establishing their relationships is a form of pollution.

*Mind Pollution*

*Cybernetics*, Volume 14, 1971

### Hutton, James 1726–97

Scottish geologist, chemist, and naturalist

Chaos and confusion are not to be introduced into the order of nature, because certain things appear to our partial views as being in some disorder. Nor are we to proceed in feigning causes when those seem insufficient which occur in our experience.

*The Theory of the Earth* (Volume 2)

Part II, Chapter XIV (p. 547)

Messrs. Cadwell, Junior, and Davies. London, England. 1795

### Miller, Henry 1891–1980

American writer

Confusion is a word we have invented for an order which is not understood.

*Tropic of Capricorn*

An Interlude (p. 176)

Grove Press. New York, New York, USA. 1961

### Moore, Marianne 1887–1972

American poet

Unconfusion submits

its confusion to proof; it's

not a Herod's oath that cannot change.

*Collected Poems*

The Mind Is an Enchanting Thing (p. 134)

The Macmillan Company. New York, New York, USA. 1967

### Ritchie, Arthur David 1891–1967

Scottish history of science author

If you are in the very thickest fog you are not confused because you see nothing to confuse you. But as the fog gradually disperses you catch sight indistinctly of a bit of something here and other bit of something there; you are not quite sure what each is or how it fits in with the rest. Then you are confused until it is clear enough to see everything.



The Atomic Theory

*Memoirs and Proceedings of the Manchester Literary & Philosophical Society*, Volume 86, 1944 (p. 180)

**Townson, Robert** 1763–1827

Australian scholar and scientist

When science has not connected the different parts of the great plan of Nature; whilst the various concurring means to one great end, are difficult and insulated; great disorder and want of contrivance may appear, where nothing but order really prevails; and what may be the result of infinite wisdom, will be considered as the effect of chance, and the consequence of confusion.

*Philosophy of Mineralogy*

Chapter VI (p. 76)

Printed for the author. London, England. 1798

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...leaving the vast darkness of the subject unobscured.

In J. Robert Oppenheimer

*The Open Mind*

Chapter V (p. 102)

Simon & Schuster. New York, New York, USA. 1955

## CONIC SECTION

**Sylvester, James Joseph** 1814–97

English mathematician

The discovery of the conic sections, attributed to Plato, first threw open the higher species of form to the contemplation of geometers. But for this discovery, which was probably regarded in Plato's time and long after him, as the unprofitable amusement of a speculative brain, the whole course of practical philosophy of the present day, of the science of astronomy, of the theory of projectiles, of the art of navigation, might have run a different channel; and the greatest discovery that has ever been made in the history of the world, the law of universal gravitation, with its innumerable direct and indirect consequences and applications to every department of human research and industry, might never to this hour have been elicited.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

A Probationary Lecture on Geometry

Gresham Committee and the Members of the Common Council of the City of London

4 December, 1854 (p. 7)

University Press. Cambridge, England. 1904–1912

**Whewell, William** 1794–1866

English philosopher and historian

If the Greeks had not cultivated Conic Sections, Kepler could not have superseded Ptolemy; if the Greeks had cultivated Dynamics, Kepler might have anticipated Newton.

*History of the Inductive Sciences, from the Earliest to the Present Time*

(Volume 2)

Book VI, Introduction (p. 7)

John W. Parker. London, England. 1837

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

No more impressive warning can be given to those who would confine knowledge and research to what is apparently useful, than the reflection that conic sections were studied for eighteen hundred years merely as an abstract science, without regard to any utility other than to satisfy the craving for knowledge.

*An Introduction to Mathematics*

Chapter 10 (p. 100)

Oxford University Press, Inc. New York, New York, USA. 1958

## CONJECTURE

**Adams, George** 1750–95

English instrument maker

Conjecture may lead you to form opinions, but it cannot produce knowledge. Natural philosophy must be built upon the phenomena of nature discovered by observation and experiment.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 59)

Printed by R. Hindmarsh. London, England. 1794

Conjectures in philosophy are termed hypotheses or theories; and the investigation of an hypothesis founded on some slight probability, which accounts for many appearances in nature, has too often been considered as the highest attainment of a philosopher. If the hypothesis (sic) hangs well together, is embellished with a lively imagination, and serves to account for common appearances — it is considered by many, as having all the qualities that should recommend it to our belief, and all that ought to be required in a philosophical system.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 59)

Printed by R. Hindmarsh. London, England. 1794

**Darwin, Charles Robert** 1809–82

English naturalist

If we choose to let conjecture run wild, then animals, our fellow brethren in pain, disease, suffering and famine — our slaves in the most laborious works, our companions in our amusements — they may partake of our origin in one common ancestor — we may be all melted together.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Note-Book of 1837 (p. 368)

D. Appleton & Company. New York, New York, USA. 1896

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

An ancient philosopher once remarked that people who cudgelled their brains about the nature of the moon reminded him of men who discussed the laws and institutions of a distant city of which they had heard no more than the name.

*Popular Scientific Lectures*

On Symmetry (p. 89)

The Open Court Publishing Company, Chicago, Illinois, USA. 1898

### Quinton, Anthony M.

No biographical data available

The conjectures of the scientific intelligence are genuine creative novelties, inherently unpredictable and not determined by the character of the scientist's physical environment. The thinking mind is not a causal mechanism.

In D.J. O'Connor (ed.)

*A Critical History of Western Philosophy* (p. 551)

The Free Press of Glencoe, London, England. 1964

### Shelah, Saharon 1945–

Israeli mathematician

Given a conjecture, the best thing is to prove it. The second best thing is to disprove it. The third best thing is to prove that it is not possible to disprove it, since it will tell you not to waste your time trying to disprove it. That's what Gödel did for the Continuum Hypothesis.

*Rutgers University Colloquium*

October 26, 2001

## CONQUEST

### Massey, Raymond

American actor

Rest enough for the individual man. Too much and too soon and we call it death. But for Man no rest and no ending. He must go on, conquest beyond conquest. First, this little planet and its winds and ways. And then all laws of mind and matter that restrain him. Then the planets about him. And at last, out across immensity to the stars. And when he has conquered all the deeps of space and all the mysteries of time, still he will be beginning. . . . Little animals. And if we're no more than animals we must snatch each little scrap of happiness, and live and suffer and pass, mattering no more than all the other animals do or have done. It is this, or that. All the universe or nothing. Which shall it be, Passworthy? Which shall it be?

*Things to Come*

Film (1936)

## CONSCIOUSNESS

### Jung, Carl G. 1875–1961

Swiss psychologist and psychiatrist

...nowadays most people identify themselves almost exclusively with their consciousness, and imagine that they are only what they know about themselves.

*Memories, Dreams, Reflections*

Chapter XI (p. 300)

Vintage Books, New York, New York, USA. 1970

### Watts, Alan Wilson 1915–73

American philosopher

Consciousness recurs in every newborn creature, and wherever it recurs it is "I." And in so far as it is only this "I," it struggles again and again in hundreds of millions of beings against the dissolution which would set it free. To see this is to feel the most peculiar solidarity — almost identity — with other creatures, and to begin to understand the meaning of compassion.

*Nature, Man, and Woman*

Part I, Chapter 4 (p. 117)

Vintage Books, New York, New York, USA. 1970

In this light it will be clear that consciousness is no mere phosphorescent scum upon the foundations of fire and rock — a late addition to a world which is essentially unfeeling and mineral. Consciousness is rather the unfolding, the "e-volution," of what has always been hidden in the heart of the primordial universe of stars.

*Nature, Man, and Woman*

Part II, Chapter 8 (p. 186)

Vintage Books, New York, New York, USA. 1970

## CONSEQUENCE

### Huxley, Thomas Henry 1825–95

English biologist

...logical consequences are the scarecrows of fools and the beacons of wise men.

*Science and Culture and Other Essays*

Chapter IX (p. 240)

Macmillan & Company Ltd, London, England. 1881

## CONSERVATION

### Bates, Marston 1906–74

American zoologist

We remain important, you and I and all mankind. But so is the butterfly — not because it is good for food or good for making medicine or bad because it eats our orange trees. It is important in itself, as a part of the economy of nature.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*

Chapter 1 (p. 5)

Random House, Inc, New York, New York, USA. 1960

In defying nature, in destroying nature, in building an arrogantly selfish, man-centered, artificial world, I do not see how man can gain peace or freedom or joy.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*  
Chapter 16 (p. 262)  
Random House, Inc. New York, New York, USA. 1960

### Bergman, Charles

No biographical data available

We have inherited, and created, impoverished seas. The spouting is more sporadic, gone totally from some areas of the oceans, and the whales that remain are mere relics of the swarms our ancestors wrote of with such awe.

*Wild Echoes: Encounters with the Most Endangered Animals in North America*  
Chapter IV (p. 201)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1990

I have a fantasy: I imagine myself sitting in my living room, on my sofa. Outside my house — outside our house — animals are gathering. Lost animals, endangered animals. Peering in the windows, with strange expressions on their gaunt faces. Murmuring indistinctly of Something Else. Murmuring in wild echoes.

*Wild Echoes: Encounters with the Most Endangered Animals in North America*  
Introduction (p. 1)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1990

### Berry, Wendell 1934–

American essayist, poet, critic, and farmer

Man...is the center of the universe only in the sense that wherever he is it seems to him that he is at the center of his own horizon; the truth is that he is only a part of a vast complex of life, on the totality and the order of which he is blandly dependent.

*The Hudson Review*, Autumn, 1970

### Brower, David 1912–2000

American environmentalist

When you understand how recent an arrival we are, in comparison with a forest or a mountain, and you begin to understand how much wildness contributed to making us as a successful evolutionary project, you acquire some humility.

*Let the Mountains Talk, Let the Rivers Run*  
Chapter 16 (pp. 131–132)  
HarperCollins Publishers. New York, New York, USA. 1995

Nature recycles everything.

*Let the Mountains Talk, Let the Rivers Run*  
Chapter 19 (p. 149)  
HarperCollins Publishers. New York, New York, USA. 1995

Let us begin. Let us restore the Earth. Let the mountains talk, and the rivers run.

*Let the Mountains Talk, Let the Rivers Run*  
Chapter 24 (p. 196)  
HarperCollins Publishers. New York, New York, USA. 1995

Although Thomas Jefferson argued that no one generation has a right to encroach upon another generation's

freedom, the future's right to know the freedom of wilderness is going fast.

*This Is the American Earth*  
Foreword  
Sierra Club. San Francisco, California, USA. 1968

I started out as a boy bent over a spring. Then I climbed mountains. I became a conservationist. Then I saw what we all were doing, and I wanted to stop us from doing worse. Now I want to restore what once was, not for an old man's memories, but for a baby's smile.

*Let the Mountains Talk, Let the Rivers Run*  
Chapter 11 (p. 98)  
HarperCollins Publishers. New York, New York, USA. 1995

### Carson, Rachel 1907–64

American marine biologist and author

Our attitudes toward plants is a singularly narrow one. If we see any immediate utility in a plant we foster it. If for any reason we find its presence undesirable or merely a matter of indifference, we may condemn it to destruction forthwith.

*Silent Spring*  
Chapter 6 (p. 63)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

### Hudson, William Henry

Argentinian/English ornithologist, naturalist, and author

And above all others, we should protect and hold sacred those types, Nature's masterpieces, which were first singled out for destruction on account of their size, or splendor, or rarity, and that false detestable glory which is accorded to their most successful slayers. In ancient times the spirit of life shone brightest in these; and when others that shared the earth with them were taken by death they were left, being more worthy of perpetuation. Like immortal flowers they have drifted down to us on the ocean of time, and their strangeness and beauty bring to our imagination a dream and a picture of that unknown world, immeasurable far removed, where man was not: and when they perish, something of gladness goes out from nature, and the sunshine loses something of its brightness.

*The Naturalist in La Plata*  
Chapter I (p. 29)  
Chapman & Hall, Ltd. London, England. 1892

### Leopold, Aldo 1886–1948

American naturalist

To keep every cog and wheel is the first precaution of intelligent tinkering.

*A Sand County Almanac, with Essays on Conservation from Round River Part III, Round River* (p. 190)  
Sierra Club. San Francisco, California, USA. 1970

Conservation is getting nowhere because it is incompatible with our Abrahamic concept of land. We abuse land

because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.

*A Sand County Almanac, with Essays on Conservation from Round River*  
Foreword (p. xix)

Sierra Club. San Francisco, California, USA. 1970

Conservation is a state of harmony between men and land.

*A Sand County Almanac, with Essays on Conservation from Round River*  
Part IV, The Land Ethic (p. 243)

Sierra Club. San Francisco, California, USA. 1970

### Lovejoy, Thomas E. 1941–

American tropical biologist

In the last analysis, even when we have learned to manage other aspects of the global environment, even if population reaches a stable level, even if we reach a time when environmental crises have become history, even if most wastes have gone except the most long lived, even if global cycles have settled back into more normal modes, then the best measurement of how we have managed the global environment will be how much biological diversity has survived.

In D.B. Botkin, M.F. Caswell, J.E. Estes, and A.A. Orio (eds.)

*Changing the Global Environment: Perspectives on Human Involvement*  
Deforestation and Extinction of Species (p. 97)

Academic Press. Boston, Massachusetts, USA. 1989

### Osborn, Henry Fairfield 1857–1935

American paleontologist and geologist

[The] great battle for preservation and conservation cannot be won by gentle tones, nor by appeals to the aesthetic instincts of those who have no sense of beauty, or enjoyment of Nature.

In William T. Hornaday

*Our Vanishing Wild Life*

Preface (p. vii)

Charles Scribner's Sons. New York, New York, USA. 1913

### Sheldrick, Daphne 1934–

Kenyan-born wildlife expert

With amazing arrogance we presume omniscience and an understanding of the complexities of Nature, and with amazing impertinence we firmly believe that we can better it. . . . [W]e have forgotten that we, ourselves, are just a part of nature, an animal which seems to have taken the wrong turning bent on total destruction.

*The Tsavo Story*

Chapter 15 (p. 190)

Collins & Harvill Press. London, England. 1973

### The Bible

Do no damage to land or sea or to the trees. . .

*The Revised English Bible*

Revelation 7:3

Oxford University Press, Inc. Oxford, England. 1989

### CONSERVATIONIST

#### Leopold, Aldo 1886–1948

American naturalist

A conservationist is one who is humbly aware that with each stroke he is writing his signature on the face of his land. Signatures of course differ, whether written with axe or pen, and this is as it should be.

*A Sand County Almanac, with Essays on Conservation from Round River*  
Part I, November (p. 73)

Sierra Club. San Francisco, California, USA. 1970

### CONSISTENCY

#### Davy, Sir Humphry 1778–1829

English chemist

Consistency in regard to opinions is the slow poison of the intellectual life, the destroyer of its vividness and its energy.

In Sir Richard Arman Gregory

*Discovery: The Spirit and Service of Science*

Chapter VII (p. 165)

Macmillan & Company Ltd. London, England. 1918

### CONSTELLATION

#### Aeschylus 525 BCE–456 BCE

Greek playwright

I know the nightly concourse of the stars  
And which of the sky's bright regents brings us storm,  
Which summer; when they set, and their uprisings.

In *Great Books of the Western World* (Volume 5)

*The Plays of Aeschylus*

Agamemnon, l. 4–6

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

#### Aratus 271 BCE–213 BCE

Greek statesman

So thought he good to make the stellar groups,  
That each by other lying orderly,  
They might display their forms.

And thus the stars

At once took names and rise familiar now.

In William Tyler Olcott

*Star Lore of All Ages* (p. 3)

G.P. Putnam's Sons. New York, New York, USA. 1911

Some man of ages past

Observed their goings; and devised their titles,

Forming the constellations. For the name

Of each star singly none could tell or learn; —

So numerous are they everywhere, and many

Of the same size and color, as they roll.

Thus he bethought him to combine them so,

That, ranged in neighborhood, they might present

Images, — each taking his proper name,

And henceforth none rising to doubt or guess at.

In N.L. Frothing

*Metrical Pieces*

The Appearances of the Stars (pp. 39–40)

Crosby, Nichols. Boston, Massachusetts, USA. 1855

The tiny Dolphin floats o'er Capricorn,

His middle dusky, but he has four eyes,

Two parallel to two.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter X (p. 125)

Harper & Brothers Publishers. New York, New York, USA. 1908

Below Orion's feet the Hare

Is chased eternally; behind him

Sirius ever speeds as in pursuit,

And rises after, and eyes him as he sets.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter III (p. 40)

Harper & Brothers Publishers. New York, New York, USA. 1908

### Babylonian Sun-God Marduk

Then Marduk created places for the great gods.

He set up their likeness in the constellations.

He fixed the year and defined its divisions;

Setting up three constellations for each of the twelve months.

When he had defined the days of the year by the constellations,

He set up the station of the zodiac band as a measure of them all,

That none might be too long or too short.

In John D. Barrow

*The World Within the World* (p. 34)

Clarendon Press. Oxford, England. 1988

### Brainard, John 1796–1828

American poet

O! How calm and how beautiful — look at the night!

The planets are wheeling in pathways of light;

And the lover, or poet, with heart, or with eye,

Sends his gaze with a tear, or his soul with a sigh.

But from Fesole's summit the Tuscan looked forth,

To eastward and westward, to south and to north;

Neither planet nor star could his vision delight,

'Till his own bright Pleiades should rise to his sight.

They rose, and he numbered their glittering train —

They shone bright as he counted them over again;

But the star of his love, the bright gem of the cluster,

Arose not to lend the Pleiades its lustre.

*Occasional Pieces of Poetry*

The Lost Pleiad

E. Bliss and E. White. New York, New York, USA. 1825

### Burns, Robert 1759–96

Scottish poet

...O, had I power like inclination,

I'd heeze thee up a constellation!

To canter with the Sagitarre,

Or loop the Ecliptic like a bar,

Or turn the Pole like any arrow...

*The Complete Poetical Works of Robert Burns*

Epistle to Hugh Parker

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

### Carlyle, Thomas 1795–1881

English historian and essayist

Why did not somebody teach me the constellations, and make me at home in the starry heavens, which are always overhead, and which I don't half know to this day?

In Richard Hinckley Allen

Star Names (p. v)

G.E. Stechert. New York, New York, USA. 1899

### de Cervantes, Miguel 1547–1616

Spanish novelist, playwright, and poet

...the lore I learned when I was a shepherd tells me it cannot wait three hours of dawn now, because the mouth of the Horn is overhead and makes midnight in the line of the left arm.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part 1, Chapter 20 (p. 58)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Donne, John 1572–1631

English poet and divine

And in these Constellations then arise

New Starres, and old doe vanish from our eyes.

*The Complete Poetry and Selected Prose of John Donne*

First Anniversary

Random House, Inc. New York, New York, USA. 1941

### Frost, Robert 1874–1963

American poet

You know Orion always comes up sideways.

*Complete Poems of Robert Frost*

The Star Splitter

Henry Holt & Company. New York, New York, USA. 1949

You'll wait a long, long time for anything much

To happen in heaven.

*Complete Poems of Robert Frost*

On Looking Up by Chance at the Constellations

Henry Holt & Company. New York, New York, USA. 1949

### Glasgow, Ellen 1874–1945

American writer

Last night the stars were magnificent — Pegasus and Andromeda faced me brilliantly when I lifted my shade, so I went down and had a friendly reunion with the constellations —

*Letters of Ellen Glasgow*

Letter to Mary Johnson, August 15, 1906 (pp. 53–54)

Harcourt Brace & Company. New York, New York, USA. 1958

**Homer (Smyrns of Chios)** fl. 750 BCE

Greek poet

He wrought the earth, the heavens, and the sea; the moon also at her full and the untiring sun, with all the signs that glorify the face of heaven — the Pleiades, the Hyads, huge Orion, and the Bear, which men also call the Wain and which turns around ever in one place, facing Orion, and alone never dips into the stream of Oceanus.

In *Great Books of the Western World* (Volume 4)

*The Iliad of Homer*

Book XVIII, l. 483–489 (p. 135)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He never closed his eyes, but kept them fixed on the Pleiades, on late-setting Bootes, and on the Bear — which men also call the wain, and which turns round and round where it is, facing Orion, and alone never dipping into the stream of Oceanus — for Calypso had told him to keep this to his left.

In *Great Books of the Western World* (Volume 4)

*The Odyssey*

Book V, l. 271–276

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hopkins, Frederick Gowland** 1844–89

English biochemist

Now Time's Andromeda on this rock rude,  
With not her either beauty's equal or  
Her injury's, looks of by both horns of shore  
Her flower, her piece of being, doomed dragon's food.

In Norman H. MacKenzie (ed.)

*The Poetical Works of Gerard Manley Hopkins*

Andromeda, l. 1–4

Clarendon Press. Oxford, England. 1990

**Joyce, James** 1882–1941

Expatriate Irish writer and poet

...the appearance of a star (1<sup>st</sup> magnitude) of exceeding brilliancy dominating by night and day (a new luminous sun generated by the collision and amalgamation in incandescence of two nonluminous exsuns) about the period of the birth of William Shakespeare over delta in the recumbent never setting constellation of Cassiopeia and of a star (2<sup>nd</sup> magnitude) of similar origin but of lesser brilliancy which had appeared in and disappeared from the constellation of the Corona Septentrionalis about the period of the birth of Leopold Bloom and of other stars of (presumably) similar origin which had (effectively or presumably) appeared in and disappeared from the constellation of Andromeda about the period of the birth of Stephen Dedalus, and in and from the constellation of Auriga some years after the birth and death of Rudolph Bloom, junior, and in and from other constellations some years before or after the birth or death of other persons...

*Ulysses* (p. 685)

Random House, Inc. New York, New York, USA. 1946

**Kirkup, James** 1923–

Poet and journalist

Slung between the homely poplars at the end  
of the familiar avenue, the Great  
Bear in its lighted hammock swings,  
like a neglected gate that neither bars admission nor  
invites,

hangs on the sagging pole its seven-pointed shape.

*Omens of Disaster*

Collected Shorter Poems, Volume I, Ursa Major

University of Salzburg. Salzburg, Austria. 1996

**Longfellow, Henry Wadsworth** 1807–82

American poet

Begirt with many a blazing star,  
Stood the great giant Algebar,  
Orion, the hunter of the beast!

*The Poetical Works of Henry Wadsworth Longfellow*

The Occultation of Orion

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Manilius, Marcus** fl. 10 AD

Roman poet

Near to Bootes the bright Crown is view'd  
And shines with stars of different magnitude:  
Or placed in front above the rest displays  
A vigorous light, and dwarfs surprising rays.  
This shone, since Theseus first his faith betray'd,  
The monument of the forsaken maid.

In Elijah H. Burritt

*The Geography of the Heavens* (p. 95)

Sheldon & Company. New York, New York, USA. 1873

First next the Twins, see great Orion rise,  
His arms extended stretch o'er half the skies;  
His stride as large, and with a steady pace  
He marches on, and measures a vast space;  
On each broad shoulder a bright star display'd,  
And three obliquely grace his hanging blade.

In Elijah H. Burritt

*The Geography of the Heavens*

Chapter III, Orion (p. 56)

Huntington & Savage, Mason & Law. New York, New York, USA. 1850

First Aries, glorious in his golden wool,  
Looks back and wonders at the mighty Bull.

In Mrs. Jesse B. Holman

*The Zodiac, the Constellations and the Heavens* (p. 11)

Printed by E. L. Steck Co. Austin, Texas. 1924

Close by the Kneeling Bull behold  
The Charioteer, who gained by skill of old  
His name and heaven, as first his steeds he drove  
With flying wheels, seen and installed by Jove.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter II (p. 20)

Harper & Brothers Publishers. New York, New York, USA. 1908

And next Bootes comes, whose order'd beams  
Present a figure driving of his teams.

Below his girdle, near his knees, he bears

The bright Arcturus, fairest of the stars.

In Elijah H. Burritt

*The Geography of the Heavens*

Chapter VIII, Bootes (p. 97)

Huntington and Savage, Mason and Law. New York, New York, USA. 1850

Bright Scorpio, armed with poisonous tail, prepares  
Men's martial minds for violence and wars.

His venom heats and boils their blood to rage

And rapine spreads o'er the unlucky age.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter VIII (p. 103)

Harper & Brothers Publishers. New York, New York, USA. 1908

**Noyes, Alfred** 1880–1958

English poet

Night after night, among the gabled roofs,  
Climbing and creeping through a world unknown  
Save to the roosting stork, he learned to find  
The constellations, Cassiopeia's throne,  
The Plough still pointing to the Pole star,  
The Sword-belt of Orion. There he watched  
The movement of the planets, hours and hours,  
And wondered at the mystery of it all.

*The Torch-Bearers: Watchers of the Sky* (Volume 1)

Tycho Brahe, I (p. 40)

Frederick A. Stokes Company Publishers. New York, New York, USA. 1922

**Ovid** 43 BCE–17 AD

Roman poet

There is a place above, where Scorpio bent,  
In tail and arms surrounds a vast extent;  
In a wide circuit of the heavens he shines,  
And fills the place of two celestial signs.

In Elijah H. Burritt

*The Geography of the Heavens*

Chapter VIII, Serpens (p. 102)

Sheldon & Company. New York, New York, USA. 1874

Midst golden stars he stands resplendent now,  
And thrusts the Scorpion with his bended bow.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter IX (p. 113)

Harper & Brothers Publishers. New York, New York, USA. 1908

**Payne-Gaposchkin, Celia** 1900–79

British-American astronomer

The constellations carry us back to the dawn of astronomy. They have been called the fossil remains of primitive stellar religion, and as such they have extraordinary interest.

*Introduction to Astronomy*

Chapter I, Section 1 (p. 3)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

**Peltier, Leslie C.** 1900–80

American comet hunter

No true star-gazer will fail to become familiar with the constellations and fortunate is he whose introduction to the skies comes to him through nature's eyes alone and not through any telescope.

*Starlight Nights*

Chapter 6 (p. 39)

Harper & Row, Publishers. New York, New York, USA. 1965

**Rilke, Ranier Maria** 1875–1926

Czech-born German language poet and novelist

...who sets him in a constellation and puts the measuring-stick of distance in his hands?

*The Duino Elegies* (p. 25)

Peter Pauper Press. Mount Vernon Press, New York, USA. 1957

**Sagan, Carl** 1934–96

American astronomer and science writer

In the night sky, when the air is clear, there is a cosmic Rorschach test awaiting us. Thousands of stars, bright and faint, near and far, in a glittering variety of colors, are peppered across the canopy of night. The eye, irritated by randomness, seeking order, tends to organize into patterns these separate and distinct points of light.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 2 (p. 9)

Dell Publishing, Inc. New York, New York, USA. 1975

**Statius, Publius** ca. 45–96

Roman poet

Vast as the starry Serpent, that on high  
Tracks the clear ether, and divides the sky,  
And southward winding from the Northern Wain,  
Shoots to remoter spheres its glittering train.

In Elijah H. Burritt

*The Geography of the Heavens*

Chapter VIII, Serpens (p. 103)

Huntington & Savage, Mason & Law. New York, New York, USA. 1850

**Tennyson, Alfred (Lord)** 1809–92

English poet

Many a night from yonder ivied casement, ere I went to rest,

Did I look on great Orion, sloping slowly to the west.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 4

Oxford University Press, Inc. London, England. 1953

**Thomson, James** 1700–48

Scottish poet

And fierce Aquarius stains th' inverted year...

*The Complete Poetical Works of James Thomson*

Seasons, Winter

H. Frowde. London, England. 1908

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

Constellations have always been troublesome things to name. If you give one of them a fanciful name, it will always persist in not resembling the thing it has been named for.

*Following the Equator* (Volume 1)

Chapter V (p. 75)

Harper & Brothers Publishers. New York, New York, USA. 1899

**Watts, Isaac** 1674–1748

English poet, theologian, and hymn writer

The Ram, the Bull, the Heavenly Twins,  
And next the Crab, the Lion shines,  
The Virgin and the Scales;  
The Scorpion, Archer, and Sea-goat,  
The Damsel with the Watering-pot,  
The Fish with glittering tails.

In Cecilia Payne-Gaposchkin

*Introduction to Astronomy*

Mnemonic for the zodiacal constellations (p. 4)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

**White, Henry Kirke** 1785–1806

English poet

Orion in his Arctic tower...

*The Poetical Works of Gray, Blair, Beattie, Collins, Thomson and Kirke White*

Time

Carey & Lea. Philadelphia, Pennsylvania, USA. 1830

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

The earth, that is sufficient,  
I do not want the constellations any nearer,  
I know they are very well where they are,  
I know they suffice for those who belong to them.

*Complete Poetry and Collected Prose*

Song of the Open Road

The Library of America. New York, New York, USA. 1982

**Young, Edward** 1683–1765

English poet and dramatist

A Star His Dwelling pointed out below:  
Ye Pleiades! Arcturus! Mazaroth!  
And thou, Orion! of still keener Eye!  
Say, ye, who guide the Wilder'd in the Waves,  
And bring them out of Tempest into Port!

*Night Thoughts*

Night IX, l. 1702–1706

Printed by R. Nobels for R. Edwards. London, England. 1797

## CONSTELLATION: ANDROMEDA

**Keats, John** 1795–1821

English Romantic lyric poet

Andromeda! Sweet woman! Why delaying  
So timidly among the stars: come hither!  
Join this bright throng, and nimbly follow whither

They all are going.

*The Complete Poetical Works and Letters of John Keats*

Endymion

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Kingsley, Charles** 1819–75

English clergyman and author

High for a star in the heavens, a sign and a hope for the  
seamen,  
Spreading thy long white arms all night in the heights of  
the aether,  
Hard by thy sire and the hero, thy spouse, while near  
thee thy mother  
Sits in her ivory chair, as she plaits ambrosial tresses;  
All night long thou wilt shine.

*Poems*

Andromeda

Ticknor & Fields. Boston, Massachusetts, USA. 1856

## CONSTELLATION: ARCTURUS

**Teasdale, Sara** 1884–1933

American lyrical poet

When, in the gold October dusk, I saw you near to set-  
ting,

Arcturus, bringer of spring,

Lord of the summer nights, leaving us now in autumn,

Having no pity on our withering...

*The Collected Poems of Sara Teasdale*

Arcturus in Autumn (p. 87)

Collier Books. New York, New York, USA. 1966

## CONSTELLATION: ARIES

**Longfellow, Henry Wadsworth** 1807–82

American poet

Now the zephyrs diminish the cold, and the year being  
ended,

Winter Maeotian seems longer than ever before;

And the Ram that bore unsafely the burden of Helle,

Now makes the hours of the day equal with those of the  
night.

*The Poetical Works of Henry Wadsworth Longfellow*

Ovid in Exile Tristia, Book III, Elegy XII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Spencer, Lilian White** 1876–1953

American poet and playwright

The Ram was once the golden fleece  
That bore Nephele's babes from Greece.

He died to honor Zeus. Then, he

Shone brighter than the brightest star

In Jason's dream: who wandered far

To bring his pelt to Thessaly.

Aries

*Popular Astronomy*, Volume 37, Number 4, April 1929 (p. 209)



**CONSTELLATION: CANCER**

**Spencer, Lilian White** 1876–1953  
American poet and playwright

This is the sky-crab, named of old,  
Because here, so Chaldeans told,  
The sun seemed to move backward. These  
And other tales about hime teem  
Of mangers, hives, and gods. If dream  
They are delightful fantasies.

Cancer

*Popular Astronomy*, Volume 37, Number 9, November 1929 (p. 513)

**CONSTELLATION: CANIS MAJOR**

**Frost, Robert** 1874–1963  
American poet

The great Overdog,  
That heavenly beast  
With a star in one eye,  
Gives a leap in the east.  
He dances upright  
All the way to the west  
And never once drops  
On his forefeet to rest.  
I'm a poor underdog,  
But tonight I will bark  
With the great Overdog  
That romps through the dark.

*Complete Poems of Robert Frost*

Canis Major

Henry Holt & Company. New York, New York, USA. 1949

**CONSTELLATION: CAPRICORNUS**

**Aratus** 271 BCE–213 BCE  
Greek statesman

Then blow the fearful south-winds, when the Goat  
With the sun rises; and then Jove's sharp cold,  
Still worse, besets the stiffening mariner.

In N.L. Frothingham

*Metrical Pieces*

The Appearances of the Stars (p. 33)

Crosby, Nichols. Boston, Massachusetts, USA. 1855

**Spencer, Lilian White** 1876–1953  
American poet and playwright

Once, as the gods were feasting while  
Sojourning by the river Nile  
Huge Typhon scared them. Off they ran  
And one dived eastward to escape:  
Since then he wears a sea-goat's shape  
Who really is the great go, Pan.

Capricornus

*Popular Astronomy*, Volume 37, Number 5, May 1929 (p. 261)

**CONSTELLATION: DRACO**

**Darwin, Erasmus** 1731–1802  
English physician and poet

With vast convolutions Draco holds  
Th' ecliptic axis in his scaly folds.  
O'er half the skies his neck enormous rears,  
And with immense meanders parts the Bears.

*The Botanic Garden*

Part I, Canto I, XI, l. 517

Jones & Company. London, England. 1825

**CONSTELLATION: LIBRA**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

I hear the Scales, where hang in equipoise  
The night and day.

*The Poetical Works of Henry Wadsworth Longfellow*

The Poet's Calendar, September

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**CONSTELLATION: LOST PLEIAD**

**Hemans, Felicia D.** 1793–1835  
English poet

And is there glory from the heavens departed?  
Oh! Void unmarked! —

Thy sisters of the sky

Still hold their place on high,

Though from its rank thine orb so long hath started,  
Thou, that no more art seen of mortal eye.

*The Complete Works of Mrs. Hemans* (Volume 1)

The Lost Pleiad

D. Appleton & Company. New York, New York, USA. 1868

**CONSTELLATION: ORION**

**Dickinson, Emily** 1830–86  
American lyric poet

Follow wise Orion

Till you waste your eye —

Dazzlingly decamping

He is just as high —

*The Complete Poems of Emily Dickinson*

No. 1538 (p. 642)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Tennyson, Alfred (Lord)** 1809–92  
English poet

...those three stars of the airy Giants' zone  
That glitter burnished by the frosty dark.

*Alfred Tennyson's Poetical Works*

The Princess, V

Oxford University Press, Inc. London, England. 1953

**CONSTELLATION: PISCES**

**Spencer, Lilian White** 1876–1953  
Poet and playwright

Two Fishes in the sky-deeps swim,  
Both elongated but quite dim  
Which seems to be a paradox:  
Because they lead the Zodiac,  
Are Famous in the almanac,  
And own the vernal equinox.

Pisces

*Popular Astronomy*, Volume 37, Number 4, April 1929 (p. 198)

**CONSTELLATION: PLEIADES**

**Tabb, John Banister** 1845–1909  
American poet

“Who are ye with clustered light,  
Little Sisters seven?”  
“Crickets, chirping all the night  
On the hearth of heaven.”

In Francis A. Litz (ed.)

*The Poetry of Father Tabb*

Humorous Verse, The Pleiads

Dodd, Mead. New York, New York, USA. 1928

**CONSTELLATION: SAGITTARIUS**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

The Centaur, Sagittarius, am I,  
Born of Ixion and the cloud’s embrace:  
With sounding hoofs across the earth I fly,  
A steed Thessalian with a human face.

*The Poetical Works of Henry Wadsworth Longfellow*

Poet’s Calendar, November

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**CONSTELLATION: SCORPIO**

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Though on the frigid scorpion I ride,  
The dreamy air is full, and overflows  
With tender memories of the summer-tide  
And mingled voices of the doves and crows.

*The Poetical Works of Henry Wadsworth Longfellow*

Poet’s Calendar, October

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Spencer, Lilian White** 1876–1953  
Poet and playwright

On summer’s south horizon, he  
Crawls in bright, baleful majesty:  
Antares is his old read heart,

He slew Orion with his sting  
And since he did that horrid thing  
They circle heaven far apart.

Scorpio

*Popular Astronomy*, Volume 37, Number 5, May 1929 (p. 274)

**CONSTELLATION: SOUTHERN CROSS**

**Meredith, Owen (Edward Robert Bulwer-Lytton, 1<sup>st</sup> Earl Lytton)** 1831–91

English statesman and poet

Then did I feel as one who, much perplexed,  
Led by strange legends and the light of stars  
Over long regions of the midnight sand  
Beyond the red tract of the Pyramids,  
Is suddenly drawn to look upon the sky,  
From sense of unfamiliar light, and sees,  
Reveal’d against the constellated cope,  
The great cross of the South.

*The Poetical Works of Owen Meredith*

Queen Guenevere

American News Co. New York, New York, USA. 1905

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

We saw the Cross tonight, and it is not large. Not large, and not strikingly bright. But it was low down toward the horizon, and it may improve when it gets up higher in the sky. It is ingeniously named, for it looks just as a cross would look if it looked like something else. But that description does not describe; it is too vague, too general, too indefinite. It does after a fashion suggest a cross — a cross that is out of repair — or out of drawing; not correctly shaped. It is long, with a short cross-bar, and the cross-bar is canted out of the straight line.

It consists of four large stars and one little one. The little one is out of line and further damages the shape. It should have been placed at the intersection of the stem and the cross-bar. If you do not draw an imaginary line from star to star it does not suggest a cross — nor anything in particular.

One must ignore the little star, and leave it out of the combination — it confuses everything. If you leave it out, then you can make out of the four stars a sort of cross — out of true; or a sort of kite — out of true; or a sort of coffin — out of true.

*Following the Equator* (Volume 1)

Chapter V (p. 75)

Harper & Brothers Publishers. New York, New York, USA. 1899

**CONSTELLATION: VIRGO**

**Longfellow, Henry Wadsworth** 1807–82

American poet

I am the Virgin, and my vestal flame  
Burns less intensely than the Lion's rage;  
Sheaves are my only garments, and I claim  
A golden harvest as my heritage.

*The Poetical Works of Henry Wadsworth Longfellow*

Poet's Calendar, August

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

## CONSTIPATION

**Mather, Cotton** 1663–1728

American minister and religious writer

For Costiveness. Take stewed Prunes.

*The Angel of Bethesda*

Capsula LX (p. 281)

American Antiquarian Society and Barre Publishers. Barre,

Massachusetts, USA. 1972

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

There has [never] lived a poet...ancient or modern, near or far, who ever managed to write good poetry...at a time when he was suffering from stenosis at any point along the thirty-foot via dolorosa running from the pylorus to the sigmoid flexure.... The more he tries, the more vividly he will be conscious of his impotence.

*Prejudices*

2<sup>nd</sup> Series (pp. 160–161)

Alfred A. Knopf. New York, New York, USA. 1920

## CONSTRUCT

**Feuer, Michael J.**

No biographical data available

**Towne, Lisa**

No biographical data available

The development of common constructs can also contribute to a cohesive knowledge core and further enhance theoretical understanding.

Scientific Culture and Educational Research

*Educational Researcher*, Volume 31, 2002 (p. 11)

## CONSTRUCTION

**Kipling, Rudyard** 1865–1936

British writer and poet

After me cometh a Builder. Tell him, I too have known.  
When I was King and a Mason — a Master proven and skilled —

I cleared me ground for a Palace such as a King should build.

I decreed and dug down to my levels. Presently, under the silt,

I came on the wreck of a Palace such as a King had built...

...

Swift to my use in my trenches, where my well-planned ground-works grew,  
I tumbled his quoins and his ashlar, and cut and reset them anew.

Lime I milled of his marbles; burned it, slacked it, and spread;

Taking and leaving at pleasure the gifts of the humble dead.

Yet I despised not nor gloried; yet as we wrenched them apart,

I read in the razed foundation the heart of that builder's heart.

As he had risen and pleaded, so did I understand

The form of the dream he had followed in the face of the thing he had planned.

*Collected Verse of Rudyard Kipling*

The Palace (pp. 257–258)

Doubleday, Page & Company. Garden City, New York, USA. 1915

## CONSULTANT

**Grindal, Bruce** 1940–

American anthropologist

**Salamone, Frank**

American anthropologist

In the past twenty years, “doing” anthropology has become more and more complex. In the days when we traveled long distances to far-off places, our field-work stayed in the field. Now, the distances have been narrowed. Informants have become consultants. Consultants are our friends. As such, they can board a plane in their land and come to visit, spending long nights in earnest conversation about truth and meaning and enlightenment and expectations. In the days when we wrote only inscrutable manuscripts circulated among colleagues, there was no one to dispute the validity of our work except another “expert” in the area. Now, our consultant-friends are critics, editors of our written words, commentators of their lives, and ours.

*Bridges to Humanity: Narrative on Anthropology and Friendship*

The Reflecting Pool (p. 193)

Waveland Press, Inc. Prospect Heights, Illinois, USA. 1995

## CONSULTATION

**Halle, John**

No biographical data available

When thou arte callde at anye time,

A patient to see;

And doste perceave the cure too grate,

And ponderous for thee:

See that thou laye disdeyne aside,

And pride of thyn owne skylle:

And thinke no shame counsell to take,  
But rather wyth good wyll.  
Gette one or two of experte men,  
To helpe thee in that nede;  
And make them partakers wyth thee,  
In that worke to procede.

In Mary Lou McDonough

*Poet Physician: An Anthology of Medical Poetry Written by Physicians*  
Goodly Doctrine and Instruction (p. 11)  
C.C. Thomas. Springfield, Illinois, USA. 1945

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

Now when a doctor's patients are perplexed,  
A Consultation comes in order next —  
You know what that is? In certain a certain place  
Meet certain doctors to discuss a case  
And other matters, such as weather, crops,  
Potatoes, Pumpkins, lager-beer, and hops.  
For what's the use! — there's little to be said,  
Nine times in ten your man's as good as dead;  
At best a talk (the secret to disclose)  
Where three men guess and sometimes one man knows.

*The Complete Poetical Works of Oliver Wendell Holmes*

Rip Van Winkle, M.D., Canto Second

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

## CONTAGION

### Shakespeare, William 1564–1616

English poet, playwright, and actor

Will he steal out of his wholesome bed,  
To dare the vile contagion of the night?

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Julius Caesar

Act II, Scene i, l. 264–265

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## CONTINENT

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

First-born among the Continents, though so much later in culture and civilization than some of more recent birth, America, so far as her physical history is concerned, has been falsely denominated the New World. Hers was the first dry land lifted out of the waters, hers the first shore washed by the ocean that enveloped all the earth beside; and while Europe was represented only by islands rising here and there above the sea, America already stretched an unbroken line of land from Nova Scotia to the Far West.

*Geological Structures*

Chapter I (p. 1)

Ticknor & Fields. Boston, Massachusetts, USA. 1866

### Suess, Eduard 1831–1914

Austrian geologist

If we imagine an observer to approach our planet from outer space, and, pushing aside the belts of red-brown clouds which obscure our atmosphere, to gaze for a whole day on the surface of the earth as it rotates beneath him, the feature beyond all others most likely to arrest his attention would be the wedge-like outlines of the continents as they narrow away to the South.

This is indeed the most striking character presented by our map of the world, and has been so regarded ever since the chief features of our planet have become known to us.

*The Face of the Earth* (Volume 2)

Introduction (p. 1)

At The Clarendon Press. Oxford, England. 1906

### Willis, Bailey 1857–1949

American geologist

Once a continent, always a continent; once an ocean, always an ocean.

In Naomi Oreskes

*The Rejection of Continental Drift: Theory and Method in American Earth Science*

Chapter 2 (p. 48)

Oxford University Press, Inc. New York, New York, USA. 1999

## CONTINENTAL DRIFT

### Chamberlain, Rollin T.

American geologist

Can we call geology a science when there exists such a difference of opinion on fundamental matters as to make it possible for such a theory as this to run wild.

In W.A.J.M. Waterschoot van der Gracht et. al.(eds.)

*Theory of Continental Drift: A Symposium on the Origin and Movement of Land Masses...*

Some of the Objections to Wegner's Theory (p. 83)

The American Association of Petroleum Geologists, Tulsa, Oklahoma, USA. 1928

### du Toit, Alex L. 1878–1948

South African geologist

[The geologist] will have to leave behind him — perhaps reluctantly — the dumbfounding spectacle of the present continental masses, firmly anchored to a plastic foundation yet remaining fixed in space; set thousands of kilometers apart, it may be, yet behaving in almost identical fashion from epoch to epoch and stage to stage like soldiers at drill; widely stretched in some quarters at various times and astoundingly compressed in others, yet retaining their general shapes, positions and orientations; remote from one another throughout history, yet showing in their fossil remains common or allied

forms of terrestrial life; possessed during certain epochs of climates that may have ranged from glacial to torrid or pluvial to arid, though contrary to meteorological principles when their existing geographic positions are considered — to mention but a few such paradoxes.

*Our Wandering Continents: An Hypothesis of Continental Drift*  
Chapter I (p. 3)  
Hafner Publishing Company. New York, New York, USA. 1957

### King, Lester C.

No biographical data available

The driftist is no more obligated to adduce a mechanism to prove the fact of drift than the user of an electric appliance is obligated to define the nature and mechanism of electricity.

*Proceedings of the Geological Society of London*, 1957 (p. 79)

### Lake, Philip

No biographical data available

A moving continent is as strange to us as a moving earth was to our ancestors, and we may be as prejudiced as they were. On the other hand, if continents have moved many former difficulties disappear, and we may be tempted to forget the difficulties of the theory itself and the imperfection of the evidence.

Wagner's Displacement Theory  
*Geological Magazine*, Volume 59, Number 8, August 1922 (p. 338)

### Termier, Pierre 1859–1930

French geologist

A sound almost imperceptible, so slight, so little different from silence itself, of continents *en marche*, which slowly, oh very slowly, as great pontoons floating on the calm waters of a port, or as great icebergs borne by the polar currents, are drifting towards the equator.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*  
The Drifting of the Continents (p. 219)  
Government Printing Office. Washington, D.C. 1925

The theory of [Alfred] Wegener is to me a beautiful dream, the dream of a great poet. One tries to embrace it and finds that he has in his arms but a little vapor or smoke; it is at the same time alluring and intangible.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*  
The Drifting of the Continents (p. 236)  
Government Printing Office. Washington, D.C. 1925

### Wegener, Alfred 1880–1930

German climatologist and geophysicist

The first concept of continental drift first came to me as far back as 1910, when considering the map of the world, under the direct impression produced by the congruence of the coastlines on either side of the Atlantic. At first I did not pay attention to the idea because I regarded it as improbable.

Translated by John Biram

*The Origin of Continents and Oceans*

Chapter 1 (p. 1)  
Dover Publications, Inc. New York, New York, USA. 1966

We shall refrain here from citing the literature in support of our statements. The obvious needs no backing by outside opinion, and the willfully blind cannot be helped by any means. As far as we are concerned, it is not now a question of whether the continental blocks have moved; doubt is no longer possible.

Translated by John Biram  
*The Origin of Continents and Oceans*  
Chapter 7 (p. 133)  
Dover Publications, Inc. New York, New York, USA. 1966

### Wilson, John Tuzo 1908–93

Canadian geologist and geophysicist

If the continents have moved, then they have drifted like rafts and formed the ocean floors in their wake. It is to this wake that we should look first.

In P. M.S. Blackett, E.C. Bullard and S.K. Runcorn  
A Symposium on Continental Drift  
*Philosophical Transactions of the Royal Society of London*, Series A,  
Volume 258, 1964

## CONTINUITY

### Sylvester, James Joseph 1814–97

English mathematician

Geometry formerly was the chief borrower from arithmetic and algebra, but it has since repaid its obligation with abundant usury; and if I were asked to name, in one word, the pole-star round which the mathematical firmament revolves, the central idea which pervades as a hidden spirit the whole corpus of mathematical doctrine, I should point to Continuity as contained in our notions of space, and say, it is this, it is this!

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)  
Presidential Address to the British Association (p. 659)  
University Press. Cambridge, England. 1904–1912

## CONTINUUM

### Wheeler, John Archibald 1911–

American theoretical physicist and educator

For the advancing army of physics, battling for many a decade with heat and sound, fields and particles, gravitation and spacetime geometry, the cavalry of mathematics, galloping out ahead, provided what it thought to be the rationale for the natural number system. Encounter with the quantum has taught us, however, that we acquire our knowledge in bits; that the continuum is forever beyond our reach. Yet for daily work the concept of the continuum has been and will continue to be as indispensable for physics as it is for mathematics.

Hermann Weyl and the Unity of Knowledge  
*American Scientist*, Volume 74, July–August 1986 (p. 374)

## CONTRACEPTIVE

**Allen, Woody** 1935–  
 American film director and actor

A fast word about oral contraception. I asked a girl to go to bed with me and she said “no.”

*Woody Allen Volume Two*  
 Colpix Cp. 488 (side 4, band 6)

**Chatton, Milton J.**  
 No biographical data available

Jack told Jill to take her pill

With a glass of water.

Jill forgot, and Jack begot

A bouncing baby daughter.

A bouncing baby daughter  
*Quotable Quotes*, March 13, 1966 (p. 16)

**Glasser, Allen**  
 No biographical data available

When a patient asked which sulfa compounds make the safest contraceptives, his doctor replied: “Sulfa-denial and sulfa-control!”

*Quote, the Weekly Digest*, May 7, 1967 (p. 377)

**Sharpe, Tom** 1928–  
 English satirical author

Skullion had little use for contraceptives at the best of times. Unnatural, he called them, and placed them in the lower social category of things along with elastic-sided boots and made-up bow-ties. Not the sort of attire for a gentleman.

*Porterhouse Blue*  
 Chapter 9 (p. 96)  
 Secker & Warburg. London, England. 1974

## CONTROL

**Nabokov, Vladimir** 1899–1977  
 Russian-born American writer

What can be controlled is never completely real; what is real can never be completely controlled.

In Ilya Prigogine  
*The End of Certainty: Time, Chaos, and the New Laws of Nature* (p. 154)  
 The Free Press. New York, New York, USA. 1997

## CONUNDRUM

**Ramsay, Sir William** 1852–1916  
 English chemist

The solving of conundrums has for many people a great attraction: Nature surrounds us with conundrums, and

it is one of the greatest pleasures in life to attempt their solution.

*Essays Biographical and Chemical*  
 Chemical Essays  
 The Aurora Borealis (p. 225)  
 Archibald Constable & Company Ltd. London, England. 1908

## CONVALESCENCE

**Lamb, Charles** 1775–1834  
 English essayist and critic

How convalescence shrinks a man back to his pristine stature! where is now the space, which he occupied so lately, in his own, in the family’s eye?

*Essays of Elia*  
 The Last Essays of Elia, The Convalescent (pp. 332–333)  
 Henry Altemus. Philadelphia, Pennsylvania, USA. 1893

**Shaw, George Bernard** 1856–1950  
 Irish comic dramatist and literary critic

I enjoy convalescence. It is the part that makes the illness worth while.

*Back to Methuselah*  
 Part II, XXXIII (p. 59)  
 Constable & Company Ltd. London, England. 1921

## CONVICTION

**Darwin, Charles Robert** 1809–82  
 English naturalist

I could not employ my life better than in adding a little to Natural Science. This I have done to the best of my abilities, and critics may say what they like, but they cannot destroy this conviction.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter II (p. 73)  
 D. Appleton & Company. New York, New York, USA. 1896

**Medawar, Sir Peter Brian** 1915–87  
 Brazilian-born English zoologist

I cannot give any scientist of any age better advice than this: the intensity of the conviction that a hypothesis is true has no bearing on whether it is true or not. The importance of the strength of our conviction is only to provide a proportionately strong incentive to find out if the hypothesis will stand up to critical evaluation.

*Advice to a Young Scientist*  
 Chapter 6 (p. 39)  
 Basic Books, Inc. New York, New York, USA. 1979

## COPERNICAN DOCTRINE

**Galilei, Galileo** 1564–1642  
 Italian physicist and astronomer

In order to suppress the Copernican doctrine, it would be necessary not only to prohibit the book of Copernicus and the writings of authors who agree with him, but to interdict the whole science of astronomy, and even to forbid men to look at the sky lest they might see Mars and Venus at very varying distances from the earth, and discover Venus at one time crescent, at another time round, or make other observations irreconcilable with the Ptolemaic system.

In Arthur Mee and J.A. Hammerton (Eds.)

*The World's Greatest Books* (Volume 13)  
*The Authority of Scripture in Philosophical Controversies*

Section II

Scripture and Experimental Truth (p. 134)

W.H. Wise. New York, New York, USA. 1910

## CORRELATION

**Aron, Raymond** 1905–83

French sociologist and historian

There is no correlation between the cause and the effect. The events reveal only an aleatory determination, connected not so much with the imperfection of our knowledge as with the structure of the human world.

*The Opium of the Intellectuals*

Chapter VI (p. 163)

Secker & Warburg. London, England. 1957

**Balchin, Nigel** 1908–70

English novelist

“You know those penetration figures?”

“Mm.”

“Well, there’s a positive correlation between penetration and the height of the man firing.”

“Easy,” I said. “The taller the man, the more rarefied the atmosphere and the less the air resistance.”

*The Small Back Room* (p. 8)

Collins. London, England. 1943

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

“Very true,” said the Duchess: “flamingos and mustard both bite. And the moral of that “Birds of a feather flock together.”

“Only mustard isn’t a bird.” Alice remarked.

“Right as usual,” said the Duchess: “what a clear way you have of putting things!”

*The Complete Works of Lewis Carroll*

Alice’s Adventures in Wonderland

Chapter IX (p. 97)

The Modern Library. New York, New York, USA. 1936

**Cook, Robin**

American author

Reading the twenty-sixth chart, one correlation suddenly occurred to Jason. Although the patients did not share physical symptoms, their charts showed a predominance

of high-risk social habits. They were overweight, smoked heavily, used drugs, drank too much, and failed to exercise, or combined any and all of these unhealthy practices; they were men and women who were eventually destined to have severe medical problems. The shaking fact was that they deteriorated so quickly. And why the sudden upswing in deaths. People weren’t indulging in vices more than they were a year ago. Maybe it was a kind of statistical equalizing. They’d been lucky and now the numbers were catching up to them.

*Mortal Fear*

Chapter 11 (p. 220)

G.P. Putnam’s Sons. New York, New York, USA. 1988

**Cronbach, L. J.** 1916–2001

American educational psychologist

The well-known virtue of the experimental method is that it brings situational variables under tight control. It thus permits rigorous tests of hypotheses and confidential statements about causation. The correlational method, for its part, can study what man has not learned to control. Nature has been experimenting since the beginning of time, with a boldness and complexity far beyond the resources of science. The correlator’s mission is to observe and organize the data of nature’s experiments.

*The Two Disciplines of Scientific Psychology*

*The American Psychologist*, Volume 12, November 1957 (p. 672)

**Dickson, Paul**

American freelance writer

Hall’s Law. There is a statistical correlation between the number of initials in an Englishman’s name and his social class (the upper class having significantly more than three names, while members of the lower class average 2.6.)

*The Official Rules* (p. H–80)

Delacorte Press. New York, New York, USA. 1978

**Pearson, Karl** 1857–1936

English mathematician

Biological phenomena in their numerous phases, economic and social, were seen to be only differentiated from the physical by the intensity of their correlations. The idea Galton placed before himself was to represent by a single quantity the degree of relationships, or of partial causality between the different variables of our ever-changing universe.

*The Life, Letters, and Labours of Francis Galton* (Volume 3a)

Chapter XIV (p. 2)

Cambridge University Press. Cambridge, England. 1914–30

## COSMIC BALANCE

**Tesla, Nikola** 1856–1943

Austrian-born Serbian American physicist and inventor

Every living being is an engine geared to the wheelwork of the universe. Though seemingly affected only by its immediate surrounding, the sphere of external influence extends to infinite distance. There is no constellation or nebula, no sun or planet, in all the depths of limitless space, no passing wander of the starry heavens, that does not exercise some control over its destiny — not in the vague and delusive sense of astrology, but in the rigid and positive meaning of physical science. More than this can be said. There is nothing endowed with life — from man, who is enslaving the elements, to the humblest creature — in all this world that does not sway it in turn. Whenever action is born from force, though it be infinitesimal, the cosmic balance is upset and universal motion results.

How Cosmic Forces Shape Our Destiny  
*New York American*, February 7, 1915

## COSMIC EVOLUTION

**Chaisson, Eric J.** 1946–  
American astrophysicist

Put bluntly yet magnanimously, the scenario of cosmic evolution grants us unparalleled “big thinking,” from which may well emerge the global ethics and planetary citizenship likely needed if our species is to remain part of that same cosmic evolutionary scenario.

*Cosmic Evolution: The Rise of Complexity in Nature*  
Epilogue (p. 224)  
Harvard University Press. Cambridge, Massachusetts, USA. 2001

## COSMIC RAY

**Powell, Cecil** 1903–69  
English physicist

Coming out of space and incident on the high atmosphere, there is a thin rain of charged particles known as the primary cosmic radiation.

*Nobel Lectures, Physics 1942–1962*  
Nobel lecture for award received in 1950  
The Cosmic Radiation (p. 144)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## COSMOCHEMISTRY

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

Universe has no pollution.  
All the chemistries of the Universe are essential  
To its comprehensive self regulation.

In John S. Lewis  
*Physics and Chemistry of the Solar System*  
Chapter II (p. 43)  
Academic Press. San Diego, California, USA. 1995

**Marcet, Mrs. Jane Haldimand** 1769–1858  
English expository author in chemistry, botany, religion and economics

Nature also has her laboratory, which is the universe, and there she is incessantly employed in chemical operations.

*Conversations on Chemistry, in Which the Elements of that Science Are Familiarly Explained and Illustrated by Experiments* (Volume 1)  
Conversation I (p. 2)  
Sidney’s Press for Cooke. New Haven, Connecticut, USA. 1809

## COSMOGONIST

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The cosmogonist has finished his task when he has described to the best of his ability the inevitable sequence of changes which constitute the history of the material universe. But the picture which he draws opens questions of the widest interest not only to science, but also to humanity. What is the significance of the vast processes it portrays? What is the meaning, if any there be which is intelligible to us, of the vast accumulations of matter which appear, on our present interpretations of space and time, to have been created only in order that they may destroy themselves?

*Astronomy and Cosmogony*  
Chapter XVII (p. 422)  
Dover Publications, Inc. New York, New York, USA. 1961

## COSMOGONY

**Bridgman, Percy Williams** 1882–1961  
American physicist

...the most striking thing about cosmogony is the perfectly hair raising extrapolations which it is necessary to make. We have to extend the times of the order of  $10^{13}$  years and distances of the order of  $10^9$  light years [regarding] laws which have been checked in a range of not more than  $3 \times 10^2$  years, and certainly in distances not greater than the distance which the solar system has traveled in that time, or about  $4 \times 10^{-2}$  light years. It seems to me that one cannot take such extrapolations seriously unless one subscribes to a metaphysics that claims that laws of the necessary mathematical precision *really* control the actual physical universe.

*The Nature of Physical Theory*  
Chapter VIII (p. 109)  
Princeton University Press. Princeton, New Jersey, USA. 1936

**Lemaître, Abbé Georges** 1894–1966  
Belgian astronomer and cosmologist

Cosmogony is atomic physics on a large scale — large scale of space and time — why not large scale of atomic weight?



Contributions to a British Association Discussion on the Evolution of the Universe  
*Nature*, Supplement, October 24, 1931 (p. 705)

The purpose of any cosmogonic theory is to seek out ideally simple conditions which could have initiated the world from which, by the play of recognized physical forces, that world, in all its complexity, may have resulted.

*The Primeval Atom*  
Chapter V (p. 162)

D. Van Nostrand Company, Inc. New York, New York, USA. 1950

**Weyl, Hermann** 1885–1955  
German mathematician

Only on the basis of the spectroscopic investigation of stars and the modern atomic physics, and only after well-founded opinions about spatial order of the stellar universe had been derived by analysis of vast observational material, could the astronomers undertake to draw a picture, first of the inner constitution and then also of the temporal development, of stars. Cosmogony still remains a rather problematic enterprise.

*Philosophy of Mathematics and Natural Science*  
Appendix F (p. 286)

Princeton University Press. Princeton, New Jersey, USA. 1949

## COSMOLOGICAL

**Guth, Alan** 1947–  
American physicist

...I believe that soon any cosmological theory that does not lead to the eternal reproduction of universes will be considered as unimaginable as a species of bacteria that cannot reproduce.

*The Inflationary Universe: The Quest For a New Theory of Cosmic Origins*

Chapter 15 (p. 252)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

## COSMOLOGIST

**Darling, David** 1953–  
British astronomer and science writer

What is a big deal — the biggest deal of all — is how you get something out of nothing. Don't let the cosmologists try to kid you on this one. They have not got a clue either — despite the fact that they are doing a pretty good job of convincing themselves and others that this is really not a problem. "In the beginning," they will say, "there was nothing — no time, space, matter, or energy. Then there was a quantum fluctuation from which...." Whoa! Stop right there. You see what I mean? First there is nothing, then there is something. And the cosmologists try to bridge the two with a quantum flutter, a tremor of

uncertainty that sparks it all off. Then they are away and before you know it, they have pulled a hundred billion galaxies out of their quantum hats.

On Creating Something from Nothing

*New Scientist*, Volume 151, Number 2047, 1996 (p. 49)

**Zeldovich, Yakov Borisovich** 1914–87  
Russian physicist

Cosmologists are often in error, but never in doubt.

In Rudolf Kippenhahn

Translated by Storm Dunlop

*Light from the Depths of Time*

Introduction (p. 1)

Springer-Verlag. Berlin, Germany. 1987

## COSMOLOGY

**Bondi, Sir Hermann** 1919–2005  
English mathematician and cosmologist

There are probably few features of theoretical cosmology that could not be completely upset and rendered useless by new observational discoveries.

In G. Borner

*The Early Universe*

Chapter 2 (p. 26)

Springer-Verlag, Berlin, Germany. 1988

**Chaisson, Eric J.** 1946–  
American astrophysicist

Exploring the whole universe requires large thoughts. There are no larger thoughts than cosmological ones.

*Cosmic Dawn: The Origins of Matter and Life*

Prologue (p. 3)

Little, Brown & Company. Boston, Massachusetts, USA. 1981

**Clifford, William Kingdon** 1845–79  
English philosopher and mathematician

The character of the emotion with which men contemplate the world, the temper in which they stand in the presence of the immensities and the eternities, must depend first of all on what they think the world is.

In L. Stephen and F. Pollock (eds.)

*Lectures and Essays*

Cosmic Emotion (p. 395)

Macmillan & Company Ltd. London, England. 1879

**Ferris, Timothy** 1944–  
American science writer

So it seems reasonable to ask what cosmology, now that it is a science, can tell us about God.

Sadly, but in all earnestness, I must report that the answer as I see it is: Nothing. Cosmology presents us neither the face of God, nor the handwriting of God, nor such thoughts as may occupy the mind of God. This does not mean that God does not exist, or that he did not create the

universe, or universes. It means that cosmology offers no resolution to such questions.

*The Whole Shebang: A State-of-the Universe's Report*  
 Contrarian Theological Afterword (pp. 303–304)  
 Simon & Schuster. New York, New York, USA. 1996

### Görtznitz, Thomas

No biographical data available

Modern cosmology is myth which does not know itself to be myth.

Connections between Abstract Quantum Theory and Space-Time  
 Structure II, A Model of Cosmological Evolution  
*International Journal of Theoretical Physics*, Volume 27, Number 6,  
 June 1988 (p. 659)

### Hawking, Stephen William 1942–

English theoretical physicist

Cosmology used to be considered a pseudoscience and the preserve of physicists who might have done some useful work in their earlier years but who had gone mystic in their dotage.

*The Nature of Space and Time*  
 Chapter Five (p. 75)

Princeton University Press. Princeton, New Jersey, USA. 1996

### Holz, Daniel E.

American astrophysicist

Over 2,000 years ago, the Greeks thought they had it all worked out. In their cosmology, the entire Universe was composed of four elements: earth, wind, fire and water. Now, despite several millennia of effort, modern cosmologists are significantly worse off. We have no idea what the bulk of the Universe is composed of.

Shedding Light on Dark Matter

*Nature*, Volume 400, Number 6746, 26 August, 1999 (p. 819)

### McCrea, William Hunter 1904–98

Irish theoretical astrophysicist and mathematician

I am always surprised when a young man tells me he wants to work at cosmology; I think of cosmology as something that happens to one, not something one can choose.

Presidential Address

Royal Astronomical Society, February 1963

### Peebles, Phillip James Edwin 1935–

Canadian-American theoretical cosmologist

In cosmology the reliance on physical simplicity, pure thought and revealed knowledge is carried well beyond the fringe because we have so little else to go on. By this desperate course we have arrived at a few simple pictures of what the Universe may be like. The great goal is now to become more familiar with the Universe, to learn whether any of these pictures may be a reasonable approximation, and if so how the approximation may be

improved. The great excitement in cosmology is that the prospects for doing this seem to be excellent.

*Physical Cosmology* (p. vii)

Princeton University Press. Princeton, New Jersey, USA. 1971

### Popper, Karl R. 1902–94

Austrian/British philosopher of science

I, however, believe that there is at least one philosophical problem in which all thinking men are interested. It is the problem of cosmology: the problem of understanding the world — including ourselves and our knowledge, as part of the world. All science is cosmology, I believe, and for me the interest of philosophy lies solely in the contributions which it has made to it.

*The Logic of Scientific Discovery*

Preface to English Edition (p. 15)

Basic Books, Inc. New York, New York, USA. 1959

### Rucker, Rudy (Rudolph von Bitter

Rucker) 1946–

American scientist, writer, and editor

I love cosmology: there's something uplifting about viewing the entire universe as a single object with a certain shape. What entity, short of God, could be nobler or worthier of man's attention than the cosmos itself? Forget about interest rates, forget about war and murder, let's talk about space.

*The Fourth Dimension: Toward a Geometry of Higher Reality*

Chapter 7 (p. 91)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1984

### Tolman, R. C.

No biographical data available

It is appropriate to approach the problems of cosmology with feelings of respect for their importance, of awe for their vastness, and of exultation for the temerity of the human mind in attempting to solve them. They must be treated, however, by the detailed, critical, and dispassionate methods of the scientist.

*Relativity, Thermodynamics and Cosmology*

Part IV, Section 187 (p. 488)

At The Clarendon Press. Oxford, England. 1934

### Turok, Neil G.

South African mathematical physicist

Maybe the problems cosmology has set for itself will turn out to be just too difficult to solve scientifically. After all, we've got a lot of gall to suppose that the universe can be described by some simple theory.

In John Hogan

Universal Truths

*Scientific American*, Volume 263, Number 4, October 1990 (p. 117)

### Whitehead, Alfred North 1861–1947

English mathematician and philosopher

Cosmology...restrains the aberrations of the mere undisciplined imagination.

*The Function of Reason*

Chapter III (p. 76)

Beacon Press. Boston, Massachusetts, USA. 1929

## COSMOS

**Alfven, Hannes** 1908–95

Swedish physicist

To try to write a grand cosmical drama leads necessarily to myth. To try to let knowledge substitute ignorance in increasingly larger regions of space and time is science.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 6 (p. 214)

Random House, Inc. New York, New York, USA. 1991

**Chaisson, Eric J.** 1946–

American astrophysicist

If we are examples of anything in the cosmos, it is probably of magnificent mediocrity.

*Cosmic Dawn: The Origins of Matter and Life*

Epoch Seven (p. 291)

Little, Brown & Company. Boston, Massachusetts, USA. 1981

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

The Cosmos is about the smallest hole that a man can hide his head in.

*Orthodoxy*

Chapter II (p. 39)

John Lane Company. New York, New York, USA. 1918

A cosmic philosophy is not constructed to fit a man; a cosmic philosophy is constructed to fit a cosmos.

*The Book of Job*

Introduction

London, England. 1916

For the universe is a single jewel, and while it is a natural cant to talk of a jewel as peerless and priceless, of this jewel it is literally true. This cosmos is indeed without peer and without price: for there cannot be another one.

*Orthodoxy*

Chapter IV (pp. 116–117)

John Lane Company. New York, New York, USA. 1918

In the fairy tales the cosmos goes mad, but the hero does not go mad. In the modern novels the hero is mad before the book begins, and suffers from the harsh steadiness and cruel sanity of the cosmos.

In John D. Barrow

*The World Within the World* (p. 271)

Clarendon Press. Oxford, England. 1988

**Donne, John** 1572–1631

English poet and divine

The Sun is lost, and the earth, and no man's wit  
Can well direct him where to looke for it.

And freely men confesse that this world's spent,  
When in the Planets, and the Firmament

They seeke so many new; then see that this

Is crumbled out againe to his Atomies.

'Tis all in peeces, all cohaerence gone;

All just supply, and all Relation.

In A.J. Smith (ed.)

*The Complete English Poems*

An Anatomie of the World, First Anniversary, l. 207–214

St. Martin's Press. New York, New York, USA. 1971

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

And we, inhabitants of the great coral of the Cosmos, believe the atom (which still we cannot see) to be full matter, whereas, it too, like everything else, is but an embroidery of voids in the Void, and we give the name of being, dense and even eternal, to that dance of inconsistencies, that infinite extension that is identified with absolute Nothingness and that spins from its own non-being the illusion of everything.

*The Island of the Day Before*

Chapter 37 (p. 473)

Penguin Group Inc. New York, New York, USA. 1996

**Ferris, Timothy** 1944–

American science writer

The history of the cosmos is arrayed in the sky for those who care to read it.

*Galaxies*

Chapter VI (p. 161)

Sierra Club Books. San Francisco, California, USA. No date

**Jastrow, Robert** 1925–

American space scientist

According to the astronomical evidence, the elements that make up the body of the earth are found in abundance throughout the Cosmos. Innumerable earth-like planets must exist in other solar systems.

*Until the Sun Dies*

Chapter 18 (p. 165)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

We and the cosmos are one. The cosmos is a vast body, of which we are still parts. The sun is a great heart whose tremors run through our smallest veins. The moon is a great gleaming nerve-centre from which we quiver forever. Who knows the power that Saturn has over us or Venus? But it is a vital power, rippling exquisitely through us all the time... Now all this is literally true, as men knew in the great past and as they will know again.

*Apocalypse*

Five (p. 45)

The Viking Press. New York, New York, USA. 1932

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

1. The cosmos is a gigantic fly-wheel making 10,000 revolutions a minute.

2. Man is a sick fly taking a dizzy ride on it.

3. Religion is the theory that the wheel was designed and set spinning to give him the ride.

*Prejudices: Third Series*

Chapter V, Section 5 (p. 132)

Alfred A. Knopf. New York, New York, USA. 1922

**Plato** 428 BCE–347 BCE

Greek philosopher

...this universe is called Cosmos, or order, not disorder or misrule.

In *Great Books of the Western World* (Volume 7)

*Gorgias*

Section 508 (p. 284)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Reeves, Hubert** 1932–

Canadian astrophysicist

Knowledge of the cosmos is much more than a luxury for cultivated souls. It is the foundation of a cosmic consciousness. It casts light on the heavy responsibilities that have fallen upon us.

*Atoms of Silence*

Chapter 13 (p. 146)

The MIT Press. Cambridge, Massachusetts, USA. 1984

**Sagan, Carl** 1934–96

American astronomer and science writer

The cosmos is all there ever was and all there ever will be.

*Cosmos*

Chapter I, Volume I, Chapter I (p. 1)

Random House, Inc. New York, New York, USA. 1980

The size and age of the Cosmos are beyond ordinary human understanding. Lost somewhere between immensity and eternity is our tiny planetary home.

*Cosmos*

Chapter I (p. 4)

Random House, Inc. New York, New York, USA. 1980

It is too late to be shy and hesitant. We have announced our presence to the cosmos — in a backward and groping and unrepresentative manner, to be sure — but here we are!

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 30 (p. 216)

Dell Publishing, Inc. New York, New York, USA. 1975

...we are the local embodiment of a Cosmos grown to self-awareness. We have begun to contemplate our origins: starstuff pondering the stars; organized assemblages of ten billion billion billion atoms considering the

evolution of atoms; tracing the long journey by which, here at least, consciousness arose.

*Cosmos*

Chapter XIII (p. 345)

Random House, Inc. New York, New York, USA. 1980

...in the last tenth of a percent of the lifetime of our species, in the instant between Aristarchus and ourselves, we reluctantly noticed that we were not the center and purpose of the Universe, but rather lived on a tiny and fragile world lost in immensity and eternity, drifting in a great cosmic ocean dotted here and there with a hundred billion galaxies and a billion trillion stars. We have bravely tested the waters and have found the ocean to our liking, resonant with our nature. Something in us recognizes the Cosmos as home. We are made of stellar ash. Our origin and evolution have been tied to distant cosmic events. The exploration of the Cosmos is a voyage of self-discovery. As the ancient mythmakers knew, we are the children equally of the sky and the Earth.

*Cosmos*

Chapter XIII (p. 318)

Random House, Inc. New York, New York, USA. 1980

**Santayana, George (Jorge Augustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

...the cosmos has its own way of doing things, not wholly rational nor ideally best, but patient, fatal, and fruitful. Great is this organism of mud and fire, terrible this vast, painful glorious experiment.

In Logan Pearsall Smith

*Little Essays Drawn from the Writings of George Santayana*

Piety (p. 86)

Charles Scribner's Sons. New York, New York, USA. 1920

**Shapley, Harlow** 1885–1972

American astronomer

Cosmography is to the Cosmos what geography is to the earth.

*Of Stars and Men: Human Response to an Expanding Universe*

Introduction (fn, p. 4)

Beacon Press. Boston, Massachusetts, USA. 1958

**Tomlinson, C.**

No biographical data available

He sees in Nature's laws a code divine,  
A living Presence he must first adore,  
Ere he the sacred mysteries explore,  
Where Cosmos is his temple, Earth his shrine.

Michael Faraday

*The Graphic*, Volume XX, Number 508, 23 August 1879 (p. 183)

**COUGH**

**Griffiths, Trevor** 1935–

No biographical data available

MCBRAIN: Cough and the world coughs with you. Fart and you stand alone.

*The Comedians*

Act I (p. 17)

The Viking Press. New York, New York, USA. 1966

**Ray, John** 1627–1705

English naturalist

A dry cough is the trumpeter of death.

*A Complete Collection of English Proverbs* (p. 5)

Printed for G. Cowie. London, England. 1813

## Second World War Health Slogan

Coughs and sneezes spread diseases. Trap the germs in your handkerchief.

Source undetermined

**Wodehouse, P. G.** 1881–1975

English comic writer

Jeeves coughed one soft, low, gentle cough like a sheep with a blade of grass stuck in its throat.

*The Inimitable Jeeves*

Chapter 13 (p. 139)

Herbert Jenkins, Ltd. London, England. 1923

**Wolcot, John** 1738–1819

English writer

And, doctor, do you really think

That ass's milk I ought to drink?

'Twould quite remove my cough, you say,

And drive my old complaints away.

It cured yourself — I grant it true;

But then — 't was mother's milk to you!

In William Davenport Adams

*English Epigrams*

To a Friend Who Recommended Ass's Milk, cclxxxvi

G. Routledge. London, England. 1878

## COUNTING

**Brautigan, Richard** 1935–84

American writer

I count a lot of things that there's no need to count, Cameron said. Just because that's the way I am. But I count all the things that need to be counted.

*The Hawkline Monster: A Gothic Western*

Picador. London, England. 1976

**Feynman, Richard P.** 1918–88

American theoretical physicist

You see, the chemists have a complicated way of counting: instead of saying "one, two, three, four, five protons", they say, "hydrogen, helium, lithium, beryllium, boron."

*QED: The Strange Theory of Light and Matter*

Chapter 3 (p. 113)

Princeton University Press. Princeton, New Jersey, USA. 1985

**Park, Ruth** 1922–

New Zealand writer

"You know, Mouse," [Tabby] said, "a brilliant cat like me should have smart friends; people who can count to more than four."

"I can count to more than four," answered Mouse, very offended. "And I can do hard sums, and I know geography and history, and I can knit and..."

*The Muddle-Headed Wombat at School*

Educational Press. Sydney, Australia. 1966

**Seares, Frederick H.**

No biographical data available

Counting the stars is not unlike counting people or sheep or pebbles on the seashore. The astronomer's difficulties are not in the counting, but rather in knowing when the counting must start and stop.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1929*

Counting the Stars and Some Conclusions (p. 183)

Government Printing Office. Washington, D.C. 1930

## COURAGE

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Have the courage to say: "I do not know."

In Burt G. Wilder

Louis Agassiz, Teacher

*The Harvard Graduate's Magazine*, June, 1907

## CRAZY

**Heinlein, Robert A.** 1907–88

American science-fiction writer

...crazy — a nonscientific term meaning that the person to whom one applies that label has a world picture differing from the accepted one.

*Time Enough for Love*

Da Capo, Chapter II (p. 480)

G.P. Putnam's Sons. New York, New York, USA. 1973

## CREATE

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

You imagine what you desire; you will what you imagine; and you create what you will.

*Back to Methuselah*

Part I, Act I (p. 8)

Constable & Company Ltd. London, England. 1921

## CREATION

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

With all our wide vision we may be looking at only a small part of a grand creation. Our universe with its billions of galaxies may be only one among many.

*Science Is Not Enough*

Chapter IX (p. 168)

William Morrow & Company, Inc. New York, New York, USA. 1967

**Dobzhansky, Theodosius** 1900–75  
Russian American scientist

The creation...is not an event which happened in the remote past but is rather a living reality of the present. Creation is a process of evolution of which man is not merely a witness but a participant and a partner as well.

*The Biological Basis of Human Freedom*

Man's Kinship with Nature, Creation by Evolution (p. 5)

Columbia University Press. New York, New York, USA. 1956

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

I do not think that the whole purpose of the Creation has been staked on the one planet where we live; and in the long run we cannot deem ourselves the only race that has been or will be gifted with the mystery of consciousness.

Man's Place in the Universe

*Harper's Magazine*, October 1928 (p. 574)

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

We have theories of races and of functions, but scarcely yet a remote approach to an idea of creation. We are now so far from the road to truth, that religious teachers dispute and hate each other, and speculative men are esteemed unsound and frivolous.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses and Lectures

Introduction (p. 4)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Flaubert, Gustave** 1821–90  
French novelist

How vast is creation! I see the planets rise and the stars hurry by, carried along with their light! What, then, is this hand which propels them? The sky broadens the more I ascend. Worlds revolve around me. And I am the center of this restless creation.

Oh, how great is my spirit! I feel superior to that miserable world lost in the immeasurable distance beneath me; planets frolic about me — comets pass by casting forth their fiery tails, and centuries hence they will return, still running like horses on the field of space. How I am

soothed by this immensity! Yes, this is indeed made for me; the infinite surrounds me on all sides. I am devouring it with ease.

*Smarh*

Librairie de France. Paris, France. 1922

**Hopkins, Gerard Manley** 1844–89  
English poet and Jesuit priest

To know what creation is look at the size of the world. Speed of light: it would fly six or seven times around the world while the clock ticks once. Yet it takes thousands of years to reach us from the Milky Way.

In Christopher Devlin, S.J.

*The Sermons and Devotional Writings of Gerard Manley Hopkins* (p. 238)  
Oxford University Press, Inc. London, England. 1959

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

There is no interruption in creation; no broken arch, no lapse; an action and its consequences embrace all nature; the chain may be longer or shorter, but never breaks. Climb this immense knotted cord, take one fact after another, and you will progress from the vibrio to the constellation. The immanent marvel has its own cohesion. Nothing is wasted; no effort is lost. The useless does not exist. The universe has what is necessary and only what is necessary.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 409)

The Heritage Press. New York, New York, USA. 1961

...who among us knows whether the creation of worlds is not determined by the fall of grains of sand?

*Les Misérables*

Volume IV, Book III, Chapter 3 (p. 67)

The Heritage Press. New York, New York, USA. 1938

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...so little do we understand time that perhaps we ought to compare the whole of time to the act of creation...

*The Mysterious Universe*

Chapter V (p. 148)

The Macmillan Company. New York, New York, USA. 1932

**Miller, Hugh** 1802–56

Scottish geologist and theologian

Who shall declare what, throughout these long ages, the history of creation has been? We see at wide intervals the mere fragments of successive floras; but know not how what seem the blank interspaces were filled, or how, as extinction overtook in succession one tribe of existences after another, and species, like individuals, yielded to the great law of death, yet other species were brought to the birth and ushered upon the scene, and the chain of being

was maintained unbroken. We see only detached bits of that green web which has covered our earth ever since the dry land first appeared; but the web itself seems to have been continuous throughout all time; though ever, as breadth after breadth issued from the creative loom, the pattern has altered, and the sculpturesque and graceful forms that illustrated its first beginnings and its middle spaces have yielded to flowers of richer colour and blow, and fruits of fairer shade and outline; and for gigantic club-mosses stretching forth their hirsute arms, goodly trees of the Lord have expanded their great boughs; and for the barren fern and the calamite, clustering in thickets beside the waters, or spreading on flowerless hill-slopes, luxuriant orchards have yielded their ruddy flush, and rich harvests their golden gleam.

*The Testimony of the Rocks; or, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Twelfth (pp. 501–502)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

Creation cannot take place without miracle; but it would be a strange reversal of all our previous conclusions on the subject, should we have to hold that the dead, dark blank out of which creation arose was miraculous also.

*The Testimony of the Rocks; or, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Third (p. 156)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

### **Parker, Barry**

Canadian physicist

Creation depends on the basic laws of nature — without them it would not be possible. Who creates these laws? There is no question but that a God will always be needed.

*Creation: The Story of the Origin and Evolution of the Universe*  
Chapter 17 (p. 282)  
Plenum Press. New York, New York, USA. 1998

### **Peacock, R.**

No biographical data available

We have used his law (the 2<sup>nd</sup> law of thermodynamics) in determining that the universe had a beginning, creation. Even though the tools of the physicist are unable to break into the secrets of the first moment, we can conclude that it initiated a period of low, but increasing entropy.

*A Brief History of Eternity*  
Chapter Eight (p. 114)  
Monarch Publications Ltd. E. Sussex, Great Britain. 1989

### **Wright, Thomas** 1711–86

English cosmologist

...we cannot long observe the beauteous Parts of the visible Creation, not only those of this World on which we live, but also the Myriads of bright Bodies round us, with any Attention, without being convinced, that a

Power supreme, and of a Nature unknown to us, presides in, and governs it...

*An Original Theory or New Hypothesis of the Universe*  
Letter the Seventh (p. 58)  
Printed for the Author. London, England. 1750

## **CREATIONISM**

### **Cloud, Preston Ercelle** 1912–91

American biogeologist, paleontologist, and humanist

Fundamentalist creationism is not a science but a form of antiscience, where more vocal practitioners, despite their master's and doctoral degrees in the sciences, play fast and loose with the facts of geology and biology.

In J. Peter Zetterberg (ed.)  
*Evolution versus Creationism: The Public Education Controversy*  
“Scientific Creationism” — A New Inquisition Brewing? (p. 134)  
Oryx Press, Phoenix, Arizona, USA. 1983

### **Darwin, Charles Robert** 1809–82

English naturalist

Do they really believe that at innumerable periods in the earth's history certain elemental atoms have been commanded suddenly to flash into living tissues? Do they believe that at each supposed act of creation one individual or many were produced? Were all the infinitely numerous kinds of animals and plants created as eggs or seed, or as full grown?

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter XV (p. 240)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The argument that the literal story of Genesis can qualify as science collapses on three major grounds: the creationists' need to invoke miracles in order to compress the events of the earth's history into the biblical span of a few thousand years; their unwillingness to abandon claims clearly disproved, including the assertion that all fossils are products of Noah's flood; and their reliance upon distortion, misquote, half-quote, and citation out of context to characterize the ideas of their opponents.

*The Verdict on Creationism*  
*The Skeptical Inquirer*, Volume 12, Winter 87/88 (p. 186)

Creation science has not entered the curriculum for a reason so simple and so basic that we often forget to mention it: because it is false, and because good teachers understand exactly why it is false. What could be more destructive of that most fragile yet most precious commodity in our entire intellectual heritage — good teaching — than a bill forcing honorable teachers to sully their sacred trust by granting equal treatment to a doctrine not only known to be false, but calculated to undermine any

general understanding of science as an enterprise?

The Verdict on Creationism

*The Skeptical Inquirer*, Volume 12, Winter 87/88 (p. 186)

**Laudan, Larry** 1945–

American philosopher of science

Rather than taking on the creationists obliquely and in wholesale fashion by suggesting that what they are doing is “unscientific” tout court (which is doubly silly because few authors can even agree on what makes an activity scientific), we should confront their claims directly and in piecemeal fashion by asking what evidence and arguments can be marshaled for and against each of them. The core issue is not whether Creationism satisfies some undemanding and highly controversial definition of what is scientific; the real question is whether the existing evidence provides stronger arguments for evolutionary theory than for Creationism.

Commentary: Science at the Bar – Cause for Concern

*Science, Technology & Human Values*, Volume 7, Number 41, Fall 1982 (p. 18)

**Lyell, Sir Charles** 1797–1875

English geologist

Whatever be the power which has for hundreds of times repeopled the Earth with tribes of plants & animals as fast as they became extinct, that power I have always held is still in full & unabated action as is its antagonist or destructive power.

In Leonard G. Wilson (ed.)

*Sir Charles Lyell's Scientific Journals on the Species Question*

Journal II, July 10, 1856 (p. 124)

Yale University Press. New Haven, Connecticut, USA. 1970

**Moore, John A.**

American writer and professor of genetics and biology

It becomes evermore important to understand what is science and what is not. Somehow we have failed to let our students in on that secret. We find as a consequence, that we have a large and effective group of creationists who seek to scuttle the basic concept of the science of biology — the science that is essential for medicine, agriculture, and life itself; a huge majority of citizens who, in “fairness,” opt for presenting as equals the “science” of creation and the science of evolutionary biology; and a president who is so poorly informed that he believes that scientists are questioning that evolution ever occurred. It is hard to think of a more terrible indictment of the way we have taught science.

In J. Peter Zetterberg (ed.)

*Evolution versus Creationism: The Public Education Controversy*

Evolution, Education, and the Nature of Science and Scientific Inquiry (p. 3)

Oryx Press, Phoenix, Arizona, USA. 1983

**Morris, Henry** 1918–2006

American creationist

Creationism is consistent with the innate thoughts and daily experiences of the child and thus is conducive to his mental health. He knows, as part of his own experience of reality, that a house implies a builder and a watch a watchmaker. As he studies the still more intricately complex nature of, say, the human body, or the ecology of a forest, it is highly unnatural for him to be told to think of these systems as chance products of irrational processes.

*Scientific Creationism*

Chapter I (p. 14)

Creation-Life Publishers. San Diego, California, USA. 1974

It seems beyond all question that such complex systems as the DNA molecule could never arise by chance, no matter how big the universe or how long the time. The creation model faces this fact realistically and postulates a great Creator, by whom came life.

*Scientific Creationism*

Chapter IV (p. 62)

Creation-Life Publishers. San Diego, California, USA. 1974

**Nelkin, Dorothy** 1933–2003

American sociologist

Creationism is a “gross perversion of scientific theory.” Scientific theory is derived from a vast mass of data and hypotheses, consistently analysed; creation theory is “God given and unquestioned”, based on an a priori commitment to a six-day creation. Creationists ignore the interplay between fact and theory, eagerly searching for facts to buttress their beliefs. Creationism cannot be submitted to independent testing and has no predictive value, for it is a belief system that must be accepted on faith.

*Science Textbook Controversies and the Politics of Equal Time*

Chapter 6 (p. 89)

**Patterson, John W.**

No biographical data available

There are many facets to “scientific creationism” and the movement can be discussed in any of several ways. However, it is best viewed as a loosely connected group of fundamentalist ministries led largely by scientifically incompetent engineers.

In J. Peter Zetterberg (ed.)

*Evolution versus Creationism: The Public Education Controversy*

An Engineer Looks at the Creationist Movement (p. 151)

Oryx Press, Phoenix, Arizona, USA. 1983

## CREATIONIST

**Albritton, Jr., Claude** 1913–

No biographical data available

One can only conclude that some creationists, recoiling from the fearsome prospect of time’s abyss, have toppled backward into the abyss of ignorance.

*The Abyss of Time: Changing Conceptions of the Earth's Antiquity after*



*the Sixteenth Century*

Chapter Seventeen (pp. 218–219)

Freeman, Cooper & Company. San Francisco, California, USA. 1980

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The basic attack of modern creationists falls apart on two general counts before we even reach the supposed factual details of their assault against evolution. First, they play upon a vernacular misunderstanding of the word “theory” to convey the false impression that we evolutionists are covering up the rotten core of our edifice. Second, they misuse a popular philosophy of science to argue that they are behaving scientifically in attacking evolution. Yet the same philosophy demonstrates that their own belief is not science, and that “scientific creationism” is a meaningless and self-contradictory phrase, an example of what Orwell called “newspeak.”

*Hen's Teeth and Horses Toes*

Evolution as Fact and Theory (p. 254)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

Our creationist detractors charge that evolution is an unproved and unprovable charade — a secular religion masquerading as science. They claim, above all, that evolution generates no predictions, never exposes itself to test, and therefore stands as dogma rather than disprovable science. This claim is nonsense. We make and test risky predictions all the time; our success is not dogma, but a highly probable indication of evolution's basic truth.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Seven, Chapter 31 (p. 409)

Random House, Inc. New York, New York, USA. 1995

Creationist critics often charge that evolution cannot be tested, and therefore cannot be viewed as a properly scientific subject at all. This claim is rhetorical nonsense.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Seven, Chapter 30 (p. 397)

Random House, Inc. New York, New York, USA. 1995

According to the idealized principles of scientific discourse, the arousal of dormant issues should reflect fresh data that give renewed life to abandoned notions. Those outside the current debate may therefore be excused for suspecting that creationists have come up with something new, or that evolutionists have generated some serious internal trouble. But nothing has changed; the creationists have presented not a single new fact or argument. Darrow and Bryan were at least more entertaining than we lesser antagonists today. The rise of creationism is politics, pure and simple; it represents one issue (and by no means the major concern) of the resurgent evangelical right. Arguments that seemed kooky just a decade ago have reentered the mainstream.

*Hen's Teeth and Horses Toes*

Evolution as Fact and Theory (p. 253)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

**Miller, Hugh** 1802–56

Scottish geologist and theologian

There is no progression. If fish rose into reptiles, it must have been by sudden transformation.... There is no getting rid of miracle in the case, — there is no alternative between creation and metamorphosis. The infidel substitutes progression for Deity; Geology robs him of his god.

*The Old Red Sandstone*

Chapter III (pp. 65–66)

J.M. Dent & Sons Ltd. London, England. 1922

## CREATIVITY

**Adler, Alfred** 1870–1937

Austrian psychiatrist

The essential feature of mathematical creativity is the exploration, under the pressure of powerful impulsive forces, of difficult problems for whose validity and importance the explorer is eventually held accountable by reality.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 9)

Wadsworth, Inc. Belmont, California, USA. 1984

**Arieti, Silvano** 1914–81

Italian-American psychologist

However, creativity is not simply originality and unlimited freedom. There is much more to it than that. Creativity also imposes restrictions. While it uses methods other than those of ordinary thinking, it must not be in disagreement with ordinary thinking — or rather, it must be something that, sooner or later, ordinary thinking will understand, accept, and appreciate. Otherwise the result would be bizarre, not creative.

*Creativity: The Magic Synthesis*

Chapter 1 (p. 4)

Basic Books, Inc. New York, New York, USA. 1976

Indeed, it is the perennial (and almost always unverbalized) premise of creativity, to show that the tangible, visible, and audible universe is infinitesimal in comparison to the one that awaits discovery through exploration of the external world and of the human psyche.

*Creativity: The Magic Synthesis*

Chapter 1 (p. 5)

Basic Books, Inc. New York, New York, USA. 1976

**Birch, Arthur J.** 1915–1995

Australian chemist

...creativity is the ability to see the obvious over the long term, and not to be restrained by short-term conventional wisdom.

*To See the Obvious*

Random Conversations with the Editor (p. 196)

American Chemical Society. Washington, D.C. 1995

**Bolz, Ray E.**

No biographical data available

**Dean, Jr., Robert C.**

No biographical data available

What the educational experience almost completely excludes is the exercise and development of the students' creativity — even though creativity is probably the single most important characteristic demanded of a modern, practicing engineer.

In Daniel V. DeSimone

*Education for Innovation*

Strategies and Teaching Methods, Chapter 11 (p. 128)

Pergamon Press. New York, New York, USA. 1968

**Calvin, Melvin** 1911–97

American biochemist

There is no such thing as pure science. By this I mean that physics impinges on astronomy on the one hand, and chemistry and biology on the other. The synthesis of a really new concept requires some sort of union in one mind of the pertinent aspects of several disciplines.... It's no trick to get the right answer when you have all the data. The real creative trick is to get the right answer when you have only half of the data in hand and half of it is wrong and you don't know which half is wrong. When you get the right answer under these circumstances, you are doing something creative.

*Following the Trail of Light: A Scientific Odyssey*

Bringing It Together (p. 134)

American Chemical Society. Washington, D.C. 1992

**Duren, Peter L.**

No biographical data available

A lot of mathematicians are a little bit strange in one way or another. It goes with creativity.

*New York Times*, May 26, 1996 (p. 23)

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

The creative element in the mind of man...emerges in as mysterious a fashion as those elementary particles which leap into momentary existence in great cyclotrons, only to vanish again like infinitesimal ghosts.

*The Night Country*

Chapter 13 (p. 212)

Charles Scribner's Sons. New York, New York, USA. 1971

**Freund, C. J.**

No biographical data available

For one thing, engineering creativity is much more like inventiveness than like research. The creative engineer is a cousin to Edison and Marconi; he is no relation at all to Einstein or Enrico Fermi.

Creativity Is a Task, Not a Trait

*Machine Design*, May 25, 1967 (p. 161)

**Gilmer, Ben S.**

No biographical data available

We need men who have been schooled in the principles of creativity and who dare to court the ridicule of the masses for the sake of improving the lot of mankind.

Times Demand as Goal: Education for Creativity

*Auburn Alumnews*, July 1961 (p. 7)

**Glegg, Gordon L.**

American engineer

Disciplined thinking focuses inspiration rather than blinkers it.

*The Design of Design*

Introduction (p. 1)

Cambridge University Press. Cambridge, England. 1979

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Creative work, in geology and anywhere else, is interaction and synthesis; half-baked ideas from a bar room, rocks in the field, chains of thought from lonely walks, numbers squeezed from rocks in a laboratory, numbers from a calculator riveted to a desk, fancy equipment usually malfunctioning on expensive ships, cheap equipment in the human cranium, arguments before a road cut.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 6 (p. 98)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

The nation that neglects creative thought today will assuredly have its nose ground into the dust of tomorrow.

In Sidney J. Parnes and Harold F. Harding

*A Source Book for Creative Thinking*

Creativity: Education's Stepchild (p. 17)

Charles Scribner's Sons. New York, New York, USA. 1962

It is a mistake to imagine that potentially great men are rare. It is the conditions that permit the promise of greatness to be fulfilled that are rare. What is so difficult to achieve is the cultural background that permits potential greatness to be converted into actual greatness.

*Of Men and Galaxies*

Motives and Aims of the Scientist (p. 21)

University of Washington Press. Seattle, Washington, USA. 1964

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

A creative person has little power over his own life. He is not free. He is captive and driven by his daemon.

*Memories, Dreams, Reflections*

Retrospect (p. 357)

Vintage Books. New York, New York, USA. 1963

**King, Blake**

No biographical data available

Creativity bothers engineers.

Object: Creativity

*Mechanical Engineering*, November 1963 (p. 38)

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Creativity in science could be described as the art of putting two and two together to make five. In other words, it consists in combining previously unrelated mental structures in such a way that you get more out of the emergent whole than you have put in.

*Janus: A Stumming Up*

Chapter VII (p. 131)

Random House, Inc. New York, New York, USA. 1978

**Kuhn, Thomas S.** 1922–96

American historian of science

The transition from a paradigm to a new one from which a new tradition of normal science can emerge is far from a cumulative process, one achieved by an articulation or extension of the old paradigm. Rather it is a reconstruction of the field from new fundamentals, a reconstruction that changes some of the field's most elementary theoretical generalizations as well as many of its paradigm methods and applications.

*The Structure of Scientific Revolutions*

Chapter VIII (pp. 84–85)

The University of Chicago Press. Chicago, Illinois, USA. 1970

Let us assume that crises are a necessary precondition for the emergence of novel theories and ask next how scientists respond to their existence. Part of the answer, as obvious as it is important, can be discovered by noting first what scientists never do when confronted by even severe and prolonged anomalies. Though they may begin to lose faith and then to consider alternatives, they do not renounce the paradigm that has led them into crisis. They do not, that is, treat anomalies as counterinstances, though in the vocabulary of philosophy of science that is what they are.

*The Structure of Scientific Revolutions*

Chapter VIII (p. 77)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Lipscombe, William N.** 1919–

American chemist

For me, the creative process, first of all, requires a good nine hours of sleep a night. Second, it must not be pushed by the need to produce practical applications.

*New York Times*, 7 December 1977

**Lowell, James Russell** 1819–91

American poet, critic, and editor

In creating, the only hard thing's to begin....

*A Fable for Critics*

A Fabler for the Critics (p. 28)

G.P. Putnam. New York, New York, USA. 1848

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The romantic view of the creative process of science as something cognate with poetic invention is often sneered at by people who pride themselves as shrewd, practical-minded men of the world with a sound sense of the value of money. But they don't do any better than the rest of us, and it is they, indeed — people who believe that there is a cut and dried scientific method and that they can buy scientific results by paying for them — who are the incurable daydreamers with their heads in the clouds and no real understanding of the way the mind works.

*The Strange Case of the Spotted Mice and Other Classic Essays on Science* New York Review of Books, 15 April 1976

**Moore, A. D.**

No biographical data available

Throughout the long history of the human race, we find that creativity has nearly always had to struggle against anything from discouragement to violent rejection.

*Invention, Discovery, and Creativity* (p. 140)

Doubleday & Company, Inc. Garden City, New York, USA. 1969

**Morton, Jack A.**

No biographical data available

Creativity is involved in research, discovery of new knowledge, in its application, in development engineering, in the manufacture of the hardware, in marketing and sales, in the raising of capital, and in the supplying of services.

In Daniel V. DeSimone

*Education for Innovation*

Innovation and Entrepreneurship, Discussion (p. 105)

Pergamon Press. New York, New York, USA. 1968

**Sagan, Carl** 1934–96

American astronomer and science writer

I think the most significant creative activities of our or any other human culture — legal and ethical systems, art and music, science and technology — were made possible only through the collaborative work of the left and right cerebral hemispheres. ... We might say that human culture is the function of *corpus callosum*.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

*Intelligence*

Chapter 7 (p. 185)

Random House, Inc. New York, New York, USA. 1977

I know of no significant advance in science that did not require major inputs from both cerebral hemispheres. This is not true for art, where apparently there are no

experiments by which capable, dedicated and unbiased observers can determine to their mutual satisfaction which works are great. As one of hundreds of examples, I might note that the principal French art critics, journals and museums of the late nineteenth and early twentieth centuries rejected French Impressionism *in toto*; today the same artists are widely held by the same institutions to have produced masterpieces. Perhaps a century hence the pendulum will reverse direction again.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 7 (p. 184)

Random House, Inc. New York, New York, USA. 1977

### Salzberg, Paul

No biographical data available

There is no magic formula for achieving creativity — it is simply a way of life in a laboratory dedicated to discovery and invention.

*Think*, November–December, 1962

### Selye, Hans 1907–22

Austrian endocrinologist

It is often cited as an argument against teamwork that every great new concept originates in one brain. This is true, but tossing an idea around in a group discussion helps to formulate it clearly in the brain of one participant or the other. Some of my best ideas came when I was trying to explain to my students and associates something that I myself only sensed but did not yet fully understand.

*From Dream to Discovery: On Being a Scientist*

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

### Tumin, Melvin

No biographical data available

Let us not kid ourselves. The way to the creative life for the average man is difficult in the extreme.

In Sidney J. Parnes and Harold F. Harding

*A Source Book for Creative Thinking*

Obstacles to Creativity (p. 113)

Charles Scribner's Sons. New York, New York, USA. 1962

### Weisburd, Stefi

American poet

Creativity is at once both an intensely individual act of expression and a bridge that links us to the rest of the universe. It can be a personal joy, a chance at immortality or a tool for humanity's survival. Yet, in spite of its importance to individuals and societies, creativity is not something that is freely and intensely exuded by everyone.

The Spark: Personal Testimonies of Creativity

*Science News*, November 7, 1987

### Wilson, Robert Q.

No biographical data available

He who is truly creative can distinguish between those matters worthy of change and those that are not worth the effort.

*Battelle Technical Review*, Volume 11, Number 4, April 1962 (p. 12)

## CREDIT

### Forbes, Edward 1815–54

English naturalist

As to giving credit to whom credit is due, rest assured the best way to do good to one's-self is to do justice to others. There is plenty for everybody in science, and more than can be consumed in our time.

In George Wilson and Archibald Geikie

*Memoir of Edward Forbes, F.R.S.*

Chapter XI (p. 366)

Macmillan & Company Ltd. Cambridge, England. 1861

## CREED

### Lewis, Sinclair 1885–1951

American novelist

God give me unclouded eyes and freedom from haste. God give me quiet and relentless anger against all pretense and all pretentious work and all work left slack and unfinished. God give me a restlessness whereby I may neither sleep nor accept praise until my observed results equal my calculated results, or, in pious glee, I discover and assault my error. God give me strength not to trust to God.

*Arrowsmith*

Chapter XXVI, Section II (p. 292)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

## National Society of Professional Engineers

As a Professional Engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

I Pledge:

To give the utmost of performance;

To participate in none but honest enterprise;

To live and work according to the laws of man and the highest standards of professional conduct.

To place service before profit, the honor and standing of the profession before personal advantage, and the public welfare above all other considerations.

In humility and with need for Divine Guidance, I make this pledge.

*Engineers' Creed*

Adopted June 1954

## CRITICISM

### Cram, Donald J. 1919–2001

American chemist

Anyone who wishes to grow over their lifetime needs criticism.

*From Design to Discovery*

Carbanion Stereochemistry and Mechanisms (1955–1972) (p. 45)  
American Chemical Society, Washington, D.C. 1990

### **Darwin, Charles Robert** 1809–82

English naturalist

Whenever I have found out that I have blundered, or that my work has been imperfect, and when I have been contemptuously criticized, and even when I have been overpraised, so that I have felt mortified, it has been my greatest comfort to say hundreds of time to myself that “I have worked as hard and as well as I could, and no man can do more than this.”

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin*

Chapter II, Autobiography (p. 89)

John Murray, London, England. 1887

Pray do not suppose that I expect to convert or pervert you; if I could stagger you in ever so slight a degree I should be satisfied; nor fear to annoy me by severe criticisms, for I have had some hearty kicks from some of my best friends.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Letter to J. Prestwich, March 12, 1860 (p. 89)

D. Appleton & Company, New York, New York, USA. 1896

### **Pasteur, Louis** 1822–95

French chemist

Little tolerant of frivolous or prejudiced contradiction, contemptuous of that ignorant criticism which doubts on principle, I welcome with open arms the militant attack which has a method in doubting and whose rule of conduct has the motto “More light.”

*The Harvard Classics* (Volume 38)

On the Extension of the Germ Theory to the Etiology of Certain Common Diseases (p. 382)

P.F. Collier & Son, New York, New York, USA. 1938

### **Sagan, Carl** 1934–96

American astronomer and science writer

Valid criticism does you a favor.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 32)

Random House, Inc. New York, New York, USA. 1995

## CRUST

### **Darwin, Charles Robert** 1809–82

English naturalist

The noble science of Geology loses glory from the extreme imperfection of the record. The crust of the earth with its imbedded remains must not be looked

at as a well filled museum, but as a poor collection made at hazard and at rare intervals. The accumulation of each great fossiliferous formation will be recognized as having depended on an unusual occurrence of favorable circumstances, and the blank intervals between the successive stages as having been of vast duration.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XV (p. 242)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Gutenberg, Beno** 1889–1960

German American seismologist

The books and papers dealing with hypotheses on the development of the earth’s crust are as the sands of the seas.

*Physics of the Earth* (Volume 7)

Chapter IX (p. 177)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1939

## CRYSTALLOGRAPHY

### **Lonsdale, Dame Kathleen** 1903–71

English crystallographer

...a crystal is like a class of children arranged for drill, but standing at ease, so that while the class as a whole has regularity both in time and space, each individual child is a little fidgety!

*Crystals and X-Rays*

Chapter I

D. Van Nostrand Company, New York, New York, USA. 1949

### **Pauling, Linus** 1901–94

American chemist

I miss the old days, when nearly every problem in X-ray crystallography was a puzzle that could be solved only by much thinking.

In Philip Ball

*Designing the Molecular World: Chemistry at the Frontier* (p. 111)

Princeton University Press, Princeton, New Jersey, USA. 1994

## CULTURE

### **Hart, Charles William**

Cultural anthropologist

...every culture in the world has had its own unique history and we can not therefore say that any culture observable in the present day world is an earlier form of any other.

In H.A. Innis

*Essays in Political Economy*

Social Evolution and Modern Anthropology (p. 114)

University of Toronto Press, Toronto, Ontario, Canada. No date

**CURE****Advertisement**

I have discovered the natural system of cure for all diseases, habits, defects, failings, etc., without the use of deleterious and pernicious drugs or medicines. Being Scientific, it is absolutely safe, simple, painless, pleasant, rapid, and infallible. Diseases like hysteria, epilepsy, rheumatism, loss of memory, paralysis, insanity and mania; addiction to smoking, opium, drink, etc.; impotence, sterility, adultery, and the like can be radically cured duly by My System.

In Aldous Huxley

*Jesting Pilate*

India & Burma (p. 119)

Chatto & Windus. London, England. 1926

**Alexander, Franz** 1891–1964

Hungarian-born physician and psychoanalysis pioneer

We now feel we can cure the patient without his fully understanding what made him sick. We are no longer so interested in peeling the onion as in changing it.

Psychoanalysis Then and Now

*Time*, May 19, 1961 (p. 68)

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

There is no curing a sick man who believes himself in health.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

February 1877 (p. 305)

A.L. Burt Company, Publishers. New York, New York, USA. 189?

**Baruch, Bernard M.** 1870–1965

American presidential advisor

There are no such things as incurables, there are only things for which man has not found a cure.

Address to the President's Committee on Employment of the Physically Handicapped

News report of May 1, 1954

**Beaumont, Francis** 1584–1616

English playwright and dramatic poet

**Fletcher, John**

No biographical data available

THIERRY: We study satisfaction; must the cure

Be worse than the disease?

*Beaumont and Fletcher*

Thierry and Theodoret

Act IV, Scene ii

Charles Scribner's Sons. New York, New York, USA. 1904

**Browne, Sir Thomas** 1605–82

English author and physician

...we all labour against our owne cure, for death is the cure of all diseases.

*Religio Medici*

Part II, Section 9 (p. 93)

Elliot Stock. London, England. 1883

**Burton, Robert** 1577–1640

English clergyman and scholar

It is in vain to speak of cures, or think of remedies, until such time as

we have considered of the causes...

*The Anatomy of Melancholy* (Volume 1)

Part I, Section II, Memb. I, Subsection 1 (p. 202)

AMS Press, Inc. New York, New York, USA. 1973

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Tis not amiss, ere ye're giv'no'er,

To try one desp'rate med'cine more;

For where your case can be no worse,

The desp'rat is the wisest course.

*The Poetical Works of Samuel Butler* (Volume 1)

Epistle of Hudibras to Sidrophe

I, l. 5–8

Bell & Daldy. London, England. 1835

Diseases of their own accord,

But cures come difficult and hard.

*The Poetical Works of Samuel Butler* (Volume 2)

The Weakness and Misery of Man, l. 82–83

Bell & Daldy. London, England. 1835

**Crabbe, George** 1754–1832

English poet

Man yields to custom, as he bows to fate,

In all things rul'd — mind, body, and estate:

In pain, in sickness, we for cure apply

To them we know not, and we know not why...

*Tales*

Tale III (p. 46)

Printed for J. Hatchard. London, England. 1813

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

In truth, the most important thing for curing illnesses and maintaining health is good humor and joy.

In René Dubos & Jean-Paul Escande

Translated by Patricia Ranum

*Quest: Reflections on Medicine, Science, and Humanity*

Chapter III (p. 59)

Harcourt Brace Jovanovich. New York, New York, USA. 1979

**Hardy, Thomas** 1840–1928

English poet and regional novelist

And ill it therefore suits

The mood of one of my high temperature

To pause inactive while await me means

of desperate cure for these so desperate ills!

*The Dynasts*

Part First, Act IV, Scene III  
Warrington & Company. London, England. 1914

**Herrick, Robert** 1591–1674  
English poet

To an old soare a long cure must goe on...  
In J. Max Patrick (ed.)  
*The Complete Poetry of Robert Herrick*  
Great Maladies, Long Medicine (p. 50)  
W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Hitchcock, Alfred** 1899–1980  
English-born American filmmaker

I have a perfect cure for a sore throat — cut it.  
In Evan Esar  
*20,000 Quips and Quotes* (p. 199)  
Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

When desp'rate Ills demand a Speedy Cure,  
Distrust is Cowardice, and Prudence Folly.  
*Irene*  
Act IV, Scene I  
Scolar Press Ltd. Menston, England. 1973

**Kipling, Rudyard** 1865–1936  
British writer and poet  
The cure for this ill is not to sit still,  
Or frost with a book by the fire;  
But to take a large hoe and a shovel also,  
And dig till you gently perspire.  
*Just So Stories*  
How the Camel Got His Hump (p. 27)  
Doubleday & Company, Inc. Garden City, New York, USA. 1952

**Latham, Peter Mere** 1789–1875  
English physician

Let cure be looked upon as concerned with the disease  
as such, and having little or no regard to the individual  
patient whom it befalls.  
In William B. Bean  
*Aphorisms from Latham* (p. 60)  
Prairie Press. Iowa City, Iowa, USA. 1962

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Forth then issued Hiawatha,  
Wandered eastward, wandered westward,  
Teaching men the use of simples  
And the antidotes for poisons,  
And the cure of all diseases.  
Thus was first made known to mortals  
All the mystery of Medamin,  
All the sacred art of healing.  
*The Song of Hiawatha*  
Hiawatha's Lamentation (pp. 208–209)  
A.L. Burt. New York, New York, USA. 1900

**Ray, John** 1627–1705  
English naturalist

What cannot be cured must be endured.  
*A Complete Collection of English Proverbs* (p. 97)  
Printed for G. Cowie. London, England. 1813

A disease known, is half cured.  
*A Complete Collection of English Proverbs* (p. 100)  
Printed for G. Cowie. London, England. 1813

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

One's desire to live is the best cure for many illnesses.  
*Encyclopedia of Thoughts*  
Aphorisms 370  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

It is human nature to think that if a small dose helps, a  
double dose will cure.  
*Encyclopedia of Thoughts*  
Aphorisms 329  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

Activity is the best cure for many ills of body and mind.  
*Encyclopedia of Thoughts*  
Aphorisms 2252  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Shadwell, Thomas** 1642?–92  
English dramatist and poet

RAYMUND: Well a desperate disease must have a des-  
perate Cure...  
*The Complete Works of Thomas Shadwell* (Volume 1)  
The Humorists, Act IV (p. 237)  
The Fortune Press. London, England. 1927

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Care is no cure, but rather corrosive  
For things that are not to be remedied.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The First Part of King Henry the Sixth  
Act III, Scene iii, l. 3  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Szasz, Thomas** 1920–  
Hungarian-born American psychiatrist

Masturbation: the primary sexual activity of mankind. In  
the nineteenth century it was a disease; in the twentieth,  
it's a cure.  
*The Second Sin*  
Sex (p. 12)  
Anchor Press/Doubleday. Garden City, New Jersey, USA. 1974

**Tolstoy, Leo** 1828–1910  
Russian writer

What can doctors cure?  
In *Great Books of the Western World* (Volume 51)

*War and Peace*

Book Ten, Chapter XXIX (p. 449)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Trudeau, Edward

No biographical data available

*Guérir quelquefois, soulager souvent, consoler toujours.*

To sometimes cure, often help, always console.

In René Dubos & Jean-Paul Escande

Translated by Patricia Ranum

*Quest: Reflections on Medicine, Science, and Humanity*

Chapter III (p. 56)

Harcourt Brace Jovanovich. New York, New York, USA. 1979

## CURIOSITY

### Amaldi, Ginestra Giovene

No biographical data available

Man in his universe is like a baby in a strange room. Just as a baby reaches out to finger or taste all the mysterious objects in the room, so man's curiosity is excited by the wonderful sights, sounds, and smells that greet him whichever way he turns.

*Our World and the Universe Around Us* (Volume 1)

Introduction (p. ix)

Abtradale Press. New York, New York, USA. 1966

### Bauer, Henry H. 1931–

American chemist

One can fool all the people some of the time, and some of the people all the time, but one cannot fool all the people all the time when the evidence is as clear as it can be in natural science. Nothing, by contrast, can force one person to agree with another about which approach to literary criticism is the best, right, or most fruitful; and we simply do not know what makes some children grow up curious and others uninterested; and we can and do argue and disagree over such matters without end.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 143)

University of Illinois Press. Urbana, Illinois, USA. 1992

### Born, Max 1882–1970

German-born English physicist

The collective enterprise of practical science consists in the end of individuals and cannot thrive without their devotion. But devotion does not suffice; nothing great can be achieved without the elementary curiosity of the philosopher.

*Natural Philosophy of Cause and Chance*

Chapter X (p. 128)

At The Clarendon Press. Oxford, England. 1949

### Bostwick, Arthur Elmore 1860–1942

No biographical data available

The lives of the great scientific men show that they all have something in common — a passion for truth, a life-long effort to get at new facts and to explain the old ones, a “divine curiosity,” pursued for its own sake and not for that of any personal advantage.

In Frederick Houk Law

*Science in Literature*

Pivotal Figures of Science (p. 350)

Harper & Brothers Publishers. New York, New York, USA. 1929

### Charlie Chan

Fictional character

Knowledge only gained through curiosity.

*Charlie Chan at the Wax Museum*

Film (1940)

### Coman, Dale Rex 1906–

American research physician and wildlife writer

Youth's insatiable curiosity is soon squelched and its breadth of view quickly forced into the furrow cut by the plow of convention.

*The Endless Adventure*

The Swamp Pink and Long-Eared Owls (p. 139)

Henry Regnery Company. Chicago, Illinois, USA. 1972

### Day, Clarence 1874–1935

American writer

Creatures whose mainspring is curiosity will enjoy the accumulating of facts, far more than pausing at times to reflect on those facts.

*This Simian World*

Chapter Nine (p. 51)

Alfred A. Knopf. New York, New York, USA. 1941

### Descartes, René 1596–1650

French philosopher, scientist, and mathematician

So blind is the curiosity by which mortals are possessed, that they often conduct their minds along unexplored routes, having no reason to hope for success, but merely being willing to risk the experiment of finding whether the truth they seek lies there.

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule IV (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Douglas, A. Vibert 1894–1988

Canadian astronomer

To every investigator there come moments when his thought is baffled, when the limits of experimental possibility seem to have been reached and he faces a barrier which defies his curiosity. Then it is that imagination, like a glorious greyhound, comes bounding along, leaps the barrier, and a vision is flashed before the mind — a vision no doubt that is partly false, but a vision that may be partly true. It stirs up new ideas in the thoughts of the



investigator, it fires him with a fresh enthusiasm and his curiosity spurs him on to further endeavors.

From *Atoms to Stars*

*The Atlantic Monthly*, Volume 144, August 1929 (p. 158)

**Einstein, Albert** 1879–1955

German-born physicist

The important thing is not to stop questioning. Curiosity has its own reason for existence. One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries merely to comprehend a little of this mystery each day. Never lose a holy curiosity.

Old Man's Advice to Youth: "Never Lose a Holy Curiosity"

*Life*, May 2, 1955 (p. 64)

It is, in fact, nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of inquiry; for this delicate little plant, aside from stimulation, stands mainly in need of freedom; without this the plant goes to wreck and ruin without fail.

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 17)

Open Court. La Salle, Illinois, USA. 1979

**Feynman, Richard P.** 1918–88

American theoretical physicist

...I stand at the seashore, alone, and start to think: There are the rushing waves...mountains of molecules each stupidly minding its own business...trillions apart...yet forming white surf in unison.

Ages on ages...before any eyes could see...year after year...thunderously pounding the shore as now. For whom, for what? ...On a dead planet with no life to entertain.

Never at rest tortured by energy...wasted prodigiously by the sun...poured into space. A mite makes the sea roar.

Deep in the sea, all molecules repeat the patterns of one another till complex new ones are formed. They make others like themselves...and a new dance starts.

Growing in size and complexity...living things, masses of atoms, DNA, protein...dancing a pattern ever more intricate.

Out of the cradle, onto dry land...here it is standing...atoms with consciousness...matter with curiosity.

Stands at the sea...wonders at wondering...I...a universe of atoms...an atom in the universe.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 6 (p. 144)

Perseus Books. Cambridge, Massachusetts, USA. 1999

**Frisch, Otto** 1904–79

Austrian-born English physicist

...I think scientists have one thing in common with children: curiosity. To be a good scientist you must have kept this trait of childhood, and perhaps it is not easy to keep just this one trait. A scientist has to be curious like a child; perhaps one can understand that there are other childish features he hasn't grown out of.

*What Little I Remember*

Denmark 1934–1939: I (p. 86)

Cambridge University Press. Cambridge, England. 1979

**Gamow, George** 1904–68

Russian-born American physicist

They say "curiosity kills the cat"; I say "Curiosity makes a scientist."

*Mr. Tompkins in Paperback*

Chapter 15 (p. 186)

At The University Press. Cambridge, England. 1965

**Haber, Heinz** 1913–90

German physicist

The curiosity of man must forever find its greatest challenge in the magnificent riddle of the universe.

*Stars, Men and Atoms*

Chapter 11 (p. 188)

Golden Press. New York, New York, USA. 1962

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...the laws of nature are not only permanent, but consistent, intelligible, and discoverable with such a moderate degree of research, as is calculated rather to stimulate than to weary curiosity.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter III, Section 33 (pp. 42–43)

Printed for Longman, Rees, Orme, Brown & Green. London, England.

1831

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

He that enlarges his curiosity after the works of nature, demonstrably multiplies the inlets to happiness.

*The Rambler* (Volume 1)

No. 5, April 3, 1750 (p. 75)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Lauden, Larry** 1945–

American philosopher of science

If a sound justification for most scientific activity is going to be found, it will eventually come perhaps from a recognition that man's sense of curiosity about the world and himself is every bit as compelling as his need for clothing and food.... Making sense of the world and one's place in that world has roots deep within the human psyche.... We can drop the dangerous pretense that science is legitimate only in so far as it contributes to our material well-being or to our store of perennial truths.

Viewed in this light, the repudiation of theoretical scientific inquiry is tantamount to a denial of what may be our most characteristically human trait.

*Progress and Its Problems: Toward a Theory of Scientific Growth*  
Epilogue (p. 225)  
University of California Press. Berkeley, California, USA. 1977

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The value the world sets upon [scientists'] motives is often grossly unjust and inaccurate. Consider, for example, two of them: mere insatiable curiosity and the desire to do good. The latter is put high above the former, and yet it is the former that moves some of the greater men the human race has yet produced: the scientific investigators. What actually urges him on is not some brummagem idea of Service, but a boundless, almost pathological thirst to penetrate the unknown, to uncover the secret, to find out what has not been found out before. His prototype is not the liberator releasing slaves, the good Samaritan lifting up the fallen, but a dog sniffing tremendously at an infinite series of rat-holes.

*Prejudices: Third Series*  
Chapter XIV, Section 6 (pp. 269–270)  
Alfred A. Knopf. New York, New York, USA. 1922

**Newman, Paul** 1925–

American actor

I'm depending upon his curiosity. It's a pretty strong instinct among most people, but among scientists it's a bloody obsession.

*Torn Curtain*  
Film (1966)

**Pittendreigh, Jr., W. Maynard**

No biographical data available

I burn with curiosity about what lies beyond the sky.

Pittendreigh's Law of Planetary Motion  
*Sky & Telescope*, Volume 87, Number 2, February 1994 (p. 6)

**Professor Barnhardt**

Fictional character

It isn't faith that makes good science Mr. Klaatu, it's curiosity.

*The Day the Earth Stood Still*  
Film (1951)

**Selye, Hans** 1907–82

Austrian endocrinologist

Scientific curiosity can be satisfied much more easily by reading the publications of others than by working in the lab. It may take years to prove by experimentation what we can learn in the few minutes needed to read the published end result. So let us not fool ourselves; the driving force is hardly sheer curiosity.

*From Dream to Discovery: On Being a Scientist*  
Chapter 1 (p. 15)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

The true scientist thrives on curiosity...

*From Dream to Discovery: On Being a Scientist*  
Chapter 1 (p. 10)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The desire of knowledge is first stimulated in us when remarkable phenomena attract our attention. In order that this attention be continued it is necessary that we should feel some interest in exercising it, and thus by degrees we become better acquainted with the object of our curiosity.

Translated by Charles Lock Eastlake  
*Goethe's Theory of Colours*  
Introduction (p. li)  
The MIT Press. Cambridge, Massachusetts, USA. 1970

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

Curiosity without compassion is inhuman; compassion without curiosity is ineffectual.

*The Development of Science during this Century*  
Talk presented at the Conference on Disarmament and Arms Limitation Obligations: Problems of Compliance and Enforcement, Geneva, Switzerland, 5–6 Aug. 1993

Science is an important part of the humanities because it is based on an essential human trait: curiosity about how and why of our environment. We must foster wonder, joy of insight.

*The Privilege of Being a Physicist*  
Chapter 4 (p. 33)  
W.H. Freeman & Company. New York, New York, USA. 1989

**Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

...the valuable attributes of research men are conscious ignorance and active curiosity.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry  
*Science*, Volume 65, Number 1862, March 25, 1927 (p. 285)

**Wright, Helen**

No biographical data available

The curiosity of Alice to see what lives behind the looking glass may be likened to the desire of the astronomer to see beyond the range of his vision. By each addition to the light-gathering power of his instrument he soon yearns for a glimpse of things farther away and plans for a larger telescope.

*Palomar: The World's Largest Telescope*  
A 200 Inch Mirror (p. 91)  
The Macmillan Company. New York, New York, USA. 1952

**CURVE**

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

...I shall have given here a sufficient introduction to the study of curves when I have given a general method of drawing a straight line making right angles with a curve at an arbitrarily chosen point upon it. And I dare say that this is not only the most useful and most general problem in geometry that I know, but even that I have ever desired to know. In *Great Books of the Western World* (Volume 31)

*Geometry*

Second Book (p. 317)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Johnson, George** 1952–  
American science writer

A theory can be thought of as the fitting of a curve to a spray of data. One can always simply go from point to point, connecting the dots like those of a child's coloring book. But all that is left is a meandering line with little explanatory power; there is no way to predict how future points are likely to fall. Science is the search for neat, predictable curves, compact ways of summarizing the data. But there is always the danger that the curves we see are illusory, like pictures of animals in clouds.

*Fire in the Mind: Science, Faith, and the Search for Order*

Introduction (p. 4)

Vintage Books. New York, New York, USA. 1995

**Kasner, Edward** 1878–1955  
American mathematician

**Newman, James Roy** 1911–66  
Mathematician and mathematical historian

The curves treated by the calculus are normal and healthy; they possess no idiosyncrasies. But mathematicians would not be happy merely with simple, lusty configurations. Beyond these their curiosity extends to psychopathic patients, each of whom has an individual case history resembling no other; these are the pathological curves in mathematics.

*Mathematics and the Imagination*

Chance and Chanceability — The Calculus (p. 343)

Simon & Schuster. New York, New York, USA. 1940

**Klein, Felix** 1849–1925  
German mathematician

Everyone knows what a curve is, until he has studied enough mathematics to become confused through the countless number of possible exceptions.

In Carl B. Boyer

The Invention of Analytic Geometry

*Scientific American*, Volume 180, Number 1, January 1949 (p. 41)

**West, Mae** 1893–1980  
American film actress

A figure with curves always offers a lot of interesting angles.

*The Wit and Wisdom of Mae West* (p. 35)

G.P. Putnam's Sons. New York, New York, USA. 1967

**CYNIC**

**Huxley, Thomas Henry** 1825–95  
English biologist

I wish not to be in any way confounded with the cynics who delight in degrading man, or with the common run of materialists, who think mind is any the lower for being a function of matter. I dislike them even more than I do the pietists.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XVI

Letter to Hooker, January 6, 1861 (p. 241)

D. Appleton & Company. New York, New York, USA. 1901

No biographical data available

My butterfly-net and pocket magnifying-glass are rare companions for a walk in the country.

*Sharp Eyes: A Rambler's Calendar*

The Sweep-Nest Harvest

July 21<sup>st</sup> (p. 117)

Harper & Brothers Publishers. New York, New York, USA. 1900

## D

### DARK ENERGY

#### **Kirshner, Robert P.**

American astronomer

We are not made of the type of particles that make up most of the matter in the universe, and we have no idea yet how to sense directly the dark energy that determines the fate of the universe.

In John Noble Wilford

From Distant Galaxies, News of a “Stop-and-Go Universe”  
*New York Times*, June 3, 2003

### DARK MATTER

#### **Belkora, Leila**

No biographical data available

Considering that more than 90% of the universe consists of unknown dark matter, we may have to admit that the stellar system we have studied so long, and with so much success since the middle of the twentieth century, may add up to only a tiny part of the galaxy — as though we had been studying the foam on a breaking wave, and thought we understood the ocean.

*Minding the Heavens: The Story of Our Discovery of the Milky Way*  
Chapter 10 (p. 369)

Institute of Physics Publishing, Bristol, England. 2003

#### **Browning, Robert** 1812–89

English poet

Greet the unseen with a cheer!

*The Poems and Plays of Robert Browning*

Asolando

Epilogue

The Modern Library, New York, New York, USA. 1934

#### **de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

What is most essential is invisible to the eye.

Translated by Katherine Woods

*The Little Prince*

Chapter XXI (p. 70)

Harcourt, Brace & Company, New York, New York, USA. 1943

#### **Herschel, Friedrich Wilhelm** 1738–1822

English astronomer

*Hier ist wahrhaftig ein Loch im Himmel!*

Here, truly, is a hole in the heavens!

In Hector Macpherson

*A Century's Progress in Astronomy*

Chapter II (p. 32)

William Blackwood & Sons, Edinburgh, Scotland. 1909

#### **Milgrom, Mordehai**

Israeli physicist

If we accept a departure from the standard laws of physics, we might do away with dark matter.

Does Dark Matter Really Exist?

*Scientific American*, Volume 287, Number 2, August 2002. (p. 44)

#### **Riordan, Michael**

No biographical data available

#### **Schramm, David N.**

No biographical data available

Modern science is based on observation and measurement, and cosmology is no exception. The mysteries of dark matter and the structure of the universe will resolve not just by thinking and calculating, but also by watching and probing.

*The Shadows of Creation*

Chapter 11 (p. 255)

H.W. Freeman & Company, New York, New York, USA. 1991

### DARKNESS

#### **Morley, Christopher** 1890–1957

American writer

Of all gifts to earth, the first and greatest was darkness. Darkness preceded light, you will remember, in Genesis. Perhaps that is why darkness seems to man natural and universal. It requires no explanation and no cause. We postulate it. Whereas light, being to our minds merely the cleansing vibration that dispels the black, requires some origin, some lamp whence to shine. From the appalling torch of the sun down to the pale belly of the glowworm we deem light a derivative miracle, proceeding from some conceivable source. We can conceive darkness without thought of light; but we cannot conceive light without darkness.

*Travels in Philadelphia*

Darkness Visible (p.108)

Wm. F. Fell Company, Philadelphia, Pennsylvania, USA. 1920

### DARWINISM

#### **Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

It is almost as if the human brain were specifically designed to misunderstand Darwinism, and to find it hard to believe.

*The Blind Watchmaker*

Preface (p. xi)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

We cannot preserve all the features of the cultural world in which these treasures flourished. We wouldn't want to.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 514)  
Simon & Schuster. New York, New York, USA. 1995

The kindly God who lovingly fashioned each and every one of us (all creatures great and small) and sprinkled the sky with shining stars for our delight — that God is, like Santa Claus, a myth of childhood, not anything a sane, undeluded adult could literally believe in. That God must either be turned into a symbol for something less concrete or abandoned altogether.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 18)  
Simon & Schuster. New York, New York, USA. 1995

Save the Baptists! Yes, of course, but not by all means. Not if it means tolerating the deliberate misinforming of children about the natural world. According to a recent poll, 48 percent of the people in the United States today believe that the book of Genesis is literally true. And 70 percent believe that “creation science” should be taught in school alongside evolution. Some recent writers recommend a policy in which parents would be able to “opt out” of materials they didn’t want their children taught. Should evolution be taught in the schools? Should arithmetic be taught? Should history? Misinforming a child is a terrible offense.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 516)  
Simon & Schuster. New York, New York, USA. 1995

Do you believe, literally, in an anthropomorphic God? If not, then you must agree with me that the song is a beautiful, comforting falsehood. Is that simple song nevertheless a valuable meme? I certainly think it is. It is a modest but beautiful part of our heritage, a treasure to be preserved. But we must face the fact that, just as there were times when tigers would not have been viable, times are coming when they will no longer be viable, except in zoos and other preserves, and the same is true of many of the treasures in our cultural heritage.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 514)  
Simon & Schuster. New York, New York, USA. 1995

The message is clear: those who will not accommodate, who will not temper, who insist on keeping only the purest and wildest strain of their heritage alive, we will be obliged, reluctantly, to cage or disarm, and we will do our best to disable the memes they fight for.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 516)  
Simon & Schuster. New York, New York, USA. 1995

Let me lay my cards on the table. If I were to give an award for the single best idea anyone ever had, I’d give it to Darwin, ahead of even Newton or Einstein and everyone else. In a single stroke, the idea of evolution by natural selection unifies the realm of life, meaning and

purpose with the realm of space and time, cause and effect, mechanism and physical law.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 21)  
Simon & Schuster. New York, New York, USA. 1995

But hasn’t there been a tremendous rebirth of fundamentalist faith in all these creeds? Yes, unfortunately, there has been, and I think that there are no forces on this planet more dangerous to us all than the fanaticisms of fundamentalism, of all the species: Protestantism, Catholicism, Judaism, Islam, Hinduism, and Buddhism, as well as countless smaller infections. Is there a conflict between science and religion here? There most certainly is.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 515)  
Simon & Schuster. New York, New York, USA. 1995

Almost no one is indifferent to Darwin, and no one should be. The Darwinian theory is a scientific theory, and a great one, but that is not all it is. The creationists who oppose it so bitterly are right about one thing: Darwin’s dangerous idea cuts much deeper into the fabric of our most fundamental beliefs than many of its sophisticated apologists have yet admitted, even to themselves.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 18)  
Simon & Schuster. New York, New York, USA. 1995

I know, I know, the lion is beautiful but dangerous; if you let the lion roam free, it would kill me; safety demands that it be put in a cage. Safety demands that religions be put in cages, too — when absolutely necessary.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 515)  
Simon & Schuster. New York, New York, USA. 1995

If you insist on teaching your children falsehoods — that the Earth is flat, that “Man” is not a product of evolution by natural selection — then you must expect, at the very least, that those of us who have freedom of speech will feel free to describe your teaching as the spreading of falsehoods, and will attempt to demonstrate this to your children at our earliest opportunity. Our future well-being — the well-being of all of us on the planet — depends on the education of our descendants.

*Darwin's Dangerous Idea*

Chapter Eighteen, Section 1 (p. 519)  
Simon & Schuster. New York, New York, USA. 1995

**Jones, F. Wood** 1879–1954

English naturalist and anthropologist

Only a fool could deny the revolutionary impact of Darwinism on the outlook of the nineteenth century, when — as one biologist put it — the educated public was faced with the alternative “for Darwin or against evolution.” But the narrow sectarianism of the neo-Darwinists of our own age is an altogether different matter; and in the not-

too-distant future biologists may well wonder what kind of benightedness it was that held their elders in thrall.

In Arthur Koestler

*Janus: A Summing Up*

Chapter X, Section 5 (p. 204)

Random House, Inc. New York, New York, USA. 1978

### **Kitcher, Philip**

No biographical data available

Darwin is the Newton of Biology.

*Abusing Science: The Case Against Creationism*

Chapter 2 Believing What We Cannot Prove (p. 54)

The MIT Press. Cambridge, Massachusetts, USA. 1982

### **McKibben, Bill** 1960–

American freelance writer

“Science,” of course, replaced “God” as a guiding concept for many people after Darwin. Or, really, the two were rolled up into a sticky ball. To some degree this was mindless worship of a miracle future, the pursuit of which has landed us in the fix we now inhabit.

*The End of Nature*

The End of Nature (pp. 80–81)

Random House, Inc. New York, New York, USA. 1989

### **Newman, Joseph S.** 1892–1960

American poet

What countless procreative mates  
Brought plasmic cells to vertebrates  
And blazed the long ancestral trails  
That substituted brains for tails!  
For when the human kind began

It did not spring full-blown to man;

It started from the very seed

That branched to snail and centipede,

And which, by devious ways Darwinian,

Made oyster, lobster, and Virginian.

*Poems for Penguins and Other Lyrical Lapses*

Anthropology

Greenburg. New York, New York, USA. 1941

### **Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

...as compared to the open-eyed intelligent wanting and trying of Lamarck, the Darwinian process may be described as a chapter of accidents. As such, it seems simple, because you do not at first realise all that it involves. But when its whole significance dawns on you, your heart sinks into a heap of sand within you. There is a hideous fatalism about it, a ghastly and damnable reduction of beauty and intelligence, of strength and purpose, of honour and aspirations, to such casually picturesque changes as an avalanche may make in a mountain landscape, or a railway accident in a human figure.

*Back to Methuselah*

Preface (p. xl)

Constable & Company Ltd. London, England. 1921

## **DATA**

### **Berkeley, Edmund C.** 1909–88

American computer theoretician

There is no substitute for honest, thorough, scientific effort to get correct data (no matter how much of it clashes with preconceived ideas). There is no substitute for actually reaching a correct claim of reasoning. Poor data and good reasoning give poor results. Good data and poor reasoning give poor results. Poor data and poor reasoning give rotten results.

Right Answers — A Short Guide for Obtaining Them

*Computers and Automation*, Volume 18, Number 10, September 1969 (p. 20)

Lots of people bring you false information.

Right Answers — A Short Guide for Obtaining Them

*Computers and Automation*, Volume 18, Number 10, September 1969 (p. 20)

### **Binford, Lewis R.** 1930–

American archaeologist

...data relevant to most, if not all, of the components of past sociocultural systems are preserved in the archaeological record.... Our task, then, is to devise means for extracting this information from the data.

*An Archaeological Perspective*

Archaeological Perspectives (p. 95)

Seminar Press. New York, New York, USA. 1972

### **Captain Kirk**

Fictional character

Insufficient data is not sufficient, Mr. Spock. You're the Science Officer, you're supposed to have sufficient data all the time.

*STAR TREK: The Original Series*

The Immunity Syndrome

Television program

Season 2, 1968

### **Chatfield, Christopher**

English statistician

More fundamentally students should be taught that instead of asking “What techniques shall I use here?,” they should ask “How can I summarize and understand the main features of this set of data?”

The Initial Examination of Data

*Journal of the Royal Statistical Society, Series A*, Volume 148, 1985

### **Childe, V. Gordon** 1892–1957

Australian-English archaeologist

All archaeological data are expressions of human thoughts and purposes and are valued only as revelations thereof.

*A Short Introduction to Archaeology*

Chapter One (p. 11)

Frederick Muller LTD. London, England. 1956

**Cousins, Norman** 1912–90

American editor and author

There is a tendency to mistake data for wisdom, just as there has always been a tendency to confuse logic with values, intelligence with insight. Unobstructed access to facts can produce unlimited good only if it is matched by the desire and ability to find out what they mean and where they lead. Facts are terrible things if left sprawling and unattended. They are too easily regarded as evaluated certainties rather than as the rawest of raw materials crying to be processed into the texture of logic.

*Human Options: An Autobiographical Notebook*

Freedom as Teacher (p. 104)

W.W. Norton & Company, Inc. New York, New York, USA. 1981

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

There is only one kind of whiskey, but two broad classes of data, good and bad.

On the Classification of Statistics

*The American Statistician*, Volume 2, Number 2, April 1948 (p. 16)

Scientific data are not taken for museum purposes; they are taken as a basis for doing something. If nothing is to be done with the data, then there is no use in collecting any. The ultimate purpose of taking data is to provide a basis for action or a recommendation for action. The step intermediate between the collection of data and the action is prediction.

On a Classification of the Problems of Statistical Inference

*Journal of the American Statistical Association*, Volume 37, Number 218, June 1942 (p. 173)

Anyone can easily misuse good data.

*Some Theory of Sampling* (p. 18)

John Wiley & Sons, Inc. New York, New York, USA. 1950

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“No data yet,” he answered. “It is a capital mistake to theorize before you have all of the evidence. It biases the judgment.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 3 (p. 166)

Wings Books. New York, New York, USA. 1967

Still, it is an error to argue in front of your data. You find yourself insensibly twisting them around to fit your theories.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of Wisteria Lodge (p. 246)

Wings Books. New York, New York, USA. 1967

“Data! Data! Data!” he cried impatiently. “I can’t make bricks without clay.”

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of the Copper Beeches (p. 120)

Wings Books. New York, New York, USA. 1967

I have no data yet. It is a capital mistake to theorize before one has data. Insensibly, one begins to twist facts to suit theories, instead of theories to suit facts.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Scandal in Bohemia (pp. 349–350)

Wings Books. New York, New York, USA. 1967

**Ehrenberg, A. S. C.**

No biographical data available

Data are often presented in a form that is not immediately clear. The reader can then either ignore the data, analyze them himself, or return them to the author for him to analyze.

*Data Reduction*

Part I (p. 1)

John Wiley & Sons Ltd. London, England. 1975

**Enarson, Harold L.** 1819–2006

American educator

It does not follow that because something can be counted it therefore should be counted.

Speech

To Society for College & University Planning, September 1975

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

No human mind is capable of grasping in its entirety the meaning of any considerable quantity of numerical data.

*Statistical Methods for Research Workers*

Chapter I (p. 6)

Oliver & Boyd. Edinburgh, Scotland. 1938

**Fort, Charles** 1874–1932

American writer

The interpretations will be mine, but the data will be for anybody to form his own opinions on.

In Damon Knight

*Charles Fort: Prophet of the Unexplained*

A Charles Fort Sampler (p. vii)

Gollancz. London, England. 1971

**Fox, Russell**

No biographical data available

**Gorbunov, Max**

No biographical data available

It has been said that data collection is like garbage collection: before you collect it you should have in mind what you are going to do with it.

*The Science of Science: Methods of Interpreting Physical Phenomena*

Chapter 6 (p. 51)

Walker. New York, New York, USA. 1964

**Freeman, R. Austin** 1862–1943  
British physician and mystery novelist

I can only suggest that, as we are practically without data, we should endeavor to obtain some.

*A Certain Dr. Thorndyke*  
Thorndyke Takes Up the Inquiry (p. 186)  
Dodd, Mead & Company. New York, New York, USA. 1928

**Greenstein, George** 1940–  
American astronomer

Data in isolation are meaningless, a collection of numbers. Only in context of a theory do they assume significance...

*Frozen Star*  
Chapter 1 (pp. 3–4)  
Freundlich Books. New York, New York, USA. 1983

**Hodnett, Edward** 1901–84  
Illustration historian

When you learn how to mobilize your data and bring them to bear on your problems, you are no longer a rank amateur.

*The Art of Problem Solving*  
Part I, Chapter 6 (p. 42)  
Harper & Brothers. New York, New York, USA. 1955

**Hooke, Robert** 1635–1703  
English physicist

If you can't have an experiment, do the best you can with whatever data you can gather, but do be very skeptical of historical data and subject them to all the logical tests you can think of.

In J.M. Tanur  
*Statistics: A Guide to the Unknown*  
Statistics, Sports, and Some Other Things (p. 195)  
Wadsworth & Brooks. Pacific Grove, California, USA. 1989

**Hoyle, Sir Fred** 1915–2001  
English mathematician, astronomer, and writer

To the optical astronomer, radio data serves like a good dog on a hunt.

*Galaxies, Nuclei and Quasars* (p. 43)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Inose, Hiroshi**  
No biographical data available

**Pierce, J. R.**  
No biographical data available

Where is the information we have lost in data?

*Information Technology and Civilization*  
Chapter 7–4 (p. 210)  
W.H. Freeman. New York, New York, USA. 1984

**James, William** 1842–1910  
American philosopher and psychologist

The ignoring of data is, in fact, the easiest and most popular mode of obtaining unity in one's thought.

*The Sentiment of Rationality*  
*Mind*, Series 1, Volume 4, 1879 (p. 320)

**Jennings, Herbert Spencer** 1868–1947  
American zoologist

...the biologist has a more intimate access [than other scientists] to a certain sample of his material, for he is himself that sample. Through this fact he discovers certain things about the materials of biological science that he cannot discover by the other method [hypothesizing] alone...he finds that the thing to be studied by the biologist include[s] emotions, sensations, impulses, desires.... Thus the biologist has two sets of data, discovered in somewhat different ways, one set being discoverable only through the fact that the biologist is himself a biological specimen.

*The Universe and Life*  
Chapter I (pp. 9, 10)  
Yale University Press. New Haven, Connecticut, USA. 1941

**Katsaros, Kristina**  
Ocean and atmosphere researcher

Sometimes there are heated arguments at meetings about how to interpret data. When you have very few facts, fully interpreting them can give rise to three or four interpretations — within the error bars, the uncertainties in the measurements. You get people adhering to one or the other interpretation for a while, and that's not based on fact because there are not enough facts. Eventually more facts are gathered and it becomes clear what the answer is, and everybody agrees. In the end you have a new result. That's the wonderful thing about science, that you can only find in science. There is a point when there is no doubt anymore. There is usually a lot of emotional stress before you get rid of some former idea. There may be a few crackpots who fight it, but if the evidence is good, eventually all accept it. I think that's wonderful. One of the best things about science is that there are some objective answers.

In Linda Jean Shepherd  
*Lifting the Veil: The Feminine Face of Science*  
Receptivity (pp. 99–100)  
Shambhala. Boston, Massachusetts, USA. 1993

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

Without the hard little bits of marble which are called "facts" or "data" one cannot compose a mosaic; what matters, however, are not so much the individual bits, but the successive patterns into which you arrange them, then break them up and rearrange them.

*The Act of Creation*  
Book One, Part Two, Chapter X (p. 235)  
The Macmillan Company. New York, New York, USA. 1964



**Krumbein, W. C.**

No biographical data available

...numerous samples collected without a clear idea of what is to be done with the data are commonly less useful than a moderate number of samples collected in accordance with a specific design.

In B. Kummel and D. Raup (eds.)

*Handbook of Paleontological Techniques*

Sampling in Paleontology (p. 147)

W.H. Freeman. San Francisco, California, USA. 1965

**Lowell, Percival** 1855–1916

American astronomer

All deduction rests ultimately upon the data derived from experience. This is the tortoise that supports our conception of the cosmos.

*Mars*

Chapter I (p. 6)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Margenau, Henry** 1901–97

German-born American physicist

Data have an ephemerality, a rhapsodic spontaneity, a nakedness so utterly at variance with the orderly instincts that pervade our being and with the given unity of our own experience as to be unfit for use in the building of reality. The constructs, on the other hand, are foot-loose, subjective, and altogether too fertile with logical implications to serve in their indiscriminate totality as material for the real world. They do, however, contain the solid logical substance which a stable reality must contain.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 21 (pp. 448–449)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Mellor, J. W.**

Chemist

By no process of sound reasoning can a conclusion drawn from limited data have more than a limited application.

*Higher Mathematics for Students of Chemistry and Physics* (p. 4)

Dover Publications. New York, New York, USA. 1955

**Morris, Henry** 1918–2006

American creationist

The data must be explained by the evolutionist, but they are predicted by the creationist.

*Scientific Creationism*

Chapter I (p. 13)

Creation-Life Publishers. San Diego, California, USA. 1974

**Pirsig, Robert M.** 1928–

American writer

Data without generalization is just gossip.

*Lila: An Inquiry into Morals*

Chapter 9 (p. 55)

Bantam Books. New York, New York, USA. 1991

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

When a man of science speaks of his “data,” he knows very well in practice what he means. Certain experiments have been conducted, and have yielded certain observed results, which have been recorded. But when we try to define a “datum” theoretically, the task is not altogether easy. A datum, obviously, must be a fact known by perception. But it is very difficult to arrive at a fact in which there is no element of inference, and yet it would seem improper to call something a “datum” if it involved inferences as well as observation. This constitutes a problem...

*The Analysis of Matter*

Chapter XIX (p. 187)

Harcourt, Brace &amp; Company, Inc. New York, New York, USA. 1927

...there is more difficulty in stating our principle so as to be applicable when our data are confined to a finite part of the universe. Things from outside may always crash in and have unexpected effects.

*Religion and Science*

Determinism (p. 149)

Henry Holt &amp; Company. New York, New York, USA. 1935

**Schramm, David N.** 1945–97

American astrophysicist

**McKee, Christopher F.** 1942–

American astrophysicist

When datataking yields huge archives without understanding, a field goes through intellectual stagnation.

*Astronomy in the Mind and the Lab**Sky and Telescope*, Volume 82, Number 4, October 1991 (p. 352)**Stamp, Josiah** 1880–1941

English economist and financier

The individual source of the statistics may easily be the weakest link. Harold Cox tells a story of his life as a young man in India. He quoted some statistics to a Judge .... His friend said, “Cox, when you are a bit older, you will not quote Indian statistics with that assurance. The Government are very keen on amassing statistics — they collect them, and they raise them to the nth power, take the cube root and prepare wonderful diagrams. But what you must never forget is that everyone of those figures come in the first instance from the *chowty dar* (village watchman), who just puts down what he damn pleases.

*Some Economic Factors in Modern Life*

Chapter VII (p. 258)

P.S. King &amp; Son Ltd. London, England. 1929

**Stigler, Stephen M.** 1941–

American historian and statistician

Beware of the problem of testing too many hypotheses; the more you torture the data, the more likely they are to

confess, but confessions obtained under duress may not be admissible in the court of scientific opinion.

In Matthew H. Niteckl and Antoni Hoffman (eds.)  
*Neutral Models in Biology*  
Testing Hypotheses or Fitting Models? Another Look at Mass Extinctions (p. 148)  
Oxford University Press. New York, New York, USA. 1987

**Stoppard, Tom** 1937–  
Czech-born English playwright

Real data is messy.

*Arcadia*  
Act I, Scene Four (p. 46)  
Faber & Faber Limited. London, England. 1993

**Thurber, James** 1894–1961  
American writer and cartoonist

We have no scientific data whatever on clock-eating and hence no controlled observation.

*Lanterns and Lances*  
The Last Clock (p. 43)  
Time-Life Books, Inc. Alexandria, Virginia, USA. 1980

**Tippett, L. C.**  
No biographical data available

In general, it is necessary to have some data on which to calculate probabilities.... Statisticians do not evolve probabilities out of their inner consciousness, they merely calculate them.

In James R. Newman  
*The World of Mathematics* (Volume 3)  
Sampling and Standard Error (p. 1486)  
Simon & Schuster. New York, New York, USA. 1956

**Veblen, Thorstein** 1857–1929  
Economist, social critic, and author

...the data with which any scientific inquiry has to do are trivialities in some other bearing than that one in which they are of account.

*The Place of Science in Modern Civilisation and Other Essays*  
The Point of View (p. 42)  
The Viking Press, Inc. New York, New York, USA. 1942

**Woodger, Joseph Henry** 1894–1981  
English biologist

We are, therefore, in danger of being overwhelmed by our data and of being unable to deal with the simpler problems first and understand their connection. The continual heaping up of data is worse than useless if interpretation does not keep pace with it. In biology this is all the more deplorable because it leads us to slur over what is characteristically biological in order to reach hypothetical "causes."

*Biological Principles: A Critical Study*  
Part II, Chapter VI, B, 13 (p. 318)  
Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1929

## DATING

**Eldredge, Niles** 1943–  
American paleontologist

And this poses something of a problem: if we date the rocks by their fossils, how can we then turn around and talk about patterns of evolutionary change through time in the fossil record? We need an independent time frame to know that a trilobite in Ohio is roughly the same age as one in New York before we can talk about geographic variation; otherwise, their differences might as well be ascribed to the sort of process of gradual change that Darwin thought was inevitable with the simple passage of time.

*Time Frames: The Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria*  
Chapter 2 (p. 52)  
Simon & Schuster. New York, New York, USA. 1985

## DAWN

**Ackerman, Diane** 1948–  
American writer

We say dawn breaks, as if something were shattering, but what we mean is that waves of light crest over the earth.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*  
Chapter 4 (p. 170)  
Random House, Inc. New York, New York, USA. 1991

## DEATH

**Allen, Durward L.** 1910–87  
Wildlife biologist

Probably most of us are at least vaguely aware of a universal reality in the natural world. All living things are destined to die and be recycled as part of the flow of energy through the life community. Which is to say, a creature must feed, and sooner or later it will be fed upon.

*Wolves of Minong: Their Vital Role in a Wild Community*  
Chapter 6 (p. 113)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1979

**Allman, David**  
American physician

Life is precious to the old person. He is not interested merely in thoughts of yesterday's good life and tomorrow's path to the grave. He does not want his later years to be a sentence of solitary confinement in society. Nor does he want them to be a death watch.

Address to National Conference of Christian and Jews  
The Brotherhood of Healing, 1 February 1958

**Asimov, Isaac** 1920–92  
American author and biochemist

[Death] is an essential part of the successful functioning of life...new organisms cannot perform their role properly unless the old ones are removed from the scene after they have performed their function in producing the new. In short, the death of the individual is essential to the life of the species.

*A Choice of Catastrophes*  
Chapter 12 (p. 239)  
Simon & Schuster. New York, New York, USA. 1979

**Bassler, Thomas J.** 1932–  
American science fiction writer

Two out of every three deaths are premature; they are related to loafer's heart, smoker's lungs and drinker's liver. In James Fixx

*The Complete Book of Running*  
Chapter 1 (p. 4)  
Random House, Inc. New York, New York, USA. 1977

**Bates, Marston** 1906–74  
American zoologist

We think of death from old age as “natural death” and we thus come across the paradox that natural death is uncommon in nature, unnatural.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*  
Chapter 11 (p. 164)  
Random House, Inc. New York, New York, USA. 1960

**Brackenridge, Hugh Henry** 1748–1816  
American author and jurist

When the patient is dead, it was the disease killed him, not the Doctor. Dead men tell no tales.

*Modern Chivalry*  
Part II, Volume I, Chapter X (p. 378)  
American Book Company. New York, New York, USA. 1937

**Browne, Sir Thomas** 1605–82  
English author and physician

Men that looke no further than their outsides, thinke health an appertinance unto life, and quarrell with their constitutions for being sick; but I that have examined the parts of man, and know upon what tender filaments that Fabrik hangs, doe wonder that we are not always so; and considering the thousand dores that lead to death, doe thank my God that we can die but once.

*Religio Medici*  
Part I, Section 44 (p. 57)  
Elliot Stock. London, England. 1883

**Chamfort, Nicolas** 1741–94  
French ironist and maker of maxims

Living is an illness to which sleep provides relief every sixteen hours. It's a palliative. The remedy is death.

*Maximes et Pensées*  
Chapter 2  
A. Silvaire. Paris, France. 1999

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author, playwright

When there is someone in a family who has long been ill, and hopelessly ill, there come terrible moments when all those close to him timidly, secretly, at the bottom of their hearts wish for his death...

*The Portable Chekhov*  
Peasants (p. 296)  
Penguin Books. New York, New York, USA. 1977

**Dawkins, Richard** 1941–  
English ethologist, evolutionary biologist, and popular science writer

...however many ways there may be of being alive, it is certain that there are vastly more ways of being dead, or rather not alive.

*The Blind Watchmaker*  
Chapter 1 (p. 9)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Fechner, Gustav** 1801–87  
German experimental psychologist

[At death] we step into a still more free, quite new empire, that is not detached from the former one, but rather encloses it...

*Life After Death*  
Continued Existence of Ideas (p. 123)  
Pantheon Books, Inc. New York, New York, USA. 1943

**Fielding, Henry** 1707–54  
English novelist, playwright, and barrister

There is nothing more unjust than the vulgar opinion, by which physicians are misrepresented as friends to death. On the contrary, if the number of those who recover by physic could be opposed to that of the martyrs to it, the former would rather exceed the latter. Nay, some are so cautious on this head, that, to avoid a possibility of killing the patient, they abstain from all method of curing, and prescribe nothing but what can neither do good nor harm. I have heard some of these, with great gravity, deliver it as a maxim that Nature should be left to do her own work, while the physician stands by as it were to clap her on the back and encourage her when she doth well.

*The History of Tom Jones: A Foundling* (Volume 1)  
Book II, Chapter 9 (p. 86)  
P.F. Collier & Son Company. New York, New York, USA. 1917

Death, that inexorable judge, had passed sentence on him, and refused to grant him a reprieve, though two doctors who arrived, and were fee'd at one and the same instant, were his counsel.

*The History of Tom Jones: A Foundling* (Volume 1)  
Book II, Chapter 9 (p. 85)  
P.F. Collier & Son Company. New York, New York, USA. 1917

**Fuller, Thomas** 1608–61  
English clergyman and author

[The physician]...when he can keep life no longer in, he makes a fair and easy passage for it to go out.

In Harvey Cushing  
*The Life of Sir William Osler* (Volume 2) (p. 299)  
Clarendon Press. Oxford, England. 1925

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

For life and death are one, even as the river and the sea are one.

*The Prophet*  
Death (p. 87)  
Alfred A. Knopf. New York, New York, USA. 1969

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Old age leaps upon [the nose] as his saddle, and rides triumphant, unchallenged, until the darkness comes which no glasses can penetrate. Nature is pitiless in carrying out the universal sentence, but very pitiful in her mode of dealing with the condemned on his way to the final scene.

*Over the Teacups*  
Chapter XII (p. 295)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Lewis, C. S. (Clive Staples)** 1898–1963  
British author, scholar, and popular theologian

How much better for us if all humans died in costly nursing homes amid doctors who lie, nurses who lie, friends who lie...

*The Screwtape Letters*  
Chapter V (p. 32)  
Geoffrey Bles. London, England. 1942

**Lincoln, Abraham** 1809–65  
16<sup>th</sup> president of the United States

...we here highly resolved that these dead shall not have died in vain.

*Gettysburg Address*

**Lovelock, James Ephraim** 1919–  
English scientist

...the unending death-roll of all creatures, including ourselves, is the essential complement to the unceasing renewal of life.

*Gaia: A New Look at Life on Earth*  
Chapter 8 (p. 117)  
Oxford University Press, Inc. Oxford, England. 2000

**Mann, Thomas** 1875–1955  
German-born American novelist

A man's dying is more the survivor's affair than his own.

*The Magic Mountain*  
Chapter VI  
Alfred A. Knopf. New York, New York, USA. 1966

**McCullers, Carson** 1917–67  
American writer

Death is always the same, but each man dies in his own way.

*Clock Without Hands*  
Chapter 1 (p. 1)  
Houghton Mifflin & Company. New York, New York, USA. 1961

**Muir, John** 1838–1914  
American naturalist

Leaves have their time to fall, and though indeed there is a kind of melancholy present when they, withered and dead, are plucked from their places and made the sport of the gloomy autumn wind, yet we hardly deplore their fate, because there is nothing unnatural in it. They have done all that their Creator wished them to do, and they should not remain longer in their green vigor.

In Sally M. Miller (ed.)  
*John Muir: Life and Work*  
Part I, Chapter 1 (p. 28)  
University of New Mexico Press. Albuquerque, New Mexico, USA. 1993

**Nashe, Thomas**  
No biographical data available

Adieu! farewell earth's bliss!

This world uncertain is:  
Fond are life's lustful joys,  
Death proves them all but toys.  
None from his darts can fly:

I am sick, I must die —  
Lord, have mercy on us!

In Robert Coope  
*The Quiet Art* (p. 155)  
E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

We speak of death as the King of Terrors, yet how rarely does the act of dying appear to be painful, how rarely do we witness AGONY in the last few hours. Strict, indeed, is the fell sergeant in his arrest, but few feel the iron grip; the hard process of nature's law is for the most of us mercifully effected, and death, like birth, is "but a sleep and a forgetting."

In Harvey Cushing  
*The Life of Sir William Osler* (Volume 1)  
Captor XII (p. 294)  
Clarendon Press. Oxford, England. 1925

**Pope, Alexander** 1688–1744  
English poet

But just disease to luxury succeeds,  
 And ev'ry death its own avenger breeds.  
*The Complete Poetical Works* (Volume 3)  
 Essay on Man, Epis. Iii, l. 165–166  
 Houghton Mifflin & Company. New York, New York, USA. 1903

### Proverb, Scottish

Death defies the doctor.  
*A Complete Collection of English Proverbs* (p. 283)  
 Printed for G. Cowie. London, England. 1813

**Rothman, Tony** 1953–  
 American cosmologist

The Graveyard Principle: To be behind one's time is permanent death. To be ahead of one's time may be temporary death. But Confucius say: dead is dead.  
*Instant Physics: From Aristotle to Einstein, and Beyond*  
 Chapter 2 (p. 56)  
 Ballantine Books. New York, New York, USA. 1995

**Rous, Francis**  
 English puritan

Now Death his servant Sickness forth hath sent...  
*Thule; or, Vertues historie*  
 The Second Book, Canto 4 (p. 103)  
 B. Franklin. New York, New York, USA. 1967

**Sakaki, Nanao**  
 Japanese poet

At a department store in Kyoto  
 One of my friends bought a beetle  
 For his son, seven years old.  
 A few hours later  
 The boy brought his dead bug  
 To a hardware store, asking  
 "Change battery please."  
*Break the Mirror*  
 Future Knows (p. 27)  
 North Point Press. San Francisco, California, USA. 1987

**Shakespeare, William** 1564–1616  
 English poet, playwright, and actor

No cataplasm so rare,  
 Collected from all simples that have virtue  
 Under the moon, can save the thing from death.  
*In Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Hamlet, Prince of Denmark  
 Act IV, Scene viii, l. 144–146  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The patient dies while the physician sleeps.  
*The Complete Works of William Shakespeare*  
 The Rape of Lucrece, l. 909  
 Oxford University Press. London, England. 1954

By medicine life may be prolonged, yet death  
 Will seize the doctor too.  
*In Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Cymbeline  
 Act V, Scene v, l. 29–30  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He had rather  
 Groan so in perpetuity, than be cured  
 By the sure physician, death.  
*In Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Cymbeline  
 Act V, Scene iv, l. 4–6  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is silliness to live when to live is torment; and then have  
 we a prescription to die when death is our physician.  
*In Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Othello, The Moor of Venice  
 Act I, Scene iii, l. 307–309  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Strehler, Bernard** 1925–2001  
 American biochemist and gerontologist

Aging and death do seem to be what Nature has planned  
 for us. But what if we have other plans?  
 In J. Lyon and P. Gorner  
*Altered Fates*  
 Part II (p. 295)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1995

**Teale, Edwin Way** 1899–1980  
 American naturalist

In nature, there is less death and destruction than death  
 and transmutation.  
*Circle of the Seasons*  
 July 5 (p. 143)  
 Dodd, Mead & Company. New York, New York, USA. 1953

**Thomas, Lewis** 1913–93  
 American physician and biologist

We continue to share with our remotest ancestors the  
 most tangled and evasive attitudes about death, despite  
 the great distance we have come in understanding some  
 of the profound aspects of biology. We have as much  
 distaste for talking about personal death as for thinking  
 about it; it is an indelicacy, like talking in mixed com-  
 pany about venereal disease or abortion in the old days.  
*The Lives of a Cell: Notes of a Biology Watcher*  
 The Long Habit (p. 47)  
 The Viking Press. New York, New York, USA. 1974

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

Every part of nature teaches that the passing away of one  
 life is the making room for another. The oak dies down  
 to the ground, leaving within its rind a rich virgin mold,  
 which will impart a vigorous life to an infant forest.  
*Journal* (Volume 1: 1837–1844)

October 24, 1837 (p. 5)  
Princeton University Press. Princeton, New Jersey, USA. 1981

### Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910  
American author and humorist

Whoever has lived long enough to find out what life is, knows how deep a debt of gratitude we owe to Adam, the first great benefactor of our race. He brought death into the world.

*The Tragedy of Pudd'nhead Wilson*  
Chapter III (p. 33)  
New American Library. New York, New York, USA. 1980

### von Goethe, Johann Wolfgang

1749–1832  
German poet, novelist, playwright, and natural philosopher

Death is Nature's expert advice to get plenty of life.

In J. Arthur Thomson  
*The Outline of Science* (Volume 1)  
Chapter VI (p. 200)  
G.P. Putnam's Sons. New York, New York, USA. 1937

### Watts, Alan Wilson

1915–73  
American philosopher

Life and death are not two opposed forces; they are simply two ways of looking at the same force, for the movement of change is as much the builder as the destroyer.

*The Wisdom of Insecurity*  
Chapter III (p. 41)  
Pantheon. New York, New York, USA. 1951

### Wheeler, John Archibald

1911–  
American theoretical physicist and educator

As we make our way into the world of tomorrow, with its endless frontiers and its opportunities for a deeper and richer civilization than ever before, we will meet and overcome many a new risk. But we know that the greatest risk of all is what it always has been — to be born — for then we are sure to die.

*At Home in the Universe*  
Dealing with Risk (p. 221)  
The American Institute of Physics. Woodbury, New York, USA. 1994

## DECAY

### Hutton, James

1726–97  
Scottish geologist, chemist, and naturalist

We are thus led to see a circulation of the matter of this globe, and a system of beautiful economy in the works of nature. This earth, like the body of an animal, is wasted at the same time that it is repaired. It has a state of growth and augmentation; it has another state, which is that of diminution and decay. This world is thus destroyed in one part, but it is renewed in another; and the operations by which this world is thus constantly renewed are as

evident to the scientific eye, as are those in which it is necessarily destroyed.

*The Theory of the Earth* (Volume 2)  
Part II, Chapter XIV (p. 562)  
Messrs. Cadwell, Junior, and Davies. London, England. 1795

...the surface of this land...is made by nature to decay...

*The Theory of the Earth* (Volume 1)  
Part I, Chapter I, Section I (p. 13)  
Messrs. Cadwell, Junior & Davies. London, England. 1795

### Lucretius

ca. 99 BCE–55 BCE  
Roman poet

Again, see you not that even stones are conquered by time, that high towers fall and rocks moulder away, that shrines and idols of gods are worn out with decay, and that the holy divinity cannot prolong the bounds of fate or struggle against the fixed laws of nature? In *Great Books of the Western World* (Volume 12)

*On the Nature of Things*  
Book V, 306 (p. 65)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Tait, Peter Guthrie

1831–1901  
Scottish physicist and mathematician

Everything cosmical must be gradually decaying.

In Alexander Winchell  
*World-Life or Comparative Geology*  
Part II, Chapter IV (p. 451)  
S.C. Griggs & Company. Chicago, Illinois, USA. 1883

### Tennyson, Alfred (Lord)

1809–92  
English poet

The hills are shadows, and they flow  
From form to form and nothing stands;  
They melt like mists the solid lands,  
Like clouds they form themselves and go.

*Alfred Tennyson's Poetical Works*  
In Memoriam A.H.H., Part CXXIII, Stanza II  
Oxford University Press, Inc. London, England. 1953

### Thoreau, Henry David

1817–62  
American essayist, poet, and practical philosopher

How much beauty in decay! I pick up a white oak leaf, dry and stiff, but yet mingled red and green, October-like, whose pulpy part some insect has eaten beneath, exposing the delicate network of its veins. It is very beautiful held up to the light, such work as only an insect eye could perform.... To rebuild the tortoise-shell is a far finer game than any geographical or other puzzle, for the pieces do not merely make part of a plane surface, but you have got to build a roof and a floor and the connecting walls. These are not only thus dovetailed and braced and knitted and bound together, but also held together by the skin and within. It is a band-box.

In Bradford Torrey and Francis H. Allen (eds.)

*The Journal of Henry D. Thoreau* (Volume 7)  
October 18, 1855 (p. 495, 496–497)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1949

## DECIMAL

**Churchill, Lord Randolph** 1849–95  
English politician

...I could never make out what those damned dots meant.

In Winston S. Churchill  
*Lord Randolph Churchill* (Volume 2)  
Chapter XV (p. 184)  
The Macmillan Company. New York, USA. 1906

## DECISION

### British Admiralty

It is necessary for technical reasons that these warheads be stored upside down, that is, with the top at the bottom and the bottom at the top. In order that there may be no doubt as to which is the bottom and which is the top, it will be seen to it that the bottom of each warhead immediately be labeled with the word TOP.

Of Optics and Opticists  
*Applied Optics*, Volume 7, Number 1, January 1968 (p. 19)

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

It may be right to go ahead, I guess:  
It may be right to stop, I do confess;  
Also, it may be right to retrogress.

*The Complete Works of Lewis Carroll*  
The Elections to the Hebdomadad Council (p. 910)  
The Modern Library. New York, New York, USA. 1936

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

Take time to consider. The smallest point may be the most essential.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
The Adventure of the Red Circle (p. 692)  
Wings Books. New York, New York, USA. 1967

**Huxley, Thomas Henry** 1825–95  
English biologist

And when you cannot prove that people are wrong, but only that they are absurd, the best course is to let them alone.

*Collected Essays*  
On the Method of Zadig (p. 13)  
D. Appleton & Company. New York, New York, USA. 1898

**Simon, Herbert Alexander** 1916–2001  
American social scientist

Decisions are something more than factual propositions. To be sure, they are descriptive of a future state of affairs, and this description can be true or false in a strictly empirical sense; but they possess, in addition, an imperative quality — they select one future state of affairs in preference to another and direct behavior toward the chosen alternative. In short, they have an ethical as well as factual content.

*Administrative Behavior: A Study of Decision-Making Processes in Administrative Organization*  
Chapter III (p. 46)  
Free Press. New York, New York, USA. 1965

**Taylor, E. S.**  
American aircraft engine pioneer

...the most important decisions in a design problem must often be made without assistance from higher mathematics.

Report on Engineering Design  
*Journal of Engineering Education*, Volume 51, Number 8, April 1961 (p. 649)

## DEDUCTION

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

...the two operations of our understanding...[are] intuition and deduction, on which alone we have said we must rely in the acquisition of knowledge.

In *Great Books of the Western World* (Volume 31)  
*Rules for the Direction of the Mind*  
Rule IX (p. 14)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Jevons, William Stanley** 1835–82  
English economist and logician

Deduction is certain and infallible, in the sense that each step in deductive reasoning will lead us to some result, as certain as the law itself. But it does not follow that deduction will lead the reasoner to every result of a law or combination of laws.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book IV, Chapter XXIV (p. 534)  
Macmillan & Company Ltd. London, England. 1887

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

...philosophers and logicians since the days of Bacon have been entirely clear on this point: deduction merely makes explicit information that is already there. It is not a procedure by which new information can be brought into being.

*The Limits of Science*  
Chapter 3 (p. 80)  
Harper & Row, Publishers. New York, New York, USA. 1984

**Ritchie, Arthur David** 1891–1967  
Scottish philosopher and science history writer

The question whether any branch of science can ever become purely deductive is easily answered. It cannot. If science deals with the external world, as we believe it does, and not merely with the relations of propositions then no branch of science can ever be purely deductive. Deductive reasoning by itself can never tell us about facts. The use of deduction in science is to serve as a calculus to make our observations go further, not to take the place of observation.

*Scientific Method: An Inquiry into the Character and Validity of Natural Laws*

Chapter I (p. 12)

Kegan Paul, Trench, Trubner & Company., Ltd. London, England. 1923

**Whewell, William** 1794–1866  
English philosopher and historian

These sciences have no principles besides definitions and axioms, and no process of proof but deduction; this process, however, assuming a most remarkable character; and exhibiting a combination of simplicity and complexity, of rigor and generality, quite unparalleled in other subjects.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 1)

Part 1, Book 2, Chapter 1, Section 2 (p. 83)

John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Mathematical reasoning is deductive in the sense that it is based upon definitions which, as far as the validity of the reasoning is concerned (apart from any existential import) needs only the test of self-consistency. Thus no external verification of definitions is required in mathematics, as long as it is considered merely as mathematics.

*A Treatise on Universal Algebra, with Applications*

Preface (p. vi)

Hafner Publishing Company. New York, New York, USA. 1960

## DEEDS

**Jung, Carl G.** 1875–1961  
Swiss psychologist and psychiatrist

“Deeds” were never invented, they were done; thoughts, on the other hand, are a relatively late discovery of man. First he was moved to deeds by unconscious factors; it was only a long time afterward that he began to reflect upon the causes that had moved him; and it took him a very long time indeed to arrive at the preposterous idea that he must have moved himself — his mind being unable to identify any other motivating force than his own.

*Man and His Symbols*

Part I, The Archetype in Dream Symbolism (p. 81)  
Doubleday & Company Inc. Garden City, New York, USA. 1964

**Roosevelt, Theodore** 1858–1919  
26<sup>th</sup> president of the United States

It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.

*Citizenship in a Republic*

Speech at the Sorbonne, 23 April 1910

## DEFINITION

**Anscombe, Francis John** 1918–2001  
English-born American statistician

An observation with an abnormally large residual will be referred to as an outlier. Other terms in English are “wild”, “straggler”, “sport” and “maverick”; one may also speak of a “discordant”, “anomalous” or “aberrant” observation.

Rejection of Outliers

*Technometrics*, Volume 2, 1960

**Arnold, Thurman** 1891–1961  
American lawyer and author

Definition is ordinarily supposed to produce clarity in thinking. It is not generally recognized that the more we define our terms the less descriptive they become and the more difficulty we have in using them.

*The Folklore of Capitalism*

Chapter VII (p. 180)

Yale University Press. New Haven, Connecticut, USA. 1937

**Bornstein, Kate** 1948–  
American author

Definitions have their uses in much the same way that road signs make it easy to travel: they point out the directions. But you don’t get where you’re going when you just stand underneath some sign, waiting for it to tell you what to do.

*Gender Outlaw: On Men, Women, and the Rest of Us* (p. 21)

Vintage Books. New York, New York, USA. 1994

**Boutroux, Émile** 1845–1921  
French philosopher



There can be nothing clearer or more convenient for the purpose of setting one's ideas in order and for conducting an abstract discussion, than precise definitions and inviolable lines of demarcation.

*Science & Religion in Contemporary Philosophy*  
Chapter I (p. 39)  
Duckworth & Company, London, England. 1909

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

The beginner has in his head a definition of the science; a childish definition, perhaps, but still a definition; on the science's subject-matter he has no definition at all.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*  
Part I, Chapter I, aphorism I.43 (p. 3)  
At The Clarendon Press, Oxford, England. 1942

**Davy, Sir Humphry** 1778–1829  
English chemist

There is nothing more difficult than a good definition, for it is scarcely possible to express, in a few words, the abstracted view of an infinite variety of facts.

*Consolations in Travel, or the Last Days of a Philosopher*  
Dialogue V (p. 247)  
J. Murray, London, England. 1830

**de Morgan, Augustus** 1806–71  
English mathematician and logician

...there are terms which cannot be defined, such as number and quantity. Any attempt at a definition would only throw difficulty in the student's way, which is already done in geometry by the attempts at an explanation of the terms point, straight line, and others, which are to be found in treatise on that subject. A point is defined to be that "which has no parts and which has no magnitude"; a straight line is that which "lies evenly between its extreme points...." In this case the explanation is a great deal harder than the term to be explained, which must always happen when we are guilty of the absurdity of attempting to make the simplest ideas yet more simple.

*On the Study and Difficulties of Mathematics*  
Chapter II (pp. 12–13)  
The Open Court Publishing Company, La Salle, Illinois, USA. 1943

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

A chunk is a convenient slice of a population.

*Some Theory of Sampling* (p. 14)  
John Wiley & Sons, Inc. New York, New York, USA. 1950

**Durand, David**  
No biographical data available

Degrees of freedom. The number of fetters on the statistician. The number of d.f. is usually considered self-evident — except for the analysis of data that have not appeared in a textbook.

A Dictionary for Statismagicians  
*The American Statistician*, Volume 24, Number 3, June 1970 (p. 21)

**Einstein, Albert** 1879–1955  
German-born physicist

Every physical concept must be given a definition such that one can in principle describe, in virtue of this definition, whether or not it applies in each particular case.

In Maurice Solovine  
*Letters a Maurice Solovine* (p. 20)  
Gauthier-Villars, Paris, France. 1956

The strangest thing in all this medieval literature is the conviction that if there is a word there must also be a clear meaning behind it, and the only problem is to find out that meaning.

In James T. Cushing, C.F. Delaney and Gary M. Gutting  
*Science and Reality*  
Letter to Rabbi P.D. Bookstaber, August 24, 1951 (p. 108)  
University of Notre Dame Press, Notre Dame, Indiana, USA. 1984

**Fischer, Martin H.** 1879–1962  
German-American physician

When there is no explanation, they give it a name, which immediately explains everything.

In Howard Fabing and Ray Marr  
*Fischerisms* (p. 4)  
C.C. Thomas, Springfield, Illinois, USA. 1944

**Frege, Friedrich Ludwig Gottlob** 1848–1925  
German logician

One cannot require that everything shall be defined, any more than one can require that a chemist shall decompose every substance.

In Peter Geach and Max Black  
*Translations from the Philosophical Writings of Gottlob Frege*  
On Concept and Object (p. 42)  
Basil Blackwell, Oxford, England. 1952

**Freudenthal, Hans** 1905–80  
Dutch mathematician

Fundamental definitions do not arise at the start but at the end of the exploration, because in order to define a thing you must know what it is and what it is good for.

In A.G. Howson (ed.)  
*Developments in Mathematical Education*  
What Groups Mean in Mathematics and What They Should Mean in Mathematical Education (p. 107)  
At the University Press, Cambridge, England. 1973

**Green, Celia** 1935–  
English philosopher and psychologist

Thinking in words, consciousness is behavior, experiment is measurement.

*The Decline and Fall of Science*  
Aphorisms (p. 172)  
Hamilton, London, England. 1976

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Mathematics is an experimental science, and definitions do not come first but later on.

On Operators in Physical Mathematics, Part 2

*Proceedings of the Royal Society of London*, Series A, Volume 54 (p. 122)

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

...a man that seeketh precise truth, had need to remember what every name he uses stands for; and to place it accordingly; or else he will find himselfe entangled in words, as a bird in lime-twigs; the more he struggles, the more belimed.

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 4 (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huff, Darrell** 1913–2001

American writer

Misinforming people by use of statistical material might be called statistical manipulation; in a word (though not a very good one), statisticalation.

*How to Lie with Statistics*

Chapter 9 (p. 100)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

**Huxley, Aldous** 1894–1963

English writer and critic

In the scientist verbal caution ranks among the highest of virtues. His words must have a one-to-one relationship with some specific class of data or sequence of ideas. By the rules of the scientific game he is forbidden to say more than one thing at a time, to attach more than one meaning to a given word, to stray outside the bounds of logical discourse, or to talk about his private experiences in relation to his work in the domains of public observation and public reasoning...

*Literature and Science*

Chapter 14 (p. 36)

Harper & Row, Publishers. New York, New York, USA. 1963

**Moment, Gairdner B.**

No biographical data available

Any science should define its basic concepts. Yet life is almost as difficult to define as the redness of red.

*General Zoology*

Chapter 3 (p. 23)

Houghton Mifflin Company. New York, New York, USA. 1958

**Moroney, M. J.**

American statistician

The words figure and fictitious both derive from the same Latin root, *ingere*. Beware!

*Facts from Figures*

Scatter (p. 56)

Penguin Books Ltd., Harmondsworth, England. 1951

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

My Design in this Book is not to explain the Properties of Light by Hypotheses, but to propose and prove by Reason and Experiments: In order to which I shall premise the following Definitions and Axioms.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book One, Part I (p. 379)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Paulos, John Allen** 1945–

American mathematician

Innumeracy, an inability to deal comfortably with the fundamental notions of numbers and chance, plagues far too many otherwise knowledgeable citizens.

*Innumeracy*

Introduction (p. 3)

Hill & Wang. New York, New York, USA. 1988

**Ruse, Michael** 1940–

English historian and philosopher of science

It is simply not possible to give a neat definition — specifying necessary and sufficient characteristics — which separates all and only those things that have ever been called “science.”

Response to the Commentary: Pro Justice

*Science, Technology & Human Values*, Volume 7, Number 41, Fall 1982 (p. 72)

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

Define your terms, you will permit me again to say, or we shall never understand one another.

*The Portable Voltaire*

Philosophical Dictionary, Miscellany (p. 225)

The Viking Press. New York, New York, USA. 1959

**Walsh, John E.** 1919–72

Statistician

A precise and universally acceptable definition of the term “nonparametric” is not presently available.

*Handbook of Nonparametric Statistics* (Volume 1)

Chapter 1 (p. 2)

Van Nostrand Company, Inc. Princeton, New Jersey, USA. 1962–1968

**Durand, David** 1912–96

American educator

Degrees of freedom. The number of fetters on the statistician. The number of d.f. is usually considered self-evident — except for the analysis of data that have not appeared in a textbook.

A Dictionary for Statismagicians  
*The American Statistician*, Volume 24, Number 3, June 1970 (p. 21)

## DELIRIUM

**Hippocrates** 460 BCE–377 BCE  
 Greek physician

When in acute fevers, pneumonia, phrenitis, or headache, the hands are waved before the face, hunting through empty space, as if gathering bits of straw, picking the nap from the coverlet, or tearing chaff from the wall — all such symptoms are bad and deadly.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

The Book of Prognostics, 4 (p. 20)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## DEMONSTRATION

**Fejer, M. M.**

No biographical data available

Franken's first demonstration of nonlinear optical frequency conversion in 1961 employed a quartz crystal to double the frequency of 694-nm light from a ruby laser. Because that interaction was not phase matched, the ultraviolet output power was so small that the editors at Physical Review Letters mistook for a blemish the spot on Franken's spectrograph plate that demonstrated the new effect. They airbrushed it out of the published version, rendering the first evidence of nonlinear frequency conversion truly invisible.

Nonlinear Optical Frequency Conversion

*Physics Today*, Volume 47, Number 5, May 1994 (p. 27)

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

...no isolated experiment, however significant in itself, can suffice for the experimental demonstration of any natural phenomenon; for the "one chance in a million" will undoubtedly occur, with no less and no more than its appropriate frequency, however surprised we may be that it should occur to us.

*The Design of Experiments*

II, 7 (pp. 13–14)

Hafner Publishing Company. New York, New York, USA. 1971

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Nothing ever satisfies her [Eve] but demonstration; untested theories are not in her line, and she won't have them.

*Eve's Diary*

Friday (p. 75)

Harper & Brothers Publishers. New York, New York, USA. 1906

## DENSITY

**Brown, Gerald**

American physicist

**Bethe, Hans** 1906–2005

German-born American physicist

... $2.7 \times 10^{14}$  grams per cubic centimeter. This is the density of matter inside a large atomic nucleus, and in effect the nucleons in the core [of a star] merge to form a single gigantic nucleus. A teaspoonful of such matter has about the same mass as all the buildings in Manhattan combined.

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*

How a Supernova Explodes (p. 285)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

## DENTIST

**Author undetermined**

Nitrous oxide is called laughing gas because it is used by dentists.

Class-Room Chemical Emanations

*Journal of Chemical Education*, Volume 3, Number 1, 1926

Members of the seventh grade class (in Louisville) were instructed to write an essay on what they wanted to be when they grew older. One youngster wrote: "I want to be a dentist, like my father because I figure by the time I grow up, he will have all of his equipment paid for."

*Quote, the Weekly Digest*, October 27, 1968 (p. 334)

Drill, fill and bill.

A Free Bike with Your Braces

*Newsweek*, May 5, 1986 (p. 82)

A dentist named Archibald Moss

Fell in love with the dainty Miss Ross,

But he held in abhorrence

Her Christian name, Florence,

So he renamed her his Dental Floss.

In William S. Baring-Gould (ed.)

*The Lure of the Limerick* (p. 102)

Clarkson N. Potter, Inc. New York, New York, USA. 1967

**Benjamin, Arthur**

No biographical data available

We all basically go back to being a child when we're in a dentist's chair.

A Free Bike with Your Braces

*Newsweek*, May 5, 1986 (p. 82)

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

DENTIST, n. A prestidigitator who puts metal into your mouth, pulls coins out of your pocket.

*The Enlarged Devil's Dictionary* (p. 62)  
Doubleday. Garden City, New York, USA. 1967

**Davies, Robertson** 1913–95  
Canadian novelist

In odd corners of the world strange dentists still lurk; an Irish friend of mine told me recently of visiting a dentist on the West Coast of Ireland who had no running water, and bade his patients spit into a potted fern which was conveniently placed by the chair...

*The Table Talk of Samuel Marchbanks* (p. 178)  
Clarke, Irwin. Toronto, Ontario, Canada. 1949

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

His neighbor is a tooth-drawer. That bag at his girdle is full of the teeth that he drew at Winchester fair. I warrant that there are more sound ones than sorry, for he is quick at his work and a trifle dim in the eye.

*The White Company*  
Chapter V (p. 55)  
John Murray. London, England. 1975

**Fillery, Frank**  
No biographical data available

Dentists' precept: The tooth, the holed tooth, and nothing but the tooth.

*Quote, the Weekly Digest*, November 12, 1967 (p. 397)

**Flaubert, Gustave** 1821–90  
French novelist

Dentists. All untruthful. They use steel balm: are said to be also chiropodists. Pretend to be surgeons, just as opticians pretend to be physicists.

*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

**Gilman, Charlotte Perkins** 1860–1935  
American writer and feminist

"You told us about your dentists," she said, at length, "those quaintly specialized persons who spend their lives filling little holes in other persons' teeth — even in children's teeth sometimes."

*Herland*  
Chapter 7 (p. 83)  
Pantheon Books. New York, New York, USA. 1979

**Hale, Susan** 1833–1910  
American artist and art teacher

He got into my mouth along with a pickaxe and telescope, battering-ram and other instruments, and drove a lawn-cutting machine up and down my jaws for a couple of hours. When he came out he said he meant wonderful improvements, and it seems I'm going to have a bridge and mill-wheel and summit and crown of gold, and harps,

and Lord knows what.

In Caroline P. Atkinson (ed.)  
*Letters of Susan Hale*  
Chapter X, To Mrs. William G. Weld, September 19, 1897 (p. 327)

**Hood, Thomas** 1582–98  
English poet and editor

Of all our pains, since man was curst,  
I mean of body, not the mental,  
To name the worst, among the worst,  
The dental sure is transcendental;  
Some bit of masticating bone,  
That ought to help to clear a shelf:  
But lets its proper work alone,  
And only seems to gnaw itself.

*The Complete Poetical Works of Thomas Hood*  
A True Story  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

...a dentist and the wheel  
Of Fortune are a kindred cast,  
For after all is drawn, you feel  
It's paying for a blank at last.

*The Complete Poetical Works of Thomas Hood*  
A True Story, L. 43–46  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Lower, Lennie** 1903–47  
Australian humorist

I've often wondered how people become dentists. Probably some sadistic urge due to ill-treatment in early youth.

In Cyril Pearl  
*The Best of Lennie Lower*  
Charge Your Hypodermics! (p. 211)  
Lansdowne Press. Melbourne, Australia. 1963

**Morley, Christopher** 1890–1957  
American writer

The only previous time he had taken gas was in a dentist's office in the Flatiron Building. Whenever he visited that dentist he was always thrilled by the view from the chair, which included the ornate balconies of the old Madison Square Garden and the silhouette of Diana tip-toe in the sky.

*Human Being*  
Pathology (p. 205)  
Doubleday, Doran & Company, Inc. New York, New York, USA. 1932

**Nash, Ogden** 1902–71  
American writer of humorous poetry

Some tortures are physical and some are mental.  
But one that's both is dental.

Have You a Pash for Ogden Nash  
*The Reader's Digest*, July 1952 (p. 10)

**Perelman, Sidney Joseph** 1904–79  
American comic writer

For years I have let dentists ride roughshod over my teeth; I have been sawed, hacked, chopped, whittled, bewitched, bewildered, tattooed, and signed on again; but this is cupid's last stand.

*Crazy Like a Fox*

Nothing But the Tooth (p. 72)

Random House, Inc. New York, New York, USA. 1944

I had always thought of dentists as of the phlegmatic type — square-jawed sadists in white aprons who found release in trying out new kinds of burs on my shaky little incisors.

*Crazy Like a Fox*

Nothing But the Tooth (p. 69)

Random House, Inc. New York, New York, USA. 1944

### Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910

American author and humorist

When teeth became touched with decay or were otherwise ailing, the doctor knew of but one thing to do — he fetched his tongs and dragged them out. If the jaw remained, it was not his fault.

*Mark Twain's Autobiography* (Volume 1)

Chapters Begun in Vienna (p. 107)

Harper & Brothers Publishers. New York, New York, USA. 1924

Some people who can skirt precipices without a tremor have a strong dread of the dentist's chair...

*Europe and Elsewhere*

Down the Rhone (p. 161)

Harper & Brothers Publishers. New York, New York, USA. 1932

Most cursed of all are the dentists who made too many parenthetical remarks — dentists who secure your instant and breathless interest in a tooth by taking a grip on it, and then stand there and drawl through a tedious anecdote before they give the dreaded jerk. Parentheses in literature and dentistry are in bad taste.

*A Tramp Abroad*

Appendix D, The Awful German Language (p. 392)

Penguin Books. New York, New York, USA. 1997

All dentists talk while they work. They have inherited this from their professional ancestors, the barbers.

*Europe and Elsewhere*

Down the Rhone (p. 162)

Harper & Brothers Publishers. New York, New York, USA. 1932

### Waugh, Evelyn

1903–66

English author of satirical novels

All this fuss about sleeping together. For physical pleasure I'd sooner go to my dentist any day.

*Vile Bodies*

Chapter VI (p. 122)

Jonathan Cape. New York, New York, USA. 1930

### Wells, H. G. (Herbert George)

1866–1946

English novelist, historian, and sociologist

...he had one peculiar weakness; he had faced death in many forms but he had never faced a dentist. The thought of dentists gave him just the same sick horror as the thought of invasion.

*Bealby*

Part VIII, How Bealby Explained (p. 264)

The Macmillan Company. New York, USA. 1915

### Wilde, Oscar

1854–1900

Irish wit, poet, and dramatist

JACK: It is very vulgar to talk like a dentist when one isn't a dentist. It produces a false impression.

*The Importance of Being Earnest: A Trivial Comedy for Serious People*

Act I (p. 11)

Walter H. Baker Company. Boston, Massachusetts, USA. 19 —

### Woolf, Virginia

1882–1941

English novelist and essayist

...when we have a tooth out and come to the surface in the dentist's arm-chair ...[we] confuse his "Rinse the mouth — rinse the mouth" with the greeting of the Deity stooping from the floor of Heaven to welcome us...

*The Moment*

On Being Ill (p. 9)

Harcourt, Brace & Company, New York, New York, USA, 1948

## DENTOPEDALOGY

### Prince Philip (Phillip Mountbatten), Duke of Edinburgh

1921–

British naturalist

Dentopedalogy is the science of opening your mouth and putting your foot in it. I've been practicing it for years.

*Time*, November 21, 1960

## DENUATION

### Muir, John

1838–1914

American naturalist

When Nature lifted the ice-sheet from the mountains she may well be said not to have turned a new leaf, but to have made a new one of the old. Throughout the unnumbered seasons of the glacial epoch the range lay buried, crushed, and sunless. In the stupendous denudation to which it was then subjected, all its pre-glacial features disappeared. Plants, animals, and landscapes were wiped from its flanks like drawings from a blackboard, and the vast page left smooth and clean, to be repictured with young life and the varied and beautiful inscriptions of water, snow, and the atmosphere.

*Studies in the Sierra*

Chapter V (p. 62)

Sierra Club. San Francisco, California, USA. 1960

**DEPLETION****Jenkins, Edward B.**

American astronomer

Figuratively, when we study depletions, it is as if we were looking at the crumbs left on the plate after the grains have eaten their dinner.

In L.J. Allamandola and A.G.G.M. Tielens (eds.)  
*Interstellar Dust*

Proceedings of the 135<sup>th</sup> Symposium of the International Astronomical Union, Insights on Dust Grain Formation and Destruction Provided by Gas-Phase Element Abundances, Section 2 (p. 24)

**DERIVATIVE****Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

And what are these Fluxions? The Velocities of evanescent Increments. And what are these same evanescent Increments? They are neither finite Quantities, nor Quantities infinitely small, nor yet nothing. May we not call them Ghosts of departed Quantities?

*The Analyst*

Section 35

Kluwer Academic Publishers. Dordrecht, Netherlands. 1992

**Lehrer, Tom** 1928–

American singer-songwriter and mathematician

You take a function of  $x$  and you call it  $y$ ,  
Take any  $x$ -nought that you care to try,  
You make a little change and call it delta  $x$ ,  
The corresponding change in  $y$  is what you find next,  
And then you take the quotient and now carefully  
Send delta  $x$  to zero, and I think you'll see  
That what the limit gives us, if our work all checks,  
Is what we call  $dy/dx$ ,  
It's just  $dy/dx$ .

The Derivative Song

*The American Mathematical Monthly*, Volume 81, Number 5, May 1974 (p. 490)

**Rossi, Hugo** 1935–

American mathematician

In the fall of 1972 President Nixon announced that the rate of increase of inflation was decreasing. This was the first time a sitting president used the third derivative to advance his case for reelection.

Mathematics Is an Edifice, Not a Toolbox

*Notices of the American Mathematical Society*, Volume 43, Number 10, October 1996

**DERMATOLOGIST****Frank, Julia Bess**

No biographical data available

I wish the dermatologist  
Were less a firm apologist  
For all the terminology  
That's used in dermatology.

Dermatology

*The New England Journal of Medicine*, Volume 297, Number 12, 1977 (p. 660)

**McLaughlin, Mignon** 1915–

American journalist and author

Psychiatrists are terrible ads for themselves, like a dermatologist with acne.

*The Neurotic's Notebook* (p. 73)

The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1963

**DESCRIBE****Chapman, Frank M.** 1864–1945

American ornithologist

Not only do our memories sometimes deceive us, but we really see nothing with exactness until we attempt to describe it.

In William H. Carr

*The Stir of Nature*

Chapter Nine (p. 117)

Oxford University Press, Inc. New York, New York, USA. 1930

**DESCRIPTION****Walker, Kenneth** 1882–1966

Physician

We first described billiard balls in terms of atoms and then described atoms in terms of billiard balls, a description that brought us no nearer to a true understanding of the ultimate nature of either billiard balls or atoms.

*Meaning and Purpose*

Chapter XIV (p. 153)

Jonathan Cape. London, England. 1944

**DESERT****Abbey, Edward** 1927–89

American environmentalist and nature writer

Under the desert sun, in that dogmatic clarity, the fables of theology and the myths of classical philosophy dissolve like mist.

*Desert Solitaire*

Down the River (p. 219)

Ballantine Books. New York, New York, USA. 1968

To the east, under the spreading sunrise, are more mesas, more canyons, league on league of red cliff and arid tablelands, extending through purple haze over the bulging curve of the planet to the ranges of Colorado — a sea of desert.

*Desert Solitaire*

The First Morning (p. 5)

Ballantine Books. New York, New York, USA. 1968

The finest quality of this stone, these plants and animals, this desert landscape is the indifference to our presence, our absence, our coming, our staying or our going. Whether we live or die is a matter of absolutely no concern to the desert.

*Desert Solitaire*

Bedrock and Paradox (pp. 300–301)

Ballantine Books. New York, New York, USA. 1968

The restless sea, the towering mountains, the silent desert—what do they have in common? and what are the essential differences? Grandeur, color, spaciousness, the power of the ancient and elemental, that which lies beyond the ability of man to wholly grasp or utilize, these qualities all three share. In each there is the sense of something ultimate, with mountains exemplifying the brute force of natural processes, the sea concealing the richness, complexity and fecundity of life beneath a surface of huge monotony, and the desert — what does the desert say? The desert says nothing. Completely passive, acted upon but never acting, the desert lies there like the bare skeleton of Being, spare, sparse, austere, utterly worthless, inviting not love but contemplation. In its simplicity and order it suggests the classical, except that the desert is a realm beyond the human and in the classicist view only the human is regarded as significant or even recognized as real.

*Desert Solitaire*

Episodes and Visions (p. 270)

Ballantine Books. New York, New York, USA. 1968

The sun is touching the fretted tablelands on the west. It seems to bulge a little, to expand for a moment, and then it drops — abruptly — over the edge. I listen for a long time.

*Desert Solitaire*

Down the River (p. 219)

Ballantine Books. New York, New York, USA. 1968

It has been said, and truly, that everything in the desert either stings, stabs, stinks, or sticks. You will find the flora here as venomous, hooked, barbed, thorny, prickly, needled, saw-toothed, hairy, stickered, mean, bitter, sharp, wiry, and fierce as the animals.

*The Journey Home: Some Words in Defense of the American West*

Chapter 2 (p. 14)

E.P. Dutton. New York, New York, USA. 1977

[After supper] I put on hat and coat and go outside again, sit on the table, and watch the sky and the desert dissolve slowly into mystery under the chemistry of twilight.

*Desert Solitaire*

Solitaire (p. 13)

Ballantine Books. New York, New York, USA. 1968

**Austin, Mary Hunter** 1868–1934

American novelist and essayist

None other than this long brown land lays such a hold on the affections. The rainbow hills, the tender bluish mists, the luminous radiance of the spring, have the lotus charm. They trick the sense of time, so that once inhabiting there you always mean to go away without quite realizing that you have not done it.

*The Land of Little Rain*

The Land of Little Rain (p. 16)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

For all the toll the desert takes of a man it gives compensations, deep breaths, deep sleep, and the communion of the stars.

*The Land of Little Rain*

The Land of Little Rain (p. 21)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

Go as far as you dare in the heart of a lonely land, you cannot go so far that life and death are not before you.

*The Land of Little Rain*

The Land of Little Rain (p. 13)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

...the true desert breeds its own kind, each in its particular habitat. The angle of the slope, the frontage of a hill, the structure of the soil determines the plant.

*The Land of Little Rain*

The Land of Little Rain (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

What makes the desert beautiful is that somewhere it hides a well.

Translated by Katherine Woods

*The Little Prince*

Chapter XXIV (p. 75)

Harcourt, Brace & Company. New York, New York, USA. 1943

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

I shall never be able to express clearly whence comes this pleasure men take from aridity, but always and everywhere I have seen men attach themselves more stubbornly to barren lands than to any other. Men will die for a calcined, leafless, stony mountain. The nomads will defend to the death their great store of sand as if it were a treasure of gold dust. And we, my comrades and I, we too have loved the desert to the point of feeling that it was there we had lived the best years of our lives.

*Wind, Sand, and Stars*

Chapter 7 (p. 127)

Reynal & Hitchcock. New York, New York, USA. 1939

**L'Amour, Louis** 1872–1970  
American author

The desert was a school, a school where each day, each hour, a final examination was offered, where failure meant death and the buzzards landed to correct the papers.

*Shalako*

Chapter One

Bantam Books. New York, New York, USA. 1985

**Pattison, Eliot**  
American writer and journalist

Deserts are where mountains go when they die.

*Water Touching Stone*

Chapter Eighteen (p. 456)

St. Martin's Press. New York, New York, USA. 2001

**Walther, Johannes** 1860–1937  
German geologist

The desert, however, which once had drastically influenced the course of earthly life and caused its most important progress, today is only the symbol of unlimited desolation and rigid negation of life to mankind. Only a few guess the wealth of scientific problems hidden in the diverse desert, its strong influence on our thoughts and observations, its colorful beauty which enralls our senses, its infinite loneliness which deepens our thoughts, and how we have to regard the kingdom of the colorful life from the lifeless desert if we want to understand its oldest and last secrets.

In Eberhard Gischler and Kenneth W. Glennie (eds.)

*Johannes Walther: The Law of Desert Formations—Present and Past*

Chapter 37 (p. 263)

University of Miami. Miami, Florida, USA. 1997

## DESIGN

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

A common mistake that people make when trying to design something completely foolproof is to underestimate the ingenuity of complete fools.

*The Ultimate Hitchhiker's Guide to the Galaxy*

Mostly Harmless

Chapter 12 (p. 719)

The Ballantine Book Company. New York, New York, USA. 2002

**Ferguson, Eugene S.**  
Technological historian

No matter how vigorously a “science” of design may be pushed, the successful design of real things in a contingent world will always be based more on art than on science. Unquantifiable judgments and choices are the elements that determine the way a design comes together. Engineering design is simply that kind of process. It always has been; it always will be.

*Engineering and the Mind's Eye*

Chapter 7 (p. 194)

The MIT Press. Cambridge, Massachusetts, USA. 1992

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

If you are in a shipwreck and all the boats are gone, a piano top buoyant enough to keep you afloat that comes along makes a fortuitous life preserver. But this is not to say that the best way to design a life preserver is in the form of a piano top. I think that we are clinging to a great many piano tops in accepting yesterday's fortuitous contrivings as constituting the only means for solving a given problem.

*Operating Manual for Spaceship Earth*

Chapter 1 (p. 9)

Simon & Schuster. New York, New York, USA. 1969

**Layton, Jr., Edwin T.**  
Historian of technology

From the point of view of modern science, design is nothing, but from the point of view of engineering, design is everything. It represents the purposive adaptation of means to reach a preconceived end, the very essence of engineering.

American Ideologies of Science and Engineering

*Technology and Culture*, Number 4, October 1976 (p. 696)

**Mailer, Norman** 1923–  
American author

Indeed the early history of rocket design could be read as the simple desire to get the rocket to function long enough to give an opportunity to discover where the failure occurred. Most early debacles were so benighted that rocket engineers could have been forgiven for daubing the blood of a virgin goat on the orifice of the firing chamber.

*Of a Fire on the Moon*

Part II, Chapter I, Section iv (p. 168)

Little, Brown & Company. Boston, Massachusetts, USA. 1969

**Reswick, J. B.**  
No biographical data available

Design is the essential purpose of engineering.

In Morris Asimow

*Introduction to Design*

Forward (p. iii)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1962

**Vincenti, Walter G.** 1917–  
American aeronautical engineer

Engineering knowledge reflects the fact that design does not take place for its own sake and in isolation. Artificial design is a social activity directed at a practical set of goals intended to serve human beings in some direct way. As such, it is intimately bound up with economic,



military, social, personal, and environmental needs and constraints.

*What Engineers Know and How They Know It*

Chapter 1 (p. 11)

The Johns Hopkins University Press. Baltimore. 1990

## DESTINATION

**Bester, Alfred** 1913–87

American science fiction author

Gully Foyle is my name

And Terra is my nation.

Deep space is my dwelling place

And death's my destination.

Gully Foyle is my name

And Terra is my nation.

Deep space is my dwelling place,

The stars my destination.

*The Stars My Destination* (pp. 17–18)

Vintage Books. New York, New York, USA. 1996

## DESTINY

**Gray, George W.**

Freelance science writer

Within the limits of nature's law, a man is free to mold his future. By design he may increase the probability of a desired outcome. And so we say that destiny is a choice, a selection among alternative destinies. But the selection cannot be left to accident; it is not fortuitous, automatic, foolproof. Man himself must choose.

*The Advancing Front of Science*

Epilogue (p. 353)

Whittlesey House. New York, New York, USA. 1937

## DESTRUCTION

**Abbey, Edward** 1927–89

American environmentalist and nature writer

The philosophers and the theologians have agreed, for three thousand years, that the perfect is immutable — that which cannot alter and cannot ever be altered. They were wrong. We were wrong. Glen Canyon was destroyed. Everything changes, and nothing is more vulnerable than the beautiful.

*Down the River*

Part IV, Chapter 19 (p. 231)

E.P. Dutton. New York, New York, USA. 1982

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

If we are still here to witness the destruction of our planet some five billion years or more hence, then we will have achieved something so unprecedented in the history of

life that we should be willing to sing our swansong with joy — *Sic Transit Gloria Mundi*.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 12 (p. 142)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

**Taylor, Walter W.** 1913–97

American archaeologist

The archivist and the experimental scientist may with impunity select from their sources those facts which have for them a personal and immediate significance in terms of some special problem. Their libraries and experimental facilities may be expected to endure, so that in the future there may be access to the same or a similar body of data. If, however, it were certain that, after the archivist's first perusal, each document would be utterly and forever destroyed it would undoubtedly be required of him that he transcribe the entire record rather than just that portion which at the moment interests him. He would have difficulty in justifying his research if, knowingly, he caused the destruction of a unique record for the sake of abstracting only a narrowly selected part.

The gathering of data from archeological sites, in nearly every instance, involves the destruction of the original record.

*A Study of Archaeology*

Part II, Chapter 6 (p. 152)

Southern Illinois University Press, Carbondale, Illinois, USA. 1967

## DETAIL

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

If you wish to gain knowledge of the forms of things, begin with the detail and only move from one detail to another when you have fixed the first firmly in your memory and become well acquainted with it.

In Michael White

*Leonardo: The First Scientist*

Chapter 2 (p. 30)

Little, Brown & Company. London, England. 2000

**Garwin, R. L.**

No biographical data available

Polaroid photography itself was initiated during that time, too: In December 1943, on a family vacation in Santa Fe, Land's three-year-old daughter asked why she couldn't see instantly the picture Land took of her. Within the hour, he had thought through the camera, the film and the physical chemistry that could do the job. Instant photography had been perfected "except for those few details that took from 1943 to 1973," as he recalled later.

Book review

*Insisting on the Impossible: The Life of Edwin Land*

*Physics Today*, Volume 52, no 2, February 1999 (p. 65)

**Rowling, J. K.** 1965–  
English fiction writer

...but it was like trying to keep water in his cupped hands; the details were now trickling away as fast as he tried to hold on to them...

*Harry Potter and the Goblet of Fire* (p. 17)

Arthur A. Levine Books. New York, New York, USA. 2000

## DETECTION

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

Detection is, or ought to be, an exact science, and should be treated in the same cold and unemotional manner. You have attempted to tinge it with romanticism, which produces much the same effect as if you worked a love-story or an elopement into the fifth proposition of Euclid.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Sign of the Four, Chapter 1 (p. 611)

Wings Books. New York, New York, USA. 1967

## DETECTOR

**Glashow, Sheldon L.** 1932–  
American physicist

The detector is like the journalist who must determine what, where, when, which, and how? What is the identity of the particle? Exactly where is it when it is observed? When does the particle get to the detector? Which way is it going? How fast is it moving?

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 4 (p. 101)

Warner Books. New York, New York, USA. 1988

## DETERMINANT

**Sylvester, James Joseph** 1814–97  
English mathematician

For what is the theory of determinants? It is an algebra upon algebra; a calculus which enables us to combine and foretell the results of algebraical operations, in the same way as algebra itself enable us to dispense with the performance of the special operations of arithmetic. All analysis must ultimately clothe itself under this form.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 1)

On the Relation Between the Minor Determinants of Linearly Equivalent Quadratic Functions (pp. 246–247)

University Press. Cambridge, England. 1904–1912

## DETERMINISM

**Einstein, Albert** 1879–1955  
German-born physicist

Everything is determined, the beginning as well as the end, by forces over which we have no control. It is determined for the insect as well as the star. Human beings, vegetables, or cosmic dust, we all dance to a mysterious tune, intoned in the distance by an invisible piper.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 17)

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

The intuitive idea of determinism may be summed up by saying that the world is like a motion-picture film: the picture or still which is just being projected is the present. Those parts of the film which have already been shown constitute the past. And those which have not yet been shown constitute the future.

In the film, the future co-exists with the past; and the future is fixed, in exactly the same sense as the past. Though the spectator may not know the future, every future event, without exception, might in principle be known with certainty, exactly like the past, since it exists in the same sense in which the past exists. In fact, the future will be known to the producer of the film — to the Creator of the world.

*The Open Universe*

Chapter I (p. 5)

Rowman & Littlefield. Totowa, New Jersey, USA.

**Prigogine, Ilya** 1917–2003  
Russian-born Belgian physical chemist

The basis of the vision of classical physics was the conviction that the future is determined by the present, and therefore a careful study of the present permits an unveiling of the future. At no time, however, was this more than a theoretical possibility. Yet in some sense this unlimited predictability was an essential element to the scientific picture of the physical world. We may perhaps even call it the founding myth of classical science. The situation is greatly changed today...

*From Being to Becoming*

Chapter 9 (p. 214)

W.H. Freeman & Company. San Francisco, California, USA. 1980

## DEVELOPMENT

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

In science, as in human affairs, great events do not occur without a background of development.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1937*  
The Electron: Its Intellectual and Social Significances (p. 206)  
Government Printing Office. Washington, D.C. 1938

**Feynman, Richard P.** 1918–88  
American theoretical physicist

When the scientist tells you he does not know the answer, he is an ignorant man. When he tells you he has a hunch about how it is going to work, he is uncertain about it. When he is pretty sure of how it is going to work, and he tells you, “This is the way it is going to work, I’ll bet,” he still is in some doubt. And it is of paramount importance, in order to make progress, that we recognize this ignorance and this doubt. Because we have the doubt, we then propose looking in new directions for new ideas. The rate of development in science is not the rate at which you make observations alone but, much more important, the rate at which you create new things to test.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 27)  
Perseus Books. Reading, Massachusetts, USA. 1998

## DIAGNOSIS

**Eisenschiml, Otto** 1880–1963  
Austrian-American chemist and historian

The best physician must fail if his treatment is based on a wrong diagnosis.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Ten (p. 119)  
Duell, Sloan & Pearce. New York, New York, USA. 1947

**Field, Eugene** 1850–95  
American poet and journalist

Upon an average, twice a week,  
When anguish clouds my brow,  
My good physician and friend I seek  
To know “what ails me now.”

He taps me on my back and chest,  
And scans my tongue for bile,  
And lays an ear against my breast  
And listens there awhile;  
Then is he ready to admit  
That all he can observe

Is something wrong inside, to wit:  
My pneumogastric nerve!

*The Poems of Eugene Field*  
The Pneumogastric Nerve  
Charles Scribner’s Sons. New York, New York, USA. 1910

**Hoffmann, Friedrich** 1660–1742  
German physician

When investigating the nature of disease, we should attend to all the signs and symptoms. They should not be

considered in isolation but rather in combination with each other.

*Fundamenta Medicinæ*  
Semiotics, Chapter I, 6 (p. 83)  
American Elsevier. New York, New York, USA. 1971

Who identifies well, treats well; hence the diagnosis of disease is in the highest degree necessary for a physician.

*Fundamenta Medicinæ*  
Semiotics, Chapter I, 2 (p. 83)  
American Elsevier. New York, New York, USA. 1971

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Young doctors are particularly strong, as I understand, on what they call diagnosis — an excellent branch of the healing art, full of satisfaction to the curious practitioner who likes to give the right Latin name to one’s complaints; not quite so satisfactory to the patient, as it is not so very much pleasanter to be bitten by a dog with a collar round his neck telling you that he is called Snap or Teaser, than by a dog without a collar. Sometimes, in fact, one would a little rather not know the exact name of his complaint, as if he does he is pretty sure to look it out in a medical dictionary, and then if he reads, “This terrible disease is attended with vast suffering and is inevitably mortal,” or any such statement, it is apt to affect him unpleasantly.

*The Poet at the Breakfast-Table*  
Chapter III (p. 65)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Kraus, Karl** 1874–1936  
Austrian essayist and poet

One of the most widespread diseases is diagnosis.

In Harry Zohn (ed.)  
*Half-Truths & One-and-a-Half Truths*  
In Hollow Heads (p. 77)  
The University of Chicago Press. Chicago, Illinois, USA. 1990

**Latham, Peter Mere** 1789–1875  
English physician

You may listen to the chest for ever and be no wiser, if you do not previously know what it is you are to hear. You may beat the chest for ever, and all in vain, unless you know what it is that is capable of rendering it now dull and now resonant.

In William B. Bean  
*Aphorisms from Latham* (p. 58)  
Prairie Press. Iowa City, Iowa, USA. 1962

The diagnosis of disease is often easy, often difficult, and often impossible.

In William B. Bean  
*Aphorisms from Latham* (p. 56)  
Prairie Press. Iowa City, Iowa, USA. 1962

Ordinary diseases will sometimes occur under extraordinary circumstances, or in unusual situations; and then

we are apt to be thrown out in our diagnosis, as the pilot is in his course upon any unexpected alteration of lights and signals on the coast. He makes false points, and so do we.

In William B. Bean

*Aphorisms from Latham* (p. 57)

Prairie Press. Iowa City, Iowa, USA. 1962

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

If necessary, be cruel; use the knife and the cautery to cure the intumescence and moral necrosis which you will feel in the posterior parietal region, in Gall and Spurzheim's center of self-esteem, where you will find a sore spot after you have made a mistake in diagnosis.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XIII (p. 329)

Clarendon Press. Oxford, England. 1925

## DIAGNOSTICIAN

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

One finger in the throat and one in the rectum makes a good diagnostician.

In William Bennett Bean (ed.)

*Aphorisms from His Bedside Teachings* (p. 104)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1968

## DICE

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

Four dice are cast and a Venus throw results — that is chance; but do you think it would be chance, too, if in one hundred casts you made one hundred Venus throws? It is possible for paints flung at random on a canvas to form the outline of a face; but do you imagine that an accidental scattering of pigments could produce the beautiful portrait of Venus of Cos? Suppose that a hog should form a letter “A” on the ground with its snout; is that a reason for believing that it could write out Ennius's poem *The Andromache*?

Translated by William Armistead Falconer

*Cicero: De Senectute, De Amicitia, De Divinatione*

De Divinatione, I. XIII (pp. 249–250)

Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Tis fate that flings the dice,  
and as she flings  
of Kings makes peasants,  
and of peasants Kings.

*The Works of John Dryden*

Volume XV, 1821 Edition (p. 103)

Hurst, Robinson & Company. London, England. 1821

**Einstein, Albert** 1879–1955

German-born physicist

I can, if the worst comes to worst, still realize that God may have created a world in which there are no natural laws. In short, a chaos. But that there should be statistical laws with definite solutions, *i.e.*, laws which compel God to throw the dice in each individual case, I find highly disagreeable.

In Ronald W. Clark

*Einstein: The Life and Times*

Part Four, Chapter 12 (p. 340)

The World Publishing Company. New York, New York, USA. 1971

**Eldridge, Paul** 1888–1982

American educator

Acorns may be food for hogs or rise into magnificent oaks, as the dice of chance decree.

*Maxims for a Modern Man*

1849

T. Yoseloff. New York, New York, USA. 1965

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The dice of God are always loaded.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Compensation (p. 289)

The Library of America. New York, New York, USA. 1983

**Hawking, Stephen William** 1942–

English theoretical physicist

It therefore seems that Einstein was doubly wrong when he said that God does not play dice. Consideration of particle emission from black holes suggests that God not only plays with dice but that he sometimes throws them where they cannot be seen.

The Breakdown of Physics

*Nature*, Volume 257, Number 5525, October 2, 1975 (p. 362)

**Hood, Thomas** 1582–98

English poet and editor

For dice will run the contrary way

As well is known to all who play...

*The Complete Poetical Works of Thomas Hood*

Miss Kilmansegg and Her Precious Leg

Her Misery

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Lang, Andrew** 1844–1912

Scottish scholar and man of letters

They need only adapt to the circumstances that old Lydian tradition which says that games of chance were invented during great famine. Men permitted themselves to eat only every second day, and tried to forget their hunger by playing at draughts and dice.

*Lost Leaders*

Winter Sports

Longman, Green &amp; Company. New York, New York, USA. 1889

**Mallarme, Stephane**

Poet

*Coup de des jamis n'abolira le hasard*

A Cast of Dice Never Can Annul Chance

Translated by Neil Crawford

*A Cast of Dice Never Can Annul Chance*

Tetred. London, England. 1985

**Plutarch** 46–119

Greek biographer and author

*Jacta alea est.*

The die is cast.

*Plutarch's Lives*

Caesar

Harvard University Press. Cambridge, Massachusetts, USA. 1914

**Pólya, George** 1887–1985

Hungarian mathematician

One day in Naples the reverend Galiana saw a man from the Basilicata who, shaking three dice in a cup, wagered to throw three sixes; and, in fact, he got three sixes right away. Such luck is possible, you say. Yet the man succeeded a second time, and the bet was repeated. He put back the dice in the cup, three, four, five times, and each time he produced three sixes. “*Sangue di Bacco*,” exclaimed the reverend, “the dice are loaded!” And they were.

*Mathematics and Plausible Reasoning, Volume 2: Patterns of Plausible Inference* (p. 74)

Princeton University Press. Princeton, New Jersey, USA. 1968

**Ritsos, Yannis** 1909–90

Greek poet

I hear the clack — who cast the dice on the bathroom tiles?

Translated by Kimon Friar

*Erotica*

Small Suite in Red Major

Sachem Press. Old Chatham, New York, USA. 1982

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

And by the hazard of the spotted die

Let die the spotted.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

Timon of Athens

Act V, Scene iv, l. 34–35

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Suidas**

No biographical data available

*Midas in tesseris consultor optimus.*

Midas on the dice gives the best advice.

*Collected Works of Erasmus*

Adages II vii 1 to III iii 100 (p. 124)

University of Toronto Press. Toronto, Ontario, Canada. 1974

**Wilder, Thornton** 1897–1975

American playwright and novelist

We were shaken into existence, like dice from a box.

*The Eighth Day*

II, Illinois to Chile (p. 107)

Harper &amp; Row, Publishers, New York, New York, USA, 1967

**DISCOVERY****Cardano, Girolamo** 1501–76

Italian physician, mathematician, and astrologer

I swear to you by the Sacred Gospel, and on my faith as a gentleman, not only never to publish your discoveries, if you tell them to me, but I also promise and pledge my faith as a true Christian to put them down in cipher so that after my death no one shall be able to understand them.

In *Oystein Ore**Cardano: The Gambling Scholar*

Chapter 3 (p. 77)

Dover Publications, Inc. New York, New York, USA. 1953

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

The man who is content to make records or to collect skins and eggs will, unless he spends years of his life in a systematic analysis of his own and others' facts, not get anything from his labours — save the very real pleasure of making the observations. But he who takes the trouble to think out new problems and new lines of attack upon the old will have the same pleasure, and in addition the joy of intellectual discovery.

*Essays in Popular Science*

Birds and the Territorial System (p. 170)

Chatto &amp; Windus. London, England. 1926

**DIET****Arnoldus** 1510–82

Dutch philosopher and poet

A wise physician will not give physic, but upon necessity, and first try medicinal diet, before he proceed to medicinal cure.

In Robert Burton

*The Anatomy of Melancholy* (Volume 2)

Part 2, Sect. I, Memb. IV, subsect. 1 (p. 18)

AMS Press, Inc. New York, New York, USA. 1973

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Beware of sudden changes in any great point of diet, and, if necessity enforce it, fit the rest to it.

*Essays, Advancement of Learning, New Atlantis, and Other Pieces*  
The Essays or Counsels, Civil and Moral, XXX, Of Regiment of Health  
(p. 93)  
Odyssey Press. New York, New York, USA. 1937

**Davis, Adelle** 1904–74  
American nutritionist

When the blood sugar is extremely low, the resulting irritability, nervous tension, and mental depression are such that a person can easily go berserk.... Add a few guns, gas jets, or razor blades, and you have the stuff murders and suicides are made of. The American diet has become dangerous in many more ways than one.

*Let's Eat Right to Keep Fit*  
Chapter 2 (p. 19)  
New American Library. New York, New York, USA. 1970

### Editor of the Louisville Journal

What some call health, if purchased by perpetual anxiety about diet, isn't much better than tedious disease.

In George Denison Prentice  
*Prenticeana* (p. 302)  
Derby & Jackson. New York, New York, USA. 1859

**Grant, Claud**  
No biographical data available

Diets are for people who are thick and tired of it.  
*Quote, the Weekly Digest*, June 2, 1968 (p. 437)

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

It is probably true quite generally that in the history of human thinking the most fruitful development frequently takes place at those points where two different lines of thought meet. These lines may have roots in quite different parts of human culture, in different times or different cultural environments or different religious traditions: hence if they actually meet, that is, if they are at least so much related to each other that a real interaction can take place, then one may hope that new and interesting developments may follow.

*Physics and Philosophy*  
Chapter XI (p. 187)  
Harper & Row, Publishers. New York, New York, USA. 1962

**Simmons, Charles** 1798–1856  
American clergyman and litterateur

When I behold a fashionable table, set out in all its magnificence, I fancy that I see gouts and dropsies, fevers and lethargies, with innumerable distempers, lying in ambuscade among the dishes. Nature delights in the most plain and simple diet. Every animal, but man, keeps to one dish. Herbs are the food of this species, fish of that, and flesh of a third. Man falls upon everything that comes his way; not the smallest fruit or excrescence of the earth,

scarce a berry or mushroom can escape him.  
*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 486)  
Robert Dick. Toronto, Ontario, Canada. 1853

He who eats of but one dish, never wants a physician.  
*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 234)  
Robert Dick. Toronto, Ontario, Canada. 1853

## DIETY

**Sagan, Carl** 1934–96  
American astronomer and author

We are, almost all of us, descended from people who responded to the dangers of existence by inventing stories about unpredictable or disgruntled deities.

*Cosmos*  
Chapter VII (p. 173)  
Random House, Inc. New York, New York, USA. 1980

## DIFFERENCE

**Foster, Sir Michael** 1836–1907  
English physiologist and educator

Man, unscientific man...is often content with “the nearly” and “the almost.” Nature never is. It is not her way to call the same things which differ, though the difference may be measured by less than the thousandth of a milligramme or of a millimetre, or by any other like standard of minuteness. And the man who, carrying the ways of the world into the domain of science, thinks that he may treat Nature’s differences in any other way than she treats them herself, will find that she resents his conduct; if he in carelessness or in disdain overlooks the minute difference which she holds out to him as a signal to guide him in his search, the projecting tip, as it were, of some buried treasure, he is bound to go astray, and, the more strenuously he struggles on, the farther will he find himself from his true goal.

In J.A. Thomson  
*Introduction to Science*  
Chapter I (p. 18)  
Williams & Norgate Ltd. London, England. 1916

**Heinlein, Robert A.** 1907–88  
American science fiction writer

It has long been known that one horse can run faster than another — but which one? Differences are crucial!  
*The Notebooks of Lazarus Long* (p. 1)  
G.P. Putnam’s Sons. New York, New York, USA. 1973

**Huff, Darrell** 1913–2001  
American writer

...a difference is a difference only if it makes a difference.

*How to Lie with Statistics*

Chapter 4 (p. 58)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

## DIFFERENTIAL

**Zamyatin, Yevgeny** 1884–1937

Russian novelist, playwright, and satirist

The works of the highest faculty of man, judgment, is always directed toward the constant limiting of the infinite, toward the breaking up of the infinite into comfortably digestible portions, differentials.

Translated by Gregory Zilboorg

*We*

Record Twelve (p. 62)

E.P. Dutton & Company, Inc. New York, New York, USA. 1952

## DIFFERENTIAL EQUATION

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

Since in the differential equations of mechanics themselves there is absolutely nothing analogous to the second law of thermodynamics the latter can be mechanically represented only by means of assumptions regarding initial conditions.

In B. McGuinness (ed.)

*Theoretical Physics and Philosophical Problems. Selected Writings*

On Statistical Mechanics (pp. 170–171)

Reidel Publishing Company. Boston, Massachusetts, USA. 1974

**Born, Max** 1882–1970

German-born English physicist

The difficulty involved is that the proper and adequate means of describing changes in continuous deformable bodies is the method of differential equations.... They express mathematically the physical concept of contiguous action.

*Einstein's Theory of Relativity*

Chapter IV, Section 6 (p. 109, 111)

Dover Publications. New York, New York, USA. 1962

**Fourier, (Jean Baptiste-) Joseph** 1768–1830

French mathematician and physicist

The differential equations of the propagation of heat express the most general conditions, and reduce the physical questions to problems of pure analysis, and this is the proper object of theory.

In *Great Books of the Western World* (Volume 43)

*The Analytical Theory of Heat*

Preliminary Discourse (p. 172)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

Men have fallen in love with status and pictures. I find it easier to imagine a man falling in love with a differential equation, and I am inclined to think that some mathematicians have done so. Even in a nonmathematician like myself, some differential equations evoke fairly violent physical sensations to those described by Sappho and Catallus when viewing their mistresses. Personally, I obtain an even greater “kick” from finite difference equations, which are perhaps more like those which an up-to-date materialist would use to describe human behavior.

*The Inequality of Man and Other Essays*

Scientific Calvinism (p. 39)

Penguin Books Ltd., Harmondsworth, England. 1937

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

If one looks at the different problems of the integral calculus which arise naturally when he wishes to go deep into the different parts of physics, it is impossible not to be struck by the analogies existing. Whether it be electrostatics or electrodynamics, the propagation of heat, optics, elasticity, or hydrodynamics, we are led always to differential equations of the same family.

Sur les Equations aux Dérivées Partielles de la Physique Mathématique

*American Journal of Mathematics*, Volume 12, 1890 (p. 211)

**Pólya, George** 1887–1985

Hungarian mathematician

In order to solve a differential equation you look at it till a solution occurs to you.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The traditional mathematics professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Sholander, Marlow**

Mathematician

If the finding is essential  
Of a singular solution  
For equations differential,  
Let me sketch its execution.  
First obtain some ordinary  
Members of the family  
Of solutions — oh, not very  
Many, maybe twenty three.  
Find their curves by carefully plotting.  
Ink them quickly and you ought,  
From the points requiring blotting,  
To obtain the locus sought.

Envelopes and Nodes

*Mathematics Magazine*, Volume 34, Number 2, Nov–Dec 1960 (p. 108)

**Turing, Alan** 1912–54

English mathematician

Science is a differential equation. Religion is a boundary condition.

In John D. Barrow

*Theories of Everything: The Quest for Ultimate Explanation*

Chapter Three (p. 31)

Clarendon Press. Oxford, England. 1991

**Webster, Arthur Gordon** 1864–1923

American mathematician and experimental physicist

It seems to be the impression among students that mathematical physics consists in deriving a large number of partial differential equations and then solving them, individually, by an assortment of special mutually unrelated devices. It has not been made clear that there is any underlying unity of method and one has often been left entirely in the dark as to what first suggested a particular device to the mind of its inventor.

*Partial Differential Equations of Mathematical Physics*

Note by the Editor (p. v)

Dover Publications, Inc. New York, New York, USA. 1955

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Matter-of-fact is an abstraction, arrived at by confining thought to purely formal relations which then masquerade as the final reality. This is why science, in its perfection, re-lapses into the study of differential equations. The concrete world has slipped through the meshes of the scientific net.

*Modes of Thought*

Chapter I, Lecture One (p. 25)

The Macmillan Company. New York, New York, USA. 1938

## DIFFICULTY

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...man always believes more readily that which he prefers. He, therefore, rejects difficulties for want of patience in investigation...

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 49 (p. 111)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## DIFFUSION

**Barcroft, Joseph** 1872–1947

Irish physiologist

A number of tests were made for the purpose of discovering whether the pressure of oxygen in the blood was or was not higher than that in the alveolar air. In all cases they were so nearly the same that we attribute the passage of gas through the pulmonary epithelium to diffusion.

Observations Upon the Effect of High Altitude on the Physiological Processes of the Human Body, Carried Out in the Peruvian Andes, Chiefly at Cerro de Pasc

*Philosophical Transactions of the Royal Society of London, B*, Volume 211, 1923

**Goldsmith, Oliver** 1730?–74

Anglo-Irish author

As aromatic plants bestow

No spicy fragrance while they grow;

But crushed or trodden to the ground

Diffuse their balmy sweets around.

In Roger Lonsdale (ed.)

*The Poems of Thomas Gray, William Collins, Oliver Goldsmith*

*The Captivity*

Act I

Longmans, Green & Company. New York, New York, USA. 1969

## DIG

**Bibby, Geoffrey** 1917–2001

English archaeologist

...every archaeologist knows in his heart why he digs. He digs, in pity and humility, that the dead may live again, that what is past may not be forever lost, that something may be salvaged from the wreck of ages.

*The Testimony of the Spade*

Book Four, Chapter 28 (p. 411)

Alfred A. Knopf. New York, New York, USA. 1956

**Leakey, Mary** 1913–96

English archaeologist

Fortunately, there is so much underground still. It is a vast place, and there is plenty more under the surface for future generations that are better educated.

Marguerite Holloway

*Scientific American*, October 1994

You know, you only find what you are looking for, really, if the truth be known.

Marguerite Holloway

*Scientific American*, October 1994

**Wheeler, Sir Mortimer** 1890–1976

English archaeologist

There is no right way of digging but there are many wrong ways.

*Archaeology from the Earth*

Introduction (p. 1)

At The Clarendon Press. Oxford, England. 1954

...there must always be an element of chance and of opportunism in an excavation, however carefully planned. But scientific digging is not on that account a gamble.

*Archaeology from the Earth*

Chapter V (pp. 62–63)

At The Clarendon Press. Oxford, England. 1954

**Wodehouse, P. G.** 1881–89

English comic writer

A mere hole in the ground, which of all sights is perhaps the least vivid and dramatic, is enough to grip their [archaeologists] attention for hours at a time.



*A Damsel in Distress*  
Chapter 3 (p. 31)  
Herbert Jenkins. London, England. 1919

**Woolley, Sir Charles Leonard** 1880–1960  
English archaeologist

...the digger who will best observe and record his discoveries is precisely he who sees them as historical material and rightly appraises them: if he has not the power of synthesis and interpretation he has mistaken his calling.  
*Digging Up the Past*  
Chapter V (p. 135)  
Charles Scribner's Sons. New York, New York, USA. 1931

## DIGESTION

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English writer

...digestion exists for health, and health exists for life, and life exists for the love of music or beautiful things.  
*Generally Speaking*  
On Misunderstanding (p. 107)  
Dodd, Mead & Company. New York, New York, USA. 1929

## DIGESTIVE CANAL

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

The physiologist who succeeds in penetrating deeper and deeper into the digestive canal becomes convinced that it consists of a number of chemical laboratories equipped with various mechanical devices.  
*Nobel Lectures, Physiology or Medicine 1901–1921*  
Nobel lecture for award received in 1904  
Physiology of Digestion (p. 141)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## DIMENSION

**Abbott, Edwin A.** 1838–1926  
English schoolmaster and theologian

Yet I exist in the hope that these memoirs...may find their way to the minds of humanity in *Some Dimension*, and may stir up a race of rebels who shall refuse to be confined to limited Dimensionality.  
*Flatland: A Romance of Many Dimensions*  
Part II, Section 22 (p. 107)  
Barnes & Noble, Inc. New York, New York, USA. 1963

**Baker, W. R.**  
No biographical data available

Length, breadth, and depth are said to be  
The limits of man's comprehension,  
But when I see the pile of junk  
That she can get into a trunk

The mystery convinces me  
That woman knows a fourth dimension.  
The Magic Box  
*Harper's Magazine*, Volume CLVI, December 1927–May 1928 (p. 649)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The quest of the absolute leads into the four-dimensional world.  
*The Nature of the Physical World*  
Chapter II (p. 26)  
The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955  
German-born physicist

Imagine a bedbug completely flattened out, living on the surface of a globe. This bedbug may be gifted with analysis, he may study physics, he may even write a book. His universe will be two-dimensional. He may even intellectually or mathematically conceive of a third dimension, but he cannot visualize it. Man is in the same position as the unfortunate bedbug, except that he is three-dimensional. Man can imagine a fourth dimension mathematically, but he cannot see it, he cannot visualize it, he cannot represent it physically. It exists only mathematically for him. The mind cannot grasp it.  
*Cosmic Religion, with Other Opinions and Aphorisms*  
On Science (pp. 102–103)  
Covici-Fiede. New York, New York, USA. 1931

**Fock, Vladimir Alexandrovich** 1898–1974  
Russian theoretical physicist

Though we may weigh it as we will,  
Exhausted and delirious,  
One-hundred-thirty-seven still  
Remains for us mysterious.  
But Eddington, he, sees it clear,  
Denouncing those who tend to jeer;  
It is the number of (says he)  
The world's dimensions. Can it?! be?! —  
In George Gamow  
*Biography of Physics* (p. 327)  
Harper & Row, Publishers. New York, New York, USA. 1951

**Hamilton, Sir William Rowan** 1805–65  
Irish mathematician

Time is said to have only one dimension, and space to have three dimensions.... The mathematical quaternion partakes of both these elements; in technical language it may be said to be "time plus space," or "space plus time": and in this sense it has, or at least involves a reference to, four dimensions....  
And how the One of Time, of Space the Three,  
Might in the Chain of Symbols girdled be.  
In Robert Percival Graves

*Life of Sir William Rowan Hamilton* (Volume 3) (p. 635)  
Hodges, Figgis & Company. Dublin, Ireland. 1882–1889

**Maxwell, James Clerk** 1831–79

Scottish physicist

My soul is an entangled knot,  
Upon a liquid vortex wrought  
By Intellect in the Unseen residing,  
And thine doth like a convict sit,  
With marlinespike untwisting it,  
Only to find its knottiness abiding;  
Since all the tools for its untying  
In four-dimensional space are lying,  
Wherein thy fancy intersperses  
Long avenues of universes,  
While Klein and Clifford fill the void  
With one finite, unbounded homoloid,  
And think the Infinite is now at last destroyed.

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

A Paradoxical Ode (p. 649)

Macmillan & Company Ltd. London, England. 1882

**Ray Stantz**

Fictional character

As a duly designated representative of the City, County and State of New York, I order you to cease any and all supernatural activities and return forthwith to your place of origin or to the nearest convenient parallel dimension.

*Ghostbusters*

Film (1984)

**Reichenbach, Hans** 1891–1953

German philosopher of science

Let us assume that the three dimensions of space are visualized in the customary fashion, and let us substitute a color for the fourth dimension. Every physical object is liable to changes in color as well as in position. An object might, for example, be capable of going through all shades from red through violet to blue. A physical interaction between any two bodies is possible only if they are close to each other in space as well as in color. Bodies of different colors would penetrate each other without interference.... If we lock a number of flies into a red glass globe, they may yet escape: they may change their color to blue and then able to penetrate the red globe.

Translated by Maria Reichenback and John Freund

*The Philosophy of Space & Time*

Section 44 (pp. 281, 282)

Dover Publications, Inc. New York, New York, USA. 1958

**Thorne, Kip S.** 1940–

American theoretical physicist

Hyperspaces' third dimension has nothing whatsoever to do with any of the dimensions of our own Universe. It is a dimension into which we can never go and never see,

and from which we can never get information; it is purely hypothetical.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Chapter 3 (p. 130)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

**Updike, John** 1932–

American novelist, short story writer, and poet

Imagine nothing, a total vacuum. But wait! There's something in it! Points, potential geometry. A kind of dust of structurless points. Or, if that's too woolly for you, try "a Borel set of points not yet assembled into a manifold of any particular dimensionality."

*Roger's Version*

Chapter V (p. 303)

Alfred A. Knopf. New York, New York, USA. 1986

...you need no more or less than three dimensions to make a knot, a knot that tightens on itself and won't pull apart, and that's what the ultimate particles are — knots in space-time. You can't make a knot in two dimensions because there's no over or under...

*Roger's Version*

Chapter V (p. 302)

Alfred A. Knopf. New York, New York, USA. 1986

**Uspenskii, Petr Demianovich** 1878–1947

Russian author, thinker, and mystic

And when we shall see or feel ourselves in the world of four dimensions we shall see that the world of three dimensions does not really exist and has never existed: that it was the creation of our own fantasy, a phantom host, an optical illusion, a delusion — anything one pleases excepting only reality.

Translated by Nicholas Bessaraboff and Claude Bragdon

*Tertium Organum: The Third Canon of Thought*

Chapter IX (p. 98)

Vintage Books. New York, New York, USA. 1970

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian and sociologist

There are really four dimensions, three of which we call the three planes of Space, and a fourth, Time. There is, however, a tendency to draw an unreal distinction between the former three dimensions and the latter, because it happens that our consciousness moves intermittently in one direction along the latter from the beginning to the end of our lives.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

"Could I but rotate my arm out of the limits set to it," one of the Utopians had said to him, "I could thrust it into a thousand dimensions."

*Men Like Gods*

Book the Third, Chapter IV, Section 6 (p. 322)

The Macmillan Company. New York, New York, USA. 1923

Mathematical theorists tell us that the only way in which the right and left sides of a solid body can be changed is by taking that body clean out of space as we know it — taking it out of ordinary existence, that is and turning it somewhere outside space.... To put the thing in technical language, the curious inversion of Plattner's right and left sides is proof that he has moved out of our space into what is called the Fourth Dimension, and that he has returned again to our world.

*The Short Stories of H.G. Wells*

The Plattner Story (p. 329)

E. Benn Limited. London, England. 1927

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

I regret that it has been necessary for me in this lecture to administer a large dose of four-dimensional geometry. I do not apologise, because I am really not responsible for the fact the nature in its most fundamental aspect is four-dimensional. Things are what they are....

*The Concept of Nature*

Chapter V (p. 119)

At The University Press. Cambridge, England. 1920

### **Williams, W. H.**

No biographical data available

And space, it has dimensions four,

Instead of only three.

The square of the hypotenuse

Ain't what it used to be.

In Fred Alan Wolf

*Parallel Universes*

Part Three (p. 105)

Simon & Schuster. New York, New York, USA. 1988

## **DINOSAUR**

### **Alexander, R. McNeill** 1934–

Biomechanics researcher

Physics and engineering are as useful in the study of living animals and of the human body as in the study of dinosaurs and other extinct animals. Physics is the basic science of matter and energy, and engineering is physics applied to structures and machines. They and chemistry are the sciences that biologists need to explain the structure and mechanism of living things.

*Dynamics of Dinosaurs and Other Extinct Giants*

Chapter XIII (p. 164)

Columbia University Press. New York, New York, USA. 1989

### **Angelou, Maya**

American poet

Hosts to species long since departed,

Marked the mastodon,

The dinosaur, who left dried tokens of their sojourn here on our planet floor,

Any broad alarm of their hastening doom

Is lost in the form of dust and ages.

*On the Pulse of Morning*

A Rock, a River, a Tree

Random House, Inc. New York, New York, USA. 1993

### **Bakker, Robert T.** 1945–

American paleontologist

If we measure success by longevity, then dinosaurs must rank as the number one success story in the history of the land life. Not only did dinosaurs exercise an airtight monopoly as large land animals, they kept their commanding position for an extraordinary span of time — 130 million years. Our own human species is no more than a hundred thousand years old. And our own zoological class, the Mammalia, the clan of warm-blooded furry creatures, has ruled the land ecosystem for only seventy million years. True, the dinosaurs are extinct, but we ought to be careful in judging them inferior to our kind. Who can say that the human system will last another thousand years, let alone a hundred million? Who can predict that our Class Mammalia will rule for another hundred thousand millennia?

*The Dinosaur Heresies*

Part I The Conquering Cold-Bloods: A Conundrum.

Chapter 1 Brontosaurus in the Great Hall at Yale (p. 16)

William Morrow & Company, Inc. New York, New York, USA. 1986

### **Burroughs, Edgar Rice** 1875–1950

American writer

Bradley was in the lead when he came suddenly upon a grotesque creature of Titanic proportions. Crouching among the trees, which here commenced to thin out slightly, Bradley saw what appeared to be an enormous dragon.... From frightful jaws to the tip of its long tail it was fully forty feet in length. Its body was covered with plates of thick skin which bore a striking resemblance to armor-plate. The creature saw Bradley almost at the same instant that he saw it and reared up on its enormous hind legs until its head towered a full twenty-five feet above the ground. From the cavernous jaws issued a hissing sound of a volume equal to the escaping steam from the safety-valve of half a dozen locomotives, and then the creature came for the man.

*Out of Time's Abyss* (p. 20)

1st World Library. Fairfield Iowa, USA. 2004

### **Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

There were, as I say, five of them, two being adults and the three young ones. In size they were enormous. Even the babies were as big as elephants, while the two large ones were far beyond all creatures I have ever seen. They had slate-coloured skin, which was scaled like a lizard's and shimmered where the sun shone upon it. All

five were sitting up, balancing themselves upon their broad, powerful tails and their huge three-toed hind-feet, while with their small five-fingered front-feet they pulled down the branches upon which they browsed. I do not know what I can bring their appearance home to you better than by saying that they looked like monstrous kangaroos, twenty feet in length, and with skins like black crocodiles.

*The Lost World*

Chapter X (p. 168)

The Colonial Press, Clinton, Massachusetts, USA. 1959

I passed close to the pterodactyl swamp, and as I did so, with a dry, crisp, leathery rattle of wings, one of these great creatures — it was twenty feet at least from tip to tip — rose up from somewhere near me and soared into the air. As it passed across the face of the moon the light shone clearly through the membranous wings, and it looked like a flying skeleton against the white, tropical radiance.

*The Lost World*

Chapter XII (p. 206)

The Colonial Press, Clinton, Massachusetts, USA. 1959

Any one of the larger carnivorous dinosaurs would meet the case. Among them are to be found all the most terrible types of animal life that have ever cursed the earth or blessed a museum.

*The Lost World*

Chapter XI (p. 187)

The Colonial Press, Clinton, Massachusetts, USA. 1959

**Esar, Evan** 1899–1995

American humorist

[Dinosaur] A colossal fossil.

*Esar's Comic Dictionary*

Dinosaur

Doubleday, Garden City, New York, USA. 1983

**Johnston, Eric**

No biographical data available

The dinosaur's eloquent lesson is that if some bigness is good, an overabundance of bigness is not necessarily better.

*Quote, the Weekly Digest*, February 23, 1958

**Kurten, Bjorn** 1924–88

Vertebrate paleontologist

Dinosaurs, more than any other creatures of the past have a popular image. Museum visitors flock to the dinosaur exhibits, whether to get factual information about them, to try to visualize what life was like when these monsters existed in the flesh, or just to wonder at their odd and outlandish shapes.

*The Age of Dinosaurs*

Chapter 1 Theories and Discoveries (p. 7)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Kyte, Frank** 1949–

American geologist and geochemist

You will never convince some paleontologist that an impact killed the dinosaurs unless you find a dinosaur skeleton with a crushed skull and a ring of iridium round the hole.

Quoted in Stefi Weisburd

*Extinction Wars*

*Science News*, February 1, 1986 (p. 77)

**Lester, B. L.**

No biographical data available

Behold the mighty dinosaur,

Famous in prehistoric lore,

Not only for his power and strength

But for his intellectual length.

You will observe by these remains

The creature had two sets of brains —

One in he head (the usual place),

The other in his spinal base.

Thus he could reason “*A priori*”

As well as “*A posteriori*.”

*Chicago Tribune*, 1912

**Owen, Sir Richard** 1804–92

English zoologist and comparative anatomist

The combination of such characters, some, as the sacral bones, altogether peculiar among reptiles, others borrowed, as it were, from groups now distinct from each other, and all manifested by creatures far surpassing in size the largest of existing reptiles, will, it is presumed, be deemed sufficient ground for establishing a distinct tribe or suborder of Saurian Reptiles, for which I would propose the name of Dinosauria.

*Report of the British Association for the Advancement of Sciences*

Report on British Fossil Reptiles, Part II, April 1842 (fn, p. 103)

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

As for the dinosaur — But Noah's conscience was easy; it was not named in his cargo list and he and the boys were not aware that there was such a creature. He said he could not blame himself for not knowing about the dinosaur, because it was an American animal, and America had not then been discovered.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Adam's Soliloquy (p. 636)

The Library of America, New York, New York, USA. 1992

**Updike, John** 1932–

American novelist, short story writer, and poet

A post-heroic herbivore, I come to breakfast liking for

A bite. Behind the box of Brex

I find Tyrannosaurus rex.

*Midpoint and Other Poems*

On the Inclusion of Miniature Dinosaurs in Breakfast Cereal Boxes  
Stanza 1  
Fawcett Publications, Inc. Greenwich, Connecticut, USA. 1970

### Wilford, John Noble

American science writer

...we have...searched under the junipers for some dinosaur bones and come face to face with ourselves.

*The Riddle of the Dinosaur*

Chapter 18 (p. 272)

Alfred A. Knopf. New York, New York, USA. 1986

### Wise, William

No biographical data available

Oh, Dinosaurs, Dinosaurs,  
What do you eat?

Sir, I dine on green leaves,  
And he dines on red meat!

*Dinosaurs Forever*

Dinosaur Dinners

Dial Books for Young Readers. New York, New York, USA. 2000

## DINOSAUR: ALLOSAURUS

### Prelutsky, Jack 1940–

Poet

Allosaurus likes to bite,  
its teeth were sharp as sabers,  
it frequently, with great delight,  
made mincemeat of its neighbors.

*Tyrannosaurus Was a Beast*

Allosaurus

Greenwillow Books. New York, New York, USA. 1988

## DINOSAUR: ANKYLOSAURUS

### Prelutsky, Jack 1940–

Poet

Clankity clankity clankity clank!  
Ankylosaurus was built like a tank,  
its hide was a fortress as sturdy as steel,  
it tended to be an inedible meal.

*Tyrannosaurus Was a Beast*

Ankylosaurus

Greenwillow Books. New York, New York, USA. 1988

## DINOSAUR: ARCHAEOPTERYX

### Moore, John N.

No biographical data available

No one has produced yet a single fossil with half-way wings or a fossil of an animal showing a transition between the cold-blooded scaled reptile and the warm-blooded feathered bird.... And not even the fos-

sil Archaeopteryx can qualify as a transitional form, because it apparently had a bird-like skull, perching feet, and fully developed wings with feathers.

*Should Evolution Be Taught?* (p. 17)

Creation-Life. San Diego, California, USA. 1974

### Pallister, William Hales 1877–1946

Canadian physician

Examine well this ancient bird,  
The Archaeopteryx,  
Dismissing all you may have heard,  
And then his status fix.

*Poems of Science*

Archaeopteryx (p. 217)

Playford Press. New York, New York, USA. 1931

### Pringle, John R.

No biographical data available

One day an Archaeopteryx  
Sat brooding on her nest of sticks,  
“Can it be true what I have heard,  
That I’m a reptile, not a bird?”

*Identity Crisis*

*Perspectives in Biology and Medicine*, Volume 18, Number 3, Spring 1975 (p. 33)

## DINOSAUR: BRACHIOSAURUS

### Prelutsky, Jack 1940–

Poet

Brachiosaurus had little to do  
but stand with its head in the treetops and chew,  
it nibbled the leaves that were tender and green,  
it was a perpetual eating machine.

*Tyrannosaurus Was a Beast*

Brachiosaurus

Greenwillow Books. New York, New York, USA. 1988

## DINOSAUR: BRONTOSAURUS

### Twain, Mark (Samuel Langhorne Clemens) 1835–1910

American author and humorist

[Adam speaking] When the mighty brontosaurus came striding into camp, she regarded it as an acquisition, I considered it a calamity; that is a good sample of the lack of harmony that prevails in our views of things.... She believed it could be tamed by kind treatment and would be a good pet; I said a pet twenty-one feet high and eighty-four feet long would be no proper thing to have about the place...

*Eve's Diary*

Friday (p. 73)

Harper & Brothers Publishers. New York, New York, USA. 1906

**DINOSAUR: ICHTHYOSAURUS****Blackie, John Stuart** 1809–95

Scottish scholar

Behold a strange monster our wonder engages,  
 If dolphin or lizard your wit may defy,  
 Some thirty feet long on the shore of Lyme-Regis  
 With a saw for a jaw, and a big-staring eye.  
 A fish or a lizard? An ichthyosaurus,  
 With big goggle-eyes, and a very small brain,  
 And paddles like mill-wheels in clattering chorus  
 Smiting tremendous the dread sounding main!

*Lays and Legends of Ancient Greece: With Other Poems*

A Song of Geology (p. 23)

Sutherland &amp; Knox. Edinburgh, Scotland. 1857

**Buckland, Francis T.**

English surgeon and naturalist

“You will at once perceive,” continued PROFESSOR ICHTHYOSAURUS, “that the skull [indicating a human skull] before us belonged to some of the lower order of animals; the teeth are very insignificant, the power of the jaws trifling, and altogether it seems wonderful how the creature could have procured food.”

*Curiosities of Natural History*

Frontispiece

R. Bentley &amp; Son. London, England. 1890–1891

**DINOSAUR: IGUANODON****Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“Iguanodons,” said Summerlee. “You’ll find their foot-marks all over the Hastings sands, in Kent, and in Sussex. The South of England was alive with them when there was plenty of good lush green-stuff to keep them going. Conditions have changed, and the beasts died. Here it seems that the conditions have not changed, and the beasts have lived.”

*The Lost World*

Chapter X (p. 172)

The Colonial Press, Clinton, Massachusetts, USA. 1959

**Inscription**

He discovered the Iguanodon

Castle Palace

Gideon Mantell’s House at Lewes, Sussex

**DINOSAUR: LEPTOPTERYGIUS****Prelutsky, Jack** 1940–

Poet

Leptopterygius, big as a city bus,  
 was an insatiable ichthyosaur,  
 anything captured by Leptopterygius

Never was seen in the sea anymore.

*Tyrannosaurus Was a Beast*

Leptopterygius

Greenwillow Books. New York, New York, USA. 1988

**DINOSAUR: PTERODACTYL****Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

There is a chill in the air after dark, and we had all drawn close to the blaze. The night was moonless, but there were some stars, and one could see for a little distance across the plain. Well, suddenly out of the darkness, out of the night, there swooped something with a swish like an aeroplane. The whole group of us were covered for an instant by a canopy of leathery wings, and I had a momentary vision of a long, snake-like neck, a fierce, red, greedy eye, and a great snapping beak, filled, to my amazement, with little, gleaming teeth.

*The Lost World*

Chapter IX (pp. 144–145)

The Colonial Press. Clinton, Massachusetts, USA. 1959

**Kingsley, Charles** 1819–75

English clergyman and author

People call them Pterodactyls: but that is only because they are ashamed to call them flying dragons, after denying so long that flying dragons exist.

*The Water-Babies*

Chapter II (p. 61)

Dodd, Mead &amp; Company. New York, New York, USA. 1910

**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

The less said about the pterodactyl the better. It was a spectacle, that beast! a mixture of buzzard and alligator, a sarcasm, an affront to all animated nature, a butt for the ribald jests of an unfeeling world. After some ages Nature perceived that to put feathers on a reptile does not ennoble it, does not make it a bird, but only a sham, a joke, a grotesque curiosity, a monster; also that there was no useful thing for the pterodactyl to do, and nothing likely to turn up in the future that could furnish it employment. And so she abolished it.

In John S. Tuckey (ed.)

*Mark Twain’s Fables of Man*

Flies and Russians

University of California Press. Berkeley, California, USA. 1972

Now I’ll bet there isn’t a man here who can spell “pterodactyl,” not even the prisoner at the bar. I’d like to hear him try once — but not in public, for it’s too near Sunday, when all extravagant histrionic entertainments are barred. I’d like to hear him try in private, and when he got through trying to spell “pterodactyl” you wouldn’t know

whether it was a fish or a beast or a bird, and whether it flew on its legs or walked with its wings. The chances are that he would give it tusks and make it lay eggs.

*Mark Twain's Speeches?*

The Alphabet and Simplified Spelling (p. 201)

Harper & Brothers Publishers. New York, New York, USA. 1910

## DINOSAUR: STEGOSAURUS

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

For a moment I wondered where I could have seen that ungainly shape, that arched back with triangular fringes along it, that strange bird-like head held close to the ground. Then it came back to me. It was the stegosaurus — the very creature which Maple White had preserved in his sketch-book, and which had been the first object which arrested the attention of Challenger! There he was — perhaps the very specimen which the American artist had encountered. The ground shook beneath his tremendous weight, and his gulplings of water resounded through the still night. For five minutes he was so close to my rock that by stretching out my hand I could have touched the hideous waving hackles upon his back. Then he lumbered away and was lost among the boulders.

*The Lost World*

Chapter XII (p. 211)

The Colonial Press, Clinton, Massachusetts, USA. 1959

## DINOSAUR: TYRANNOSSAURUS

**Carpenter, Kenneth**

Paleontologist

Tyrannosaurus was truly the Schwarzenegger of dinosaurs.

*Times*, 3 July 1990

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Tyrannosaurs, enormous bipedal caricatures of men, would stalk mindlessly across the sites of future cities and go their way down into the dark of geologic time.

*The Immense Journey*

How Flowers Changed the World (p. 64)

Vintage Books. New York, New York, USA. 1957

**Wise, William**

No biographical data available

What colors were the Dinosaurs?

The fact is, no one knows.

We're only sure that each had skin

That stretched from head to toes....

But one thing I am certain of —

I truly cannot think

That huge Tyrannosaurus Rex

Could ever have been pink!

*Dinosaurs Forever*

Dinosaur Colors

Dial Books for Young Readers. New York, New York, USA. 2000

## DISCHARGE

**Flaubert, Gustave** 1821–90

French novelist

Discharge. Rejoice when it leaves any affected part, and express astonishment that the human body can contain so much matter.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

## DISCONTINUITY

**Landé, Alfred** 1888–1976

German-born American physicist

...if our world is not “the best of all possible worlds” it certainly is the only one in which it is possible to avoid the dilemma of discontinuity.

Quantum Mechanics, A Thermodynamic Approach

*American Scientist*, Volume 41, Number 3, July 1953 (p. 448)

## DISCOVER

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

We do not yet pretend to have discovered all things, or that what we have discovered can receive no addition; and therefore, pray let us agree, there are yet many things to be done in the ages to come.

*Conversations on the Plurality of Worlds*

The Second Evening (p. 66)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Edison, Thomas** 1847–1931

American inventor

When I want to discover something, I begin by reading up everything that has been done along that line in the past — that's what all these books in the library are for. I see what has been accomplished at great labor and expense in the past. I gather the data of many thousands of experiments as a starting point, and then I make a thousand more.

In Dogbert D. Runes (ed.)

*The Diary and Sundry Observations of Thomas Alva Edison*

Chapter XXVII (pp. 161–162)

Philosophical Library. New York, New York, USA. 1948

**Hadamard, Jacques** 1865–1963

French mathematician

It is important for him who wants to discover not to confine himself to one chapter of science, but to keep in touch with various others.

In Freeman Dyson  
Missed Opportunities  
*Bulletin of the American Mathematical Society*, New Series, Volume 78,  
Number 5, 1972

### Half, Robert

No biographical data available

The first step to finding something is knowing where to look.

*Robert Half on Hiring*  
Chapter 3 (p. 31)  
Crown Publishers Inc. New York, New York, USA. 1985

### Huxley, Julian 1887–1975

English biologist, philosopher, and author

To discover the real nature of things, we must discard all prejudices, all purely instinctive ways of thinking, and labour along the stony but sure path of reason and verification.

In J. Arthur Thomson  
*The Outline of Science* (Volume 3)  
Chapter XIX (p. 673)  
G.P. Putnam's Sons. New York, New York, USA. 1937

### Mach, Ernst 1838–1916

Austrian physicist and philosopher

The sailor in whose phantasy objects swept up on the coast vividly provoke the picture of a far-off land will go to look for it. Whether he finds it or not, whether its location and character correspond with his idea or not, if instead of the surmised Indian or Chinese coast he discovers a new one, in any case he has widened his experience.

*Knowledge and Error: Sketches on the Psychology of Enquiry*  
Chapter XIV (p. 172)  
D. Reidel Publishing Company. Dordrecht, Netherlands. 1976

### Thompson, Sir D'Arcy Wentworth 1860–1948

Scottish zoologist and classical scholar

It behooves us always to remember that in physics it has taken great men to discover simple things.

*On Growth and Form* (Volume 1)  
Chapter I (p. 13)  
At The University Press. Cambridge, England. 1951

### Wren, Sir Christopher 1632–1723

English mathematician architect

But then I only begin to value the Advantage of this Age in Learning before the former, when I fancy him (Seneca) continuing his Prophecy (of a new world), and imagine how much the ancient laborious Enquirers would envy us, should he have sung to them, that a Time would come, when Men should be able to stretch out their Eyes, as Snails do, and extend them to fifty feet in length; by which means, they should be able to discover Two Thousand Times as many Stars as we can; and find this Galaxy

to be Myriads of them; and every nebulous Star appearing as if it were the Firmament of some other World, at an incomprehensible Distance, buried in the vast Abyss of intermundious vacuum. ([O]r, in the original Latin “*si nebulosam quam stellam Potius Firmamentum esse, non nostrum portasse sed Remotissimi cujus da Mundi quam vastis Intermundiis dissiti.*”)

Inaugural Address  
Gresham College, 1657, Quoted by G.J. Whitrow, *The Quarterly Journal of the Royal Astronomical Society*, Volume 8, 1967 (p. 55)

### Wright, Thomas 1711–86

English cosmologist

Time and Observation will undoubtedly, at last, discover every thing to us necessary to our Natures, and proper for us to know.

*An Original Theory or New Hypothesis of the Universe*  
Letter the Second (p. 9)  
Printed for the Author. London, England. 1750

## DISCOVERY

### Author undetermined

Nothing can be more puerile than the complaints sometimes made by certain cultivators of a science, that it is very difficult to make discoveries now that the soil has been exhausted, whereas they were so easily made when the ground was first broken. It is an error begotten by ignorance out of indolence. The first discovery did not drop upon the expectant idler who, with placid equanimity waited for the goods the gods might send, but was heavily obtained by patient, systematic, and intelligent labour; and, beyond all question, the same labour of the same mind which made the first discoveries in the new science, would now succeed in making many more, trampled though the field may be by the restless feet of those unmethodical inquirers who, running to and fro, anxiously exclaim, “Who will show us any good thing?”

*Psychological Inquiries*  
*Journal of Mental Science*, 1862 (p. 212)

Pioneers occupy new land. Only later, one comes to understand that the cabins they built were really cathedrals.

In Jeremy Bernstein  
*Experiencing Science*  
Part 1. Two Faces of Physics  
Chapter I. Kepler: Harmony of the World (p. 3)  
Basic Books, Inc., Publishers. New York, New York, USA. 1978

Show me the scientific man who never made a mistake, and I will show you one who never made a discovery.

In J.A. Thomson  
*Introduction to Science*  
Chapter III (p. 73)  
Williams & Norgate Ltd. London, England. 1916



**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

They are ill discoverers that think there is no land, when they can see nothing but the sea.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VII, Section 5 (p. 44)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...brutes by their natural instinct made many discoveries, whilst men derived but few from discussion and the conclusions of reason.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 73 (p. 118)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Barth, John** 1930–

American writer

“My project,” he told us, “is to learn where to go by discovering where I am by reviewing where I’ve been — where we’ve all been...”

*Chimera*

Dunyazadiad (p. 10)

Fawcett. Greenwich, Connecticut, USA. 1972

**Bernard, Claude** 1813–78

French physiologist

Men who have excessive faith in their theories or ideas are not only ill prepared for making discoveries; they also make very poor observations.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section iii (p. 38)

Henry Schuman, Inc. New York, New York, USA. 1927

Ardent desire for knowledge, in fact, is the one motive attracting and supporting investigators in their efforts; and just this knowledge, really grasped and yet always flying away before them, becomes at once their sole torment and sole happiness. Those who do not know the torment of the unknown cannot have the joy of discovery, which is certainly the liveliest that the mind of man can ever feel.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter IV, Section iv (pp. 221–222)

Henry Schuman, Inc. New York, New York, USA. 1927

It has often been said that, to make discoveries, one must be ignorant. This opinion, mistaken in itself, nevertheless conceals a truth. It means that it is better to know nothing than to keep in mind fixed ideas based on theories whose confirmation we constantly seek, neglecting meanwhile everything that fails to agree with them.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section iii (p. 37)

Henry Schuman, Inc. New York, New York, USA. 1927

...a discovery is generally an unforeseen relation not included in theory, for otherwise it would be foreseen.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section iii (p. 38)

Henry Schuman, Inc. New York, New York, USA. 1927

A great discovery is a fact whose appearance in science gives rise to shining ideas, whose light dispels many obscurities and shows us new paths.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section II (p. 34)

Henry Schuman, Inc. New York, New York, USA. 1927

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

Often the original discovery, like the crude ore from the mine, is of little value until it has been refined and fully developed...

*The Art of Scientific Investigation*

Chapter Seven (p. 91)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

Probably the majority of discoveries in biology and medicine have been come upon unexpectedly, or at least had an element of chance in them, especially the most important and revolutionary ones.

*The Art of Scientific Investigation*

Chapter Three (p. 31)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bolyai, János** 1802–60

Hungarian mathematician

Mathematical discoveries, like springtime violets in the woods, have their season which no human can hasten or retard.

Quoted in Israel Kleiner

Thinking the Unthinkable: The Story of Complex Numbers (with a Moral), *Mathematics Teacher*, Volume 81, Number 7, October 1988 (p. 590)

**Bolyai, Wolfgang** 1775–1856

Hungarian mathematician

...it seems to be true that many things have as it were, an epoch in which they are discovered in several places simultaneously, just as the violets appear on all sides in springtime.

In Harold Wolfe

*Introduction to Non-Euclidean Geometry* (p. 45)

Dryden Press. New York, New York, USA. 1945

**Brougham, Henry** 1778–1868

English statesman

A discovery in mathematics, or a successful induction of facts, when once completed, cannot be too soon given to the world. But...an hypothesis is a work of fancy, useless in science, and fit only for the amusement of a vacant hour...

*Edinburgh Review*  
1, 1803 (p. 451)

**Bruner, Jerome Seymour** 1915–  
American psychologist

First, I should be clear about what the act of discovery entails. It is rarely, on the frontier of knowledge or elsewhere, that new facts are “discovered” in the sense of being encountered, as Newton suggested, in the form of islands of truth in an uncharted sea of ignorance. Or if they appear to be discovered in this way, it is almost always thanks to some happy hypothesis about where to navigate. Discovery, like surprise, favors the well-prepared mind.

*On Knowing: Essays for the Left Hand*  
Part I, The Quest for Clarity (p. 82)  
Harvard University Press. Cambridge, Massachusetts, USA. 1979

**Calder, Peter Ritchie** 1906–82  
Scottish journalist and author

The genealogy of scientific discovery is important because every scientist inherits so much from his predecessors. Science is evolutionary, depending upon the intermarriage of ideas. The family tree of a major scientific discovery is usually more impressively international than that of the most august royal house.

*Profile of Science*  
Chapter 2 (p. 32)  
George Allen & Unwin Ltd. London, England. 1951

**Camras, Marvin** 1916–95  
American inventor

A scientific discovery...doesn't have to please anybody. It just has to be in accordance with nature, and it has to work.

In Kenneth A Brown  
*Inventors at Work: Interviews with 16 Notable American Inventors*  
Marvin Carmas (p. 75)  
Tempus Books of Microsoft Press, Redmond, Washington, USA. 1988

**Cannon, Walter Bradford** 1871–1945  
American neurologist and physiologist

Investigators do not march straight to their goal with ease and directness.

*The Way of an Investigator: A Scientist's Experiences in Medical Research*  
Chapter II (p. 22)  
W.W. Norton & Company, Inc. New York, New York, USA. 1945

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

My life has been marked by two immense and fateful scientific discoveries: the splitting of the atom, [and] the recognition of the chemistry of heredity and its subsequent manipulation. It is the mistreatment of nucleus that, in both instances, lies at the basis: the nucleus of the atom, the nucleus of the cell. In both instances do I

have the feeling that science has transgressed a barrier that should have remained inviolate. As happens often in science, the first discoveries were made by thoroughly admirable men, but the crowd that came right after had a more mephitic smell.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Rockefeller University Press. New York, New York, USA. 1978

**Chekhov, Anton Pavlovich** 1860–1904  
Russian author and playwright

VERSHININ: Take Copernicus or Columbus, for instance — didn't their discoveries seem useless or ridiculous at first, and some fool's empty nonsense seem the truth?

Translated by Randall Jarrell  
*The Three Sisters*  
Act I (p. 14)  
Collier-Macmillan Canada, Ltd. Toronto, Ontario, Canada. 1969

**Chernyshevsky, Nikolai Gavrilovich** 1828–89  
Russian socialist reformer

Our time is a time of great discoveries and firm scientific convictions.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneerson  
Progress Publishers. Moscow, Russia. 1979

**Chomsky, Noam** 1928–  
American linguist

Discovery is the ability to be puzzled by simple things.

In Ron Grossman  
Strong Words, Asking the Questions  
*Chicago Tribune*, 1:5, Section 5, January 1, 1993

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

It is impossible to follow with intelligent interest the course of astronomical discovery without feeling some curiosity as to the means by which such surpassing results have been secured. Indeed, the bare acquaintance with what has been achieved, without any corresponding knowledge of how it has been achieved, supplies food for barren wonder rather than for fruitful and profitable thought.

*A Popular History of Astronomy During the Nineteenth Century*  
Part I, Chapter VI (p. 108)  
A. & C. Black. London, England. 1908

**Conant, James Bryant** 1893–1978  
American educator and scientist

...experimental discoveries must fit the time; facts may be at hand for years without their significance being realized; the total scientific situation must be favorable for the acceptance of new views.

*On Understanding Science*

Chapter III (p. 74)  
Yale University Press. New Haven, Connecticut, USA. 1947

**Crichton, Michael** 1942–  
American novelist

Discovery is always a rape of the natural world. Always.  
*Jurassic Park*  
Aviary (p. 284)  
Alfred A. Knopf. New York, New York, USA. 1990

**Cronenberg, David** 1943–  
Canadian director

The way a child discovers the world constantly replicates the way science began. You start to notice what's around you, and you get very curious about how things work. How things interrelate. It's as simple as seeing a bug that intrigues you. You want to know where it goes at night; who its friends are; what it eats.

*Cronenberg on Cronenberg*  
Chapter 1 (p. 5)  
Faber & Faber. London, England. 1992

**Curie, Marie Skłodowska** 1867–1934  
Polish-born French physicist and chemist

“The moment of discovery” does not always exist: the scientist's work is too tenuous, too divided, for the certainty of success to crackle out suddenly in the midst of his laborious toil like a stroke of lightening, dazzling him by its fire.

In Eve Curie  
*Madame Curie*  
Chapter XII (p. 158)  
The Literary Guild of America, Inc. New York, New York, USA. 1937

A great discovery does not leap completely achieved from the brain of the scientist, as Minerva sprang, all panoplied, from the head of Jupiter; it is the fruit of accumulated preliminary work.

*Pierre Curie*  
Chapter VII (p. 144)  
The Macmillan Company. New York, New York, USA. 1926

**Davy, Sir Humphry** 1778–1829  
English chemist

The greatest use of practical science is discovery.  
*The Collected Works of Sir Humphry Davy* (Volume 1)  
Memories of the Life of Sir Humphry Davy  
Chapter III (p. 154)  
Smith, Elder & Company. London, England. 1839–1849

Imagination, as well as reason, is necessary to perfection in the philosophical mind. A rapidity of combination, a power of perceiving analogies, and of comparing them by facts, is the creative source of discovery.

In John Davy (ed.)  
*The Collected Works of Sir Humphry Davy* (Volume 8)  
Parallels Between Art and Science (p. 308)  
Smith, Elder & Company. London, England. 1839–1840

**de Castro, Adolphe** 1890–1937  
Supernatural fiction and fantasy writer

What a grown man worships is truth — knowledge — science — light — the rending of the veil and the pushing back of the shadow. Knowledge, the juggernaut! There is death in our own ritual. We must kill — dissect — destroy — and all for the sake of discovery — the worship of the ineffable light. The goddess Science demands it. We test a doubtful poison by killing. How else? No thought for self — just knowledge — the effect must be known.

In H.P. Lovecraft (ed.)  
*The Horror in the Museum and Other Revisions*  
The Last Test (p. 215)  
Arkham House: Publishers. Sauk City, Wisconsin, USA. 1970

**de Maistre, J.**  
No biographical data available

Those who have made the most discoveries in science are those who knew Bacon least, while those who have read and pondered him, like Bacon himself, have not succeeded well.

In Hans Selye  
*From Dream to Discovery: On Being a Scientist* (p. 263)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**de Morgan, Augustus** 1806–71  
English mathematician and logician

Modern discoveries have not been made by large collections of facts, with subsequent discussion, separation, and resulting deduction of a truth thus rendered perceptible. A few facts have suggested an hypothesis which means a supposition proper to explain them. The necessary results of this supposition are worked out, and then, and not till then, other facts are examined to see if their ulterior results are found in nature.

*A Budget of Paradoxes*  
Francis Bacon (p. 55)  
Longmans, Green. London, England. 1872

Great discoveries are always laughed at: but it is very often not the laugh of incredulity; it is a mode of distorting the sense of inferiority into a sense of superiority, or a mimicry of superiority interposed between the laughter and his feeling of inferiority.

*A Budget of Paradoxes*  
Milner's Lamp (p. 149)  
Longmans, Green. London, England. 1872

**Dock, William** 1898–1990  
American physicist

The most remarkable fact about the Korotkoff sound is that it was discovered. Its observation confirmed Pasteur's thesis that “chance favors the prepared mind” — meaning that chances are innumerable or infrequent but prepared minds are very rare.

Korotkoff's Sounds  
*New England Journal of Medicine*, Volume 302, 1980

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

...we have not to discover the properties of a thing which we have recognized in nature, but to discover how to recognize in nature a thing whose properties we have assigned.

*The Mathematical Theory of Relativity*  
 Introduction (p. 6)  
 At The University Press. Cambridge, England. 1930

**Eden, Sir Anthony** 1897–1977  
 British politician and statesman

Every succeeding scientific discovery makes greater nonsense of old-time conceptions of sovereignty.

Speech  
 House of Commons, November 22, 1945

**Edison, Thomas** 1847–1931  
 American inventor

Many great discoveries remain to be made. We must start anew in many things, rejecting the old theories as Einstein did, building along new lines as Einstein did, fearing nothing any more than Einstein did.

In Dogbert D. Runes (ed.)  
*The Diary and Sundry Observations of Thomas Alva Edison*  
 Chapter XXXXI (p. 227)  
 Philosophical Library. New York, New York, USA. 1948

**Einstein, Albert** 1879–1955  
 German-born physicist

The history of scientific and technical discovery teaches us that the human race is poor in independent thinking and creative imagination.

Translated by Alan Harris  
*Essays In Science*  
 The Flettner Ship (p. 92)  
 Philosophical Library. New York, New York, USA. 1934

The use of the word "Discovery" in itself is to be deprecated. For discovery is equivalent to becoming aware of a thing which is already formed; this links up with proof, which no longer bears the character of "discovery" but, in the last instance, of the means that leads to discovery.... Discovery is really not a creative act!

In Alexander Moszkowski  
*Conversations with Einstein*  
 Chapter V (pp. 94, 95)  
 Horizon Press. New York, New York, USA. 1970

In the light of knowledge attained, the happy achievement seems almost a matter of course, and any intelligent student can grasp it without too much trouble. But the years of anxious searching in the dark, with their intense longing, their alternations of confidence and exhaustion,

and the final emergence into the light; — only those who have experienced it can understand that.

Translated by Alan Harris  
*Essays in Science*  
 The General Theory of Relativity (p. 84)  
 Philosophical Library. New York, New York, USA. 1934

...the scientist finds his reward in what Henri Poincaré calls the joy of comprehension, and not in the possibilities of application to which any discovery of his may lead.

In Max Planck  
*Where Is Science Going?*  
 Epilogue (p. 211)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Eiseley, Loren C.** 1907–77  
 American anthropologist, educator and author

Every man contains within himself a ghost continent — a place circled as warily as Antarctica was circled two hundred years ago by Captain James Cook. If, in addition, the man is a scientist, he will see strange shapes amidst his interior ice floes and be fearful of exposing to the ridicule of his fellows what he has seen.

*The Unexpected Universe*  
 Chapter One (p. 3)  
 Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Epps, John** 1805–69  
 Physician

Let it be remembered that there are, in every discovery, two accidents; the accident of meeting with the fact connected with the discovery, and the accident of possessing an ingenious, and, in most cases, a great mind to take advantage of the fact.

*Life of John Walker, M.D.*  
 Chapter XII (p. 295)  
 Whittaker, Treacher & Company. London, England. 1831

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

We are very lucky to be living in an age in which we are still making discoveries.... The age in which we live is the age in which we are discovering the fundamental laws of nature, and that day will never come again. It is very exciting, it is marvelous, but this excitement will have to go.

*The Character of Physical Law*  
 Chapter 7 (p. 172)  
 British Broadcasting Company. London, England. 1965

The prize is the pleasure of finding the thing out, the kick in the discovery, the observation that other people use it [my work] — those are the real things, the honors are unreal to me.

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 1 (p. 12)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

I think the problem is not to find the best or most efficient method to proceed to a discovery, but to find any method at all.

*Nobel Lectures, Physics 1963–1970*  
Nobel lecture for award received in 1965  
The Development of the Space-Time View of Quantum Electrodynamics  
Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Fischer, Martin H.** 1879–1962  
German-American physician

Every discovery in science is a tacit criticism of things as they are. That is why the wise man is invariably called a fool.

In Howard Fabing and Ray Marr  
*Fischerisms*  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Fleming, Sir Alexander** 1881–1955  
Scottish bacteriologist

We all know that chance, fortune, fate or destiny — call it what you will — has played a considerable part in many of the great discoveries in science. We do not know how many, for all scientists who have hit on something new have not disclosed exactly how it happened.

*Les Prix Nobel. The Nobel Prizes in 1945*  
Nobel banquet speech for award received in 1945  
Nobel Foundation. Stockholm, Sweden. 1946

It may be that while we think we are masters of the situation we are merely pawns being moved about on the board of life by some superior power.

*Les Prix Nobel. The Nobel Prizes in 1945*  
Nobel banquet speech for award received in 1945  
Nobel Foundation. Stockholm, Sweden. 1946

**Fourier, (Jean Baptiste-) Joseph** 1768–1830  
French mathematician and physicist

Profound study of nature is the most fertile source of mathematical discovery.

In *Great Books of the Western World* (Volume 43)  
*The Analytical Theory of Heat*  
Preliminary Discourse (pp. 172–173)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

Scientific discovery is invention, and vice versa.

*Nine Chains to the Moon*  
Chapter 22 (p. 169)  
Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

A discovery is the product of a previous discovery and in its turn it will give rise to a further discovery.

In Maurice Crosland  
*Gay-Lussac: Scientist and bourgeois*  
Chapter 4 (p. 71)  
Cambridge University Press. Cambridge, England. 1978

**Gilbert, William** 1544–1603  
English scientist and physician

Since in the discovery of secret things and in the investigation of hidden causes, stronger reasons are obtained from sure experiments and demonstrated arguments than from probable conjectures and the opinions of philosophical speculators of the common sort...

In *Great Books of the Western World* (Volume 28)  
*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*  
Preface (p. 1)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Glass, H. Bentley**  
No biographical data available

We are like the explorers of a great continent who have penetrated to its margins in most points of the compass and have mapped the major mountain chains and rivers. There are still innumerable details to fill in, but the endless horizons no longer exist.

Science: Endless Horizons or Golden Age?  
*Science*, Volume 171, 1971 (p. 24)

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

What could be more democratic than the principle that nuggets of real discovery abound in primary sources, located in such accessible places as major university and city libraries, for those willing to do the work and develop the skills.

*Leonardo's Mountain of Clams and the Diet of Worms*  
Introduction (p. 5)  
Harmon Brown, New York, New York, USA. 1998

Since all discovery emerges from an interaction of mind and nature, thoughtful scientists must scrutinize the main biases that record our socialization, our moment in political and geographical history, even the limitations (if we hope to comprehend them from within) imposed by a mental machinery jury-rigged in the immensity of evolution.

*Dinosaur in a Haystack: Reflections in Natural History*  
Part Seven, Chapter 27 (p. 345)  
Random House, Inc. New York, New York, USA. 1995

**Granick, Samuel**  
No biographical data available

There is a constant urge in man to seek beginnings.

Speculations on the Origins and Evolution of Photosynthesis  
*Annals of the New York Academy of Science*, Volume 69, 1957

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

The pleasure derived from the discovery of some secret of Nature unknown before except to the architect of the universe surpasses all the rewards the world can give.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 17)

Macmillan & Company Ltd. London, England. 1918

Most men of science are neither suppliants at the feet of Nature nor fiery advocates of truths wrested from her, but by critical inquiry into the origin of her strength and weakness they hope to discover the means of subduing her.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 4)

Macmillan & Company Ltd. London, England. 1918

### **Hamilton, Sir William Rowan** 1805–65

Irish mathematician

In physical sciences the discovery of new facts is open to any blockhead with patience and manual dexterity and acute senses.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eleven (p. 144)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **Harwit, Martin**

American astronomer

The history of most efforts at discovery follows a common pattern, whether we consider the discovery of varieties of insects, the exploration of the oceans for continents and islands, or the search for oil reserves in the ground. There is an initial accelerating rise in the discovery rate as increasing numbers of explorers become attracted. New ideas and tools are brought to bear on the search, and the pace of discovery quickens. Soon, however, the number of discoveries remaining to be made dwindles, and the rate of discovery declines despite the high efficiency of the methods developed. The search is approaching an end. An occasional, previously overlooked feature can be found or a particular rare species encountered; but the rate of discovery begins to decline quickly and then diminishes to a trickle. Interest drops, researchers leave the field, and there is virtually no further activity.

*Cosmic Discovery*

Chapter I (pp. 42–43)

Basic Books, Inc. New York, New York, USA. 1981

### **Henry, Joseph**

No biographical data available

The seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them.

In Walter B. Cannon

*The War of an Investigator, a Scientist's Experience in Medical Research*

Chapter VI (p. 76)

W.W. Norton & Company, Inc. New York, New York, USA. 1945

### **Hill, Archibald V.** 1886–1977

English physiologist

Those whose lives are so filled with the romance of discovery, whose years are a holiday of exploration, do not need, do not deserve, payment for their toil. Their work itself is adequate reward, they have more happiness already than their share...

*Les Prix Nobel. The Nobel Prizes in 1922*

Nobel banquet speech for award received in 1922

Nobel Foundation. Stockholm, Sweden. 1923

### **Hitching, Francis** 1933–

English author

Science is a voyage of discovery, and beyond each horizon there is another.

*The Neck of the Giraffe: Where Darwin Went Wrong*

Part Three, Chapter 9 (p. 263)

Ticknor & Fields. New Haven, Connecticut, USA. 1982

### **Holton, Gerald** 1922–

Research professor of physics and science history

...it is precisely because the drive toward discovery is in a sense irrational that it is so powerful.

*Thematic Origins of Scientific Thought: Kepler to Einstein*

Chapter 11 (p. 390)

Harvard University Press. Cambridge, Massachusetts, USA. 1973

### **Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

Great credit accrues to those who make a scientific discovery when the world is already teetering on the edge of it, whereas the discoverer who is markedly too early scarcely earns a footnote in scientific history.

*Observational Cosmology*

Final Remarks

ASP Conference Series, Volume 51, 1993 (p. 695)

### **Huggins, Sir William** 1824–1910

English astronomer

From individual minds are born all great discoveries and revolutions of thought. New ideas may be in the air, and more or less present in many minds, but it is always an individual who at the last takes the creative step and enriches mankind with the living germ — thought of a new era of opinion.

Presidential Address

Royal Society Anniversary Meeting, November 30, 1905

In William H. George

*The Scientist in Action: A Scientific Study of His Methods*

Some Problems in Theorizing (p. 265)

William & Norgate. London, England. 1936

### **Joly, John** 1857–1933

Irish physicist and geologist

In our day but little time elapses between the discovery and its application.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*  
 Uranium and Geology (p. 355)  
 Government Printing Office, Washington, D.C. 1909

**Kekulé, Friedrich August** 1829–96  
 German chemist

I fell into a reverie, and lo, the atoms were gamboling before my eyes! Whenever, hitherto, these diminutive beings had appeared to me, they had always been in motion; but up to that time I had never been able to discern the nature of their motion. Now, however, I saw how, frequently, two smaller atoms united to form a pair; how a larger one embraced the two smaller ones; how still larger ones kept hold of three or even four of the smaller; whilst the whole kept whirling in a giddy dance. I saw how the larger ones formed a chain, dragging the smaller ones after them but only at the ends of the chain.

In O. Theodor Benfey  
*From Vital Force to Structural Formulas*  
 Chapter 9 (p. 77)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Kepler, Johannes** 1571–1630  
 German astronomer

Here it is a question not only of leading the reader to an understanding of the subject matter in the easiest way, but also, chiefly, of the arguments, meanderings, or even chance occurrences by which I the author first came upon that understanding. Thus, in telling of Christopher Columbus, Magellan, and of the Portuguese, we do not simply ignore the errors by which the first opened up America, the second, the China Sea, and the last, the coast of Africa; rather, we would not wish them omitted, which would indeed be to deprive ourselves of an enormous pleasure in reading.

*New Astronomy*  
 Summaries of the individual chapters (p. 78)  
 At The University Press, Cambridge, England. 1992

**Körner, T. W.**  
 No biographical data available

It is sometimes said that the great discovery of the nineteenth century was that the equations of nature were linear, and the great discovery of the twentieth century is that they are not.

*Fourier Analysis*  
 Chapter 24 (p. 99)  
 Cambridge University Press, Cambridge England. 1988

**Kuhn, Thomas S.** 1922–96  
 American historian of science

Discovery commences with the awareness of anomaly, *i.e.*, with the recognition that nature has somehow violated the paradigm-induced expectations that govern normal science. It then continues with a more or less extended exploration of the area of anomaly. And it closes

only when the paradigm theory has been adjusted so that the anomalous has become the expected.... Until he has learned to see nature in a different way — the new fact is not quite a scientific fact at all.

*The Structure of Scientific Revolutions*  
 Chapter VI (pp. 52–53)  
 The University of Chicago Press, Chicago, Illinois, USA. 1970

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
 French biologist

...the most important discoveries of the laws, methods and progress of nature have nearly always sprung from the examination of the smallest objects which she contains...

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
 Preliminary Discourse (pp. 9–10)  
 The University of Chicago Press, Chicago, Illinois, USA. 1984

**Laplace, Pierre Simon** 1749–1827  
 French mathematician, astronomer, and physicist

One of the strongest passions in a man of genius, is the love of truth. Full of the enthusiasm which a great discovery inspires, he burns with ardor to disseminate it, and the obstacles which ignorance and superstition, armed with power, oppose to it, only stimulate and increase his energy...

*System of the World (Volume 2)*  
 Book V, Chapter IV (p. 266)  
 Longman, Rees, Orme, Brown & Green, Dublin, Ireland. 1830

**Leibniz, Gottfried Wilhelm** 1646–1716  
 German philosopher and mathematician

The art of discovering the causes of phenomena, or true hypothesis, is like the art of deciphering, in which an ingenious conjecture often greatly shortens the road.

*New Essays Concerning Human Understanding*  
 Book IV, Chapter XII (p. 526)  
 The Open Court Publishing Company, La Salle, Illinois, USA. 1916

It is an extremely useful thing to have knowledge of the true origins of memorable discoveries, especially those that have been found not by accident but by dint of meditation. It is not so much that thereby history may be attributed to each man his own discoveries and others should be encouraged to earn like commendation, as that the art of making discoveries should be extended by considering noteworthy examples of it.

*The Early Mathematical Manuscripts of Leibniz*  
 Historia et Origo Calculi Differentialis  
 Chapter III (p. 22)  
 The Open Court Publishing Company, La Salle, Illinois, USA. 1920

**Lonergan, Bernard J. F.** 1904–84  
 Canadian philosopher, theologian, and educator

Discovery is new beginning. It is the origin of new rules that supplement, or even supplant, the old. Genius is creative. It is genius precisely because it disregards established routines, because it originates the novelties that will be the routines of the future. Were there rules for discovery, then discoveries would be mere conclusions.

*Insight*

Chapter I (p. 4)

Harper & Row, Publishers. San Francisco, California, USA. 1978

### **Lowell, Percival** 1855–1916

American astronomer

The road to discovery is not an easy one to travel.... There is to add to its forbiddingness no warm compensating reception at its end, except in one's own glow of attainment. For progress is first obstructed by the reticence of nature and then opposed by the denunciation of man. Nature does not help and humanity hinders. If nature abhors a vacuum, mankind abhors filling it. A really new idea is a foundling without friends. Indeed a doorstep acquisition is welcome compared with the gift of a brand new upsetting thought. The undesired outsider is ignored, pooh-poohed, denounced, or all three according to circumstances. A generation or more is needed to secure it a hearing and more time still before its worth is recognized.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 299)

University of Arizona Press. Tucson, Arizona, USA. 1976

### **Maddox, John Royden** 1925–

Welsh chemist and physicist

The river of discovery will continue to flow without cessation, deepening our understanding of the world and enhancing our capacity to forefend calamity and live congenial lives.

*What Remains to Be Discovered*

Introduction (p. 21)

The Free Press. New York, New York, USA. 1998

### **Mayo, William J.** 1861–1939

American physician

It is a great thing to make scientific discoveries of rare value, but it is even greater to be willing to share these discoveries and to encourage other workers in the same field of scientific research.

Remarks on the Romance of Medicine

*Proceedings of Staff Meetings, Mayo Clinic*, Volume 10, June 19, 1935

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Deductivism in mathematical literature and inductivism in scientific papers are simply the postures we choose to be seen in when the curtain goes up and the public sees us. The theatrical illusion is shattered if we ask what goes

on behind the scenes. In real life discovery and justification are almost always different processes.

*Induction and Intuition in Scientific Thought*

Chapter II, Section 2 (p. 26)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

It can be said with complete confidence that any scientist of any age who wants to make important discoveries must study important problems. Dull or piffling problems yield dull or piffling answers. It is not enough that a problem should be “interesting” — almost any problem is interesting if it is studied in sufficient depth.... No, the problem must be such that it matters what the answer is — whether to science generally or to mankind.

*Advice to a Young Scientist*

Chapter 3 (p. 13)

Basic Books, Inc., Publishers. New York, New York, USA. 1979

### **Mendeleev, Dmitry** 1834–1907

Russian chemist

Scientific discoveries are rarely made overnight, for usually the heralds do not at once manage to convince the world in the verity of the discovered; but we must not forget that discoveries result from the work of many and from the accumulated aggregate of facts.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

### **Merton, Robert King** 1910–2003

American sociologist

The discovery is not true

If true, it is not new

If both new and true, it is not significant.

*On Theoretical Sociology, Five Essays, Old and New*

Chapter I (p. 21)

The Free Press. New York, New York, USA. 1967

### **Millikan, Robert Andrews** 1868–1953

American physicist

The foregoing discoveries of our generation have taught us a wholesome lesson of humility, wonder, and joy in the face of an as yet incomprehensible physical universe. We have learned not to take ourselves as seriously as the nineteenth century physics took themselves. We have learned to work with new satisfaction, new hope, and new enthusiasm because there is still so much that we do not understand, and because, instead of having to it all pigeonholed as they thought they had, we have found in our lifetime more new relations in physics than had come to light in all preceding ages put together, and because the stream of discovery as yet shows no sign of abatement.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1927*

The Evolution of Twentieth Century Physics (p. 199)

Government Printing Office. Washington, D.C. 1928



**Milne, A. A. (Alan Alexander)** 1882–1956

English playwright, poet, and story writer

“Oh!” said Pooh again. “What is the North Pole?” he asked.

“It’s just a thing you discover,” said Christopher Robin carelessly, not being quite sure himself.

*The Complete Tales & Poems of Winnie-the-Pooh*

Winnie-the-Pooh, Christopher Robin Leads an Exposition to the North Pole (p. 111)

Dutton Children’s Books. New York, New York, USA. 2001

**Mitchell, Silas Weir** 1829–1914

American physician and author

The success of a discovery depends upon the time of its appearance.

In F.H. Garrison

*Bulletin of the New York Academy of Medicine*

Volume 4, 1928 (p. 1002)

**Moynihan, Sir Berkeley** 1865–1936

English surgeon

A discovery is rarely, if ever, a sudden achievement, nor is it the work of one man; a long series of observations, each in turn received in doubt and discussed in hostility, are familiarized by time, and lead at last to the gradual disclosure of truth.

*Surgery, Gynecology & Obstetrics*

Volume 31, 1920 (p. 549)

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

No great discovery was ever made without a bold guess.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eleven (p. 145)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

I keep the subject constantly before me, and wait till the first dawns open slowly by little and little into a full and clear light.

In Robert Grant

*History of Physical Astronomy, From the Earliest Ages to the Middle of the Nineteenth Century*

Chapter II (p. 40)

Robert Baldwin. London, England. 1852

**Niebuhr, Barthold Georg** 1776–1831

German historian

...he who calls what has vanished back again into being, enjoys a bliss like that of creating.

*The History of Rome* (Volume 1)

The History of Rome (p. 4)

Taylor, Walton & Maberly. London, England. 1851

**Nobel, Alfred** 1833–96

Swedish chemist, engineer, inventor, and industrialist

Each new discovery leaves in the brains of men seeds which make it possible for an ever-increasing number of minds of new generations to embrace even greater scientific concepts.

Quoted in Camillo Golgi

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1906

The Neuron Doctrine — Theory and Facts (p. 217)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**Wilford, Noble John**

American science writer

Finding something is not the same as discovering what is found. The more astronomers study the growing evidence of extra-solar planets, the less the planets resemble anything in the one planetary system they had known and had based their theories on: the Sun’s family of planets.

Search for New Planets Yields Confusion

*The New York Times*, 2 March 1999

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

A discovery in science, or a new theory, even where it appears most unitary and most all-embracing, deals with some immediate element of novelty or paradox within the framework of far vaster, unanalyzed, unarticulated reserves of knowledge, experience, faith, and presupposition. Our progress is narrow: it takes a vast world unchallenged and for granted.

*Atom and Void*

Chapter Three (pp. 38–39)

Princeton University Press, Princeton, New Jersey, USA. 1989

**Parsons, Talcott** 1902–79

American sociologist

A scientifically unimportant discovery is one which, however true and however interesting for other reasons, has no consequences for a system of theory with which scientists in the field are concerned.

*The Structure of Social Action*

Part I, Chapter I (p. 7)

The Free Press. Glencoe, Illinois, USA. 1949

**Pasteur, Louis** 1822–95

French chemist

To him who devotes his life to science nothing can give more happiness than increasing the number of discoveries, but his cup of joy is full when the results of his studies immediately find practical applications.

In René Dubos

*The Dreams of Reason*

Chapter 6 (p. 141)

Columbia University Press. New York, New York, USA. 1961

**Planck, Max** 1858–1947

German physicist

Scientific discovery and scientific knowledge have been achieved only by those who have gone in pursuit of it without any practical purpose whatsoever in view.

*Where Is Science Going?*

Chapter IV (p. 138)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist philosopher and social scientist

Discoveries made by the surprising configuration of existing theories might in fact be likened to the feat of a Columbus whose genius lay in taking literally and as a guide to action that the earth was round, which his contemporaries held vaguely and as a mere matter for speculation.

In A.C. Crombie (ed.)

*Scientific Change*

Commentaries (p. 379)

Basic Books Inc., Publishers. New York, New York, USA. 1961

**Pólya, George** 1887–1985

Hungarian mathematician

The first rule of discovery is to have brains and good luck. The second rule of discovery is to sit tight and wait till you get a bright idea.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, Rules of discovery (p. 172)

Princeton University Press. Princeton, New Jersey, USA. 1973

A great discovery solves a great problem but there is a grain of discovery in the solution of any problem.

*How to Solve It: A New Aspect of Mathematical Method*

From the Preface to the First Printing (p. v)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...I am inclined to think that scientific discovery is impossible without faith in ideas which are of a purely speculative kind, and sometimes even quite hazy; a faith which is completely unwarranted from the point of view of science...

*The Logic of Scientific Discovery*

Part I, Chapter I, Section 4 (p. 38)

Basic Books, Inc. New York, New York, USA. 1959

**Priestley, Joseph** 1733–1804

English theologian and scientist

In completing one discovery, we never fail to get an imperfect knowledge of others, of which we could have had no idea before; so that we cannot solve one doubt without creating several new ones.

*Experiments and Observations on Different Kinds of Air* (Volume 1)

The Preface (p. xviii)

Thomas Pearson. Birmingham, England. 1790

**Racker, Efraim** 1913–91

Polish-born American biochemist

Rejoice when other scientists do not believe what you know to be true. It will give you extra time to work on it in peace. When they start claiming that they have discovered it before you, look for a new project.

Resolution and Reconstitution of Biological Pathways from 1919 to 1984  
*Federation Proceedings*, Volume 12, 1983 (p. 2902)

**Ramsay, Sir William** 1852–1916

English chemist

There is a difference between discovery and invention. A discovery brings to light what existed before, but what was not known; an invention is the contrivance of something that did not exist before.

*Essays Biographical and Chemical*

Chemical Essays

How Discoveries Are Made (p. 115)

Archibald Constable & Company Ltd. London, England. 1908

**Reichenbach, Hans** 1891–1953

German philosopher of science

The scientist who discovers a theory is usually guided to his discovery by guesses; he cannot name a method by means of which he found the theory and can only say that it appeared plausible to him, that he had the right hunch or that he saw intuitively which assumption would fit the facts.

*The Rise of Scientific Philosophy*

Chapter 14 (p. 230)

University of California Press. Berkeley, California, USA. 1951

**Richtmyer, Floyd Karker** 1881–1939

American physicist

...the whole history of physics proves that a new discovery is quite likely lurking in the next decimal place.

The Romance of the Next Decimal Place

*Science*, Volume 75, Number 1931, January 1, 1932 (p. 3)

**Rivers, Pitt**

No biographical data available

A discovery dates only from the time of the record of it, and not from the time of its being found in the soil.

Address To the Archaeological Institute of Great Britain and Ireland

Dorchester, August 3, 1887

**Rutherford, Ernest** 1871–1937

English physicist

The march of discovery has been so rapid that it has been difficult even for those directly engaged in the investigations to grasp at once the full significance of the facts that have been brought to light.

*Radioactive Transformations*

Chapter I (p. 1)

Archibald Constable & Company Ltd. London, England. 1906

It is not in the nature of things for any one man to make a sudden, violent discovery; science goes step by step

and every man depends on the work of his predecessors. When you hear of a sudden unexpected discovery — a bolt from the blue, as it were — you can always be sure that it has grown up by the influence of one man or another, and it is the mutual influence which makes the enormous possibility of scientific advance. Scientists are not dependent on the ideas of a single man, but on the combined wisdom of thousands of men, all thinking of the same problem and each doing his little bit to add to the great structure of knowledge which is gradually being erected.

In Robert B. Heywood

*The Works of the Mind*

The Scientist (p. 178)

The University of Chicago Press. Chicago, Illinois, USA. 1947

### Safonov, V.

No biographical data available

There are scientists who make their chief discovery at the threshold of their scientific career, and spend the rest of their lives substantiating and elaborating it, mapping out the details of their discovery, as it were. There are other scientists who have to tread a long, difficult and often tortuous path to its end before they succeed in crowning their efforts with a discovery.

*Courage*

Chapter 10 (p. 40)

Foreign Languages Pub. House. Moscow, Russia. 1953

### Samuelsson, Bengt I. 1934–

Swedish physician

There are almost unlimited possibilities for making discoveries and to uncover the unknown. It is in the nature of the discovery that it can not be planned or programmed. On the contrary it consists of surprises and appears many times in the most unexpected places. However, the basis of the discovery is imagination, careful reasoning and experimentation where the use of knowledge created by those who came before is an important component.

*Les Prix Nobel. The Nobel Prizes in 1982*

Nobel banquet speech for award received in 1982

Nobel Foundation. Stockholm, Sweden. 1983

### Schiller, Ferdinand Canning Scott 1864–1937

English philosopher

One curious result of this inertia [regarding acceptance of an idea], which deserves to rank among the fundamental “laws” of nature, is that when a discovery has finally won tardy recognition it is usually found to have been anticipated, often with cogent reason and in great detail.

In Charles Singer (ed.)

*Studies in the History and Method of Science* (Volume 1)

Scientific Discovery and Logical Proof (pp. 256–257)

At The Clarendon Press. Oxford, England. 1917

### Schwartz, John

No biographical data available

...scientific discovery moves less as the crow flies than as a sailboat tacks, first this way, then that, but edging ever forward.

If You Seek the Truth, Don't Trash the Science

*Washington Post*, 21 February, 1999 (p. B-1)

### Selye, Hans 1907–82

Austrian-American endocrinologist

It is not to see something first, but to establish solid connections between the previously known and the hitherto unknown that constitutes the essence of scientific discovery.

*From Dream to Discovery: On Being a Scientist*

What Should Be Done (p. 89)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

### Shaw, George Bernard 1856–1950

Irish comic dramatist and literary critic

...any fool can make a discovery. Every baby has to discover more in the first years of its life than Roger Bacon ever discovered in his laboratory.

*Back to Methuselah*

Part IV, Act I, XXXV (p. 160)

Constable & Company Ltd. London, England. 1921

### Sigerist, Henry E. 1891–1957

Medical historian

We must also keep in mind that discoveries are usually not made by one man alone, but that many brains and many hands are needed before a discovery is made for which one man receives the credit.

*A History of Medicine* (Volume 1)

Introduction (p. 13)

Oxford University Press, Inc. New York, New York, USA. 1961

### Simon, Herbert Alexander 1916–2001

American social scientist

...scientific discovery, when viewed in detail, is an excruciatingly slow and painful process.

In Robert G. Colodny (ed.)

*Mind and Cosmos*

Scientific Discovery and the Psychology of Problem Solving (p. 24)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1966

### Smith, Theobald 1859–1934

American pathologist

Discovery should come as an adventure rather than as the result of a logical process of thought. Sharp, prolonged thinking is necessary that we may keep on the chosen road, but it does not necessarily lead to discovery.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Seven (p. 81)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

Great discoveries which give a new direction to currents of thoughts and research are not, as a rule, gained by the accumulation of vast quantities of figures and statistics. These are apt to stifle and asphyxiate and they usually follow rather than precede discovery. The great discoveries are due to the eruption of genius into a closely related field, and the transfer of the precious knowledge there found to his own domain.

*Boston Medical and Surgical Journal*, Volume 172, 1915 (p. 121)

**Strauss, Maurice B.** 1904–74

American physician

Discoveries do not arise de novo, like Athena from the brow of Zeus, but are more akin to the living layers of a coral reef built on the past labors of countless predecessors.

*Medicine*, Volume 43, 1964 (p. 619)

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

Discovery consists of seeing what everybody has seen and thinking what nobody has thought.

In Irving John Good (ed.)

*The Scientist Speculates: An Anthology of Partly-Baked Ideas*

Chapter I, 6 (p. 15)

Basic Books, Inc. New York, New York, USA. 1963

**Taton, René** 1915–2004

No biographical data available

Every great discovery has produced some sort of intellectual scandal, has been opposed by current, and always badly informed, opinions on the basic nature of scientific problems, and also by the majority of scientists of the time holding outdated theories, and incapable of renouncing some of their most solidly ingrained ideas.

*Reason and Chance in Scientific Discovery*

Chapter XI (p. 147)

Philosophical Library. New York, New York, USA. 1957

**Taylor, Angus E.**

American mathematician

The process of discovery in mathematics is one in which we are concerned with both the particular and the general. Induction and imagination are as important as purely deductive reasoning. Very often it is some simple insight into a particular fact at a particular level of abstraction that provides the illumination for an important advance. Later, from the heights newly won, the practiced eye may see the opportunity to broaden the advance all along a higher level of abstraction.

Some Aspects of Mathematical Research

*American Scientist*, Volume 35, Number 2, April 1947 (p. 223)

**Thomson, Sir Joseph John** 1856–1940

English physicist

As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon: in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, whose truth is emphasized by every advance in science, that “Great are the Works of the Lord.”

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1909

Progress in Physics (p. 205)

Government Printing Office. Washington, D.C. 1910

A great discovery is not a terminus, but an avenue leading to regions hitherto unknown. We climb to the top of the peak and find that it reveals to us another higher than any we have yet seen, and so it goes on. The additions to our knowledge of physics made in a generation do not get smaller or less fundamental or less revolutionary, as one generation succeeds another. The sum of our knowledge is not like what mathematicians call a convergent series... where the study of a few terms may give the general properties of the whole.

In Sir George Thomson

*The Inspiration of Science*

Some Conclusions (p. 138)

Oxford University Press, Inc. London, England. 1961

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Do not engage to find things as you think they are.

*Familiar Letters of Henry David Thoreau* (Volume 11)

Letter, August 9, 1850 to Harrison Blake (p. 224)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1894

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

What is there that confers the noblest delight? What is that which swells a man's breast with pride above that which any other experience can bring to him? Discovery! To know that you are walking where none others have walked; that you are beholding what human eye has not seen before; that you are breathing a virgin atmosphere. To give birth to an idea, to discover a great thought — an intellectual nugget, right under the dust of a field that many a brain-plough had gone over before. To find a new planet, to invent a new hinge, to find a way to make the lightnings carry your message. To be the first — that is the idea.

*The Innocents Abroad* (Volume 1)

Chapter XXVI (p. 338)

Harper & Brothers Publishers. New York, New York, USA. 1904

If there wasn't anything to find out, it would be dull. Even trying to find out and not finding out is just as interesting as trying to find out and finding out; and I don't know but more so.

*Eve's Diary*

Friday (p. 87)

Harper & Brothers Publishers. New York, New York, USA. 1906

### Valentine, Alan

No biographical data available

Whenever science makes a discovery, the devil grabs it while the angels are debating the best way to use it.

*Reader's Digest*, April 1962 (p. 70)

### Vernadskii, Vladimir Ivanovich 1863–1945

Russian mineralogist

Scientific discoveries are never readymade or complete. The process of scientific discovery, illuminated by the intellect of great human personalities, is at the same time a slow process of universal human development stretching over the ages.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Moscow, Russia. 1979

### Verne, Jules 1828–1905

French novelist

In the first place...you must keep the whole affair a profound secret. There is no more envious race of men than scientific discoverers. Many would start on the same journey. At all events, we will be the first in the field.

*A Journey to the Center of The Earth*

Chapter 3 (p. 22)

The Limited Editions Club. New York, New York, USA. 1966

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

No one can take from us the joy of the first becoming aware of something, the so-called discovery. But if we also demand the honor, it can be utterly spoiled for us, for we are usually not the first. What does discovery mean, and who can say that he has discovered this or that? After all it's pure idiocy to brag about priority; for it's simply unconscious conceit, not to admit frankly that one is a plagiarist.

In Lancelot Law Whyte

*The Unconscious Before Freud*

Epigraph to Lancelot Law Whyte (p. 1)

Julian Friedmann Publishers. London, England. 1978

In science everything depends on what one calls an aperçu — the discovery of something that is at the bottom of phenomena. Such a discovery is infinitely fruitful.

Translated by Charles Lock Eastlake

*Theory of Colors*

Historical Part, Fifth Division, Galileo Galilei (p. 204)

The MIT Press. Cambridge, Massachusetts, USA. 1970

### von Helmholtz, Hermann 1821–94

German scientist and philosopher

A single remarkable discovery may, of course, be the result of a happy accident and may not indicate the possession of any special gift on the part of the discoverer...

*The Modern Development of Faraday's Conception of Electricity*

Faraday Lecture

Delivered before the Fellows of the Chemical Society in London on

April 5, 1881

### von Lenard, Philipp E. A. 1862–1947

Physicist

...I have by no means always been numbered among those who pluck the fruit; I have been repeatedly only one of those who planted or cared for the trees...

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1905

On Cathode Rays (p. 105)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

### von Liebig, Justus 1803–73

German organic chemist

Theories lead to experiments and investigations and he who investigates will scarcely ever fail of being rewarded by discoveries. It may be, indeed, the theory sought to be established is entirely unfounded in nature, but while searching in a right spirit for one thing, the inquirer may be rewarded by finding others far more valuable than those which he sought.

*Familiar Letters on Chemistry*

Letter IV (pp. 33–34)

Taylor & Walton. London, England. 1843

### von Siemens, Werner 1816–1892

German inventor and entrepreneur

If some phenomenon that has been shrouded in obscurity suddenly emerges into the light of knowledge, if the key of a long sought mechanical combination has been found, if the missing link of a chain of thought is fortuitously supplied, this then gives the discoverer the exultant feeling that comes with a victory of the mind, which alone can compensate him for all the struggle and effort and lift him to a higher plane of existence.

In Otto Glasser

*Dr. W.C. Röntgen*

Chapter VI (p. 77)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

### Weinberg, Steven 1933–

American nuclear physicist

Scientists have discovered many peculiar things, and many beautiful things. But perhaps the most beautiful and the most peculiar thing that they have discovered is the pattern of science itself. Our scientific discoveries are not independent isolated facts; one scientific generalization finds its explanation in another, which is itself explained by yet another. By tracing these arrows of explanation back toward their source we have discovered a

striking convergent pattern — perhaps the deepest thing we have yet learned about the universe.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Chapter II (p. 19)

Pantheon Books. New York, New York, USA. 1992

I have difficulty in understanding the philosophical content that many people seem to find in discoveries in physics. It is true, of course, that many of the subjects of physics — space and time, causality, ultimate particles — have been the concern of philosophers since the earliest times. But in my view, when physicists make discoveries in these areas, they do not so much confirm or refute the speculation of philosophers as show that philosophers were out of their jurisdiction in speculating about these phenomena.

The Forces of Nature

*American Scientist*, Volume 65, March–April, 1977 (p. 175)

### **Whewell, William** 1794–1866

English philosopher and historian

The process of scientific discovery is cautious and rigorous, not by abstaining from hypothesis, but by rigorously comparing hypotheses with facts, and by resolutely rejecting all which the comparison does not confirm.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Aphorisms Concerning Science, X (p. 468)

John W. Parker. London, England. 1847

### **Whewell, William** 1794–1866

English philosopher and historian

...advances in knowledge are not commonly made without the previous exercise of some boldness and license in guessing. The discovery of new truths requires, undoubtedly, minds careful and fertile in examining what is suggested; but it requires, no less, such as are quick and fertile in suggesting.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 1)

Book V, Chapter IV, Section 1 (p. 411)

John W. Parker. London, England. 1837

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

What Bacon omitted was the play of free imagination, controlled by the requirements of coherence and logic. The true method of discovery is like the flight of an aeroplane. It starts from the ground of particular observation; it makes a flight in the thin air of imaginative generalization; and it again lands for renewed observation rendered acute by rational interpretation.

*Process and Reality: An Essay in Cosmology*

Part I, Chapter I, Section II (p. 7)

The Macmillan Company. New York, New York, USA. 1929

### **Wigglesworth, Sir Vincent B.** 1899–1994

English entomologist

New discoveries in science are not made by plunge into the unknown. They are made on the misty fringes of “the known” by observers whose eyes can pierce the fog more deeply than others.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The Control of Form in the Living Body (p. 252)

Pergamon Press. Oxford, England. 1977

### **Willstätter, Richard** 1872–1942

German chemist

Whether we deal with such tentative explanations, or with the controversial protein nature of enzymes, I feel that it is not important for the scientist whether his own theory proves the right one in the end. Our experiments are not carried out to decide whether we are right, but to gain new knowledge. It is for knowledge's sake that we plow and sow. It is not inglorious at all to have erred in theories and hypotheses. Our hypotheses are intended for the present rather than for the future. They are indispensable to us in the explanation of the secured facts, to enliven and mobilize them and above all to blaze a trail into unknown regions toward new discoveries.

*From My Life: The Memoirs of Richard Willstätter*

Chapter 12, Willard Gibbs Medal address, American Chemical Society, Chicago, September 14, 1933 (p. 385)

W.A. Benjamin. New York, New York, USA. 1965

### **Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

What a Copernicus or a Darwin really achieved was not the discovery of a new true theory but a fertile point of view.

Translated by Peter Winch

*Culture and Value* (p. 18e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

### **Wright, Orville** 1871–1948

American aeronautical engineer

Isn't it astonishing that all these secrets have been preserved for so many years just so that we could discover them!

In Fred C. Kelly (ed.)

*Miracle at Kitty Hawk*

Chapter III, Letter to George A. Spratt, June 7, 1903 (p. 91)

Farrar, Straus & Young. New York, New York, USA. 1951

### **Wright, Thomas** 1711–86

English cosmologist

...how difficult a Talk it is to advance any new Doctrine with Success, those who have hitherto attempted to propagate astronomical Discoveries in all Ages, have been but ill rewarded for their Labours, tho' finally they have proved of the greatest Benefit and Advantage to Mankind.

*An Original Theory or New Hypothesis of the Universe*  
 Preface (p. iii)  
 Printed for the Author. London, England. 1750

## DISCUSSION

**Ruelle, David** 1935–  
 Belgian-French mathematical physicist

A meaningful physical discussion always requires an operational background. Either this is provided by an existing theory, or you have to give it yourself by the sufficiently explicit description of an experiment that can, at least in principle, be performed.

*Chance and Chaos*  
 Chapter 2 (p. 13)  
 Princeton University Press. Princeton, New Jersey, USA. 1991

## DISEASE

**Bacon, Sir Francis** 1561–1626  
 English lawyer, statesman, and essayist

...cure the disease and kill the patient.  
*Bacon's Essays*  
 Of Friendship (p. 129)  
 Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

...diseases of the body may have appropriate exercises; bowling is good for the stone and veins, shooting for the lungs and breast, gentle walking for the stomach, riding for the head and the like...

*Bacon's Essays*  
 Of Studies (p. 211)  
 Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

**Baring, Maurice** 1874–1945  
 English author  
 Pale disease

Shall linger by thy side, and thou shalt know  
 Eternal autumn to thy day of death.  
*The Black Prince and Other Poems*  
 The Black Prince and the Astrologer (p. 59)  
 John Lane. London, England. 1903

**Belloc, Hilaire** 1870–1953  
 French-born poet and historian

Physicians of the Utmost Fame  
 Were called at once;  
 but when they came  
 They answered, as they took their Fees,  
 "There is no Cure for this Disease."  
*Cautionary Tales for Children, Designed for the Admonition of Children*  
*Between the Ages of Eight and Fourteen Years*  
 Henry King (pp. 18–19)  
 Duckworth & Company. London, England. 1918

**Browne, Sir Thomas** 1605–82  
 English author and physician

Some will allow no Disease to be new, others think that many old ones are ceased; and that such which are esteemed new, will have but their time.  
*The Works of Sir Thomas Browne* (Volume One)  
 A Letter to a Friend (pp. 172–173)

...medical Predictions fail not, as sometimes in acute Diseases, and wherein 'tis as dangerous to be sentenced by a Physician as a Judge.  
*The Works of Sir Thomas Browne* (Volume Three)  
 A Letter to a Friend (p. 370)  
 John Grant. Edinburgh, Scotland. 1927

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
 English Romantic poet and satirist  
 When slow Disease, with all her host of pains,  
 Chills the warm tide which flows along the veins;  
 When Health, affrighted, spreads her rosy wing,  
 And flies with every changing gale of spring...  
*The Complete Poetical Works of Byron*  
 Childish Recollections (p. 550)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Carlyle, Thomas** 1795–1881  
 English historian and essayist

Self-contemplation...is infallibly the symptom of disease...  
*Characteristics, by Thomas Carlyle; Favorite Poems, by Percy Bysshe Shelley; the Eve of St. Agnes, and Other Poems, by John Keats*  
 Paragraph 9 (p. 17)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1882

**Chekhov, Anton Pavlovich** 1860–1904  
 Russian author and playwright

People love talking of their diseases, although they are the most uninteresting things in their lives.  
*Note-Book of Anton Chekhov* (p. 28)  
 B.W. Huebsch, Inc. New York, New York, USA. 1921

**Churchill, Winston Spencer** 1882–1965  
 British prime minister, statesman, soldier, and author

The discoveries of healing science must be the inheritance of all. That is clear. Disease must be attacked, whether it occurs in the poorest or the richest man or woman, simply on the ground that it is the enemy; and it must be attacked just in the same way as the fire brigade will give its full assistance to the humblest cottage as readily as to the most important mansion.  
 In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
 Speech, Royal College of Physicians, London, March 2, 1944 (p. 171)  
 George Allen & Unwin Ltd. London, England. 1956

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
 Roman orator, politician, and philosopher

...philosophers apply the term disease to all disorders of the soul, and they say that no foolish person is free from

such diseases; sufferers from disease however, are not sound, and the souls of all unwise persons are diseased.

Translated by J.E. King

*Cicero in Twenty Eight Volumes (XVIII)*

Tusculanarum Disputationum

III, iv, 9 (p. 235)

Harvard University Press. Cambridge, Massachusetts, USA. 1921

**de Unamuno, Miguel** 1864–1936

Spanish philosopher and writer

There are no diseases, but only persons who are diseased, some doctors say, and I say that there are no opinions, but only opining persons.

*Essays and Soliloquies*

My Religion (pp. 156–157)

Alfred A. Knopf. New York, New York, USA. 1925

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

No Sickness known before, no slow Disease,  
To soften Grief by Just Degrees.

*The Poetical Works of Dryden*

Threnodia Augustalis, Stanza 1 (p. 442)

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The difficulty of defining disease is implied in the very structure of the word: “dis-ease.” So many different kinds of disturbances can make a person feel not at ease and lead him to seek the aid of a physician that the word ought to encompass most of the difficulties inherent in the human condition.

*Man, Medicine, and Environment* (p. 67)

Frederick A. Praeger. New York, New York, USA. 1968

Eradication of microbial disease is a will-o’-the-wisp; pursuing it leads into a morass of hazy biological concepts and half truths.

*Man Adapting*

Chapter XIV (p. 381)

Yale University Press. New Haven, Connecticut, USA. 1965

Complete and lasting freedom from disease is but a dream remembered from imaginings of a Garden of Eden designed for the welfare of man.

*Mirage of Health*

Chapter I (p. 2)

Harper & Brothers Publishers. New York, New York, USA. 1959

It is seldom recognized that each type of society has diseases peculiar to itself — indeed, that each civilization creates its own diseases.

*The Dreams of Reason: Science and Utopia*

Chapter 4 (p. 71)

Columbia University Press. New York, New York, USA. 1961

**Eddy, Mary Baker** 1821–1910

Religious writer

...disease...can carry its ill-effects no farther than mortal mind maps out the way.

*Science and Health with Key to the Scriptures*

Chapter VII (p. 176)

Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Fuller, Thomas** 1608–61

English clergyman and author

Diseases are the price of ill pleasures.

*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings.*

*Ancient and Modern, Foreign and British*

No. 1297

Printed for Thomas & Joseph Allman. London, England. 1816

**Gregg, Alan** 1890–1957

American medical educator and philosopher

The perpetual enemies of the human race, apart from man’s own nature, are ignorance and disease.

In J. Bordley and A.M. Harvey

*Two Centuries of American Medicine* (p. 751)

W.B. Saunders. Philadelphia, Pennsylvania, USA. 1976

**Harrison, Jane** 1850–1920

English classical scholar

If I think of Death at all it is merely as a negation of life, a close, a last and necessary chord. What I dread is disease, that is, bad, disordered life, not Death, and disease, so far, I have escaped.

*Reminiscences of a Student’s Life*

Conclusion

L. & V. Woolf. London, England. 1925

**Heller, Joseph** 1923–99

American writer

Hungry Joe collected lists of fatal diseases and arranged them in alphabetical order so that he could put his finger without delay on any one he wanted to worry about.

*Catch-22*

Chapter Seventeen (p. 177)

Dell Publishing Company, Inc. New York, New York, USA. 1985

How do you expect anyone to believe you have a liver condition if you keep squeezing the nurses’ tits every time you get a chance? You’re going to have to give up sex if you want to convince people you’ve got an ailing liver.

*Catch-22*

Chapter Eighteen (p. 187)

Dell Publishing Company, Inc. New York, New York, USA. 1985

**Hershko, Avram** 1937–

Hungarian-born Israeli biochemist

...the boundaries between chemistry, biology, physics and medicine are rapidly disappearing. Only a comprehensive understanding of the chemical and physical processes in our cells and organ systems will yield the insights needed to develop rational approaches to the prevention and treatment of disease.



Nobel Banquet Speech (Chemistry)  
December 10, 2004  
The Nobel Foundation. 2004

**Hudson, Robert P.**

No biographical data available

If a medical and social consensus defined freckles as a disease, this benign and often winsome skin condition would become a disease. Patients would consult physicians complaining of freckles, physicians would diagnose and treat freckles, and presumably, in time, we would have a National Institute of Freckle Research.

*Disease and Its Control: The Shaping of Modern Thought* (p. x)  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1983

**James, Henry** 1843–1916

American-born English author and literary critic

...even medical families cannot escape the more insidious forms of disease...

*Washington Square*

Chapter I (p. 8)

The Modern Library. New York, New York, USA. 1950

**Jerome, Jerome K.** 1859–1927

English author

I remember going to the British Museum one day to read up the treatment for some slight ailment of which I had touch. I got down the book, and read all I came to read; and then, in an unthinking moment, I idly turned the leaves, and began to indolently study diseases. Bright's disease, I was relieved to find, I had only in a modified form, and so far as that was concerned, I might live for years. Cholera I had, with severe complications: and diphtheria I seemed to have been born with. I plodded conscientiously through the twenty-six letters, and the only malady I could conclude I had not got was housemaid's knee.

*Three Men In a Boat, to Say Nothing of The Dog!*

Chapter 1 (p. 2)

Time Incorporated. New York, New York, USA. 1964

**Jhabvala, Ruth Praver** 1927–

German-born novelist and short story writer

Doctors don't know a thing. These diseases that people [who travel there] get in India, they're not physical, they're purely psychic. We only get them because we try to resist India — because we shut ourselves up in our little Western egos and don't want to give ourselves.

*Travelers* (p. 166)

Harper & Row, Publishers. New York, New York, USA. 1973

**Latham, Peter Mere** 1789–1875

English physician

Disease is a series of new and extraordinary actions. Each link in the series is essentially to the integrity of the

whole. Let one link be fairly broken, and this integrity is spoiled; and there is an end of the disease; and then the constitution is left to resume its old and accustomed actions, which are the actions of health.

In William B. Bean

*Aphorisms from Latham* (p. 71)

Prairie Press. Iowa City, Iowa, USA. 1962

**Mann, Thomas** 1875–1955

German-born American novelist

Disease has nothing refined about it, nothing dignified.

*The Magic Mountain*

Chapter IV (p. 98)

Alfred A. Knopf. New York, New York, USA. 1949

**Mather, Cotton** 1663–1728

American minister and religious writer

*Ingluvies omnium morborum mortisque Causa.*

Gluttony is the cause of all diseases and of death.

*The Angel of Bethesda*

Capsula II, Appendix (p. 15)

American Antiquarian Society & Barre Publishers. Barre, Massachusetts, USA. 1972

**Nuland, Sherwin B.** 1930–

American surgeon and teacher of bioethics and medicine

The quest to achieve true dignity fails when our bodies fail.

*How We Die: Reflections on Life's Final Chapter* (p. xvii)

Alfred A. Knopf. New York, New York, USA. 1994

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

From Hippocrates to Hunter, the treatment of disease was one long traffic in hypotheses.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter X (p. 100)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

**Parr, William**

No biographical data available

The infectious diseases replace each other, and when one is rooted out it is apt to be replaced by others which ravage the human race indifferently whenever the conditions of health are wanting. They have this property in common with weeds and other forms of life, as one species recedes another advances.

In Rene Dubos

*The Dreams of Reason: Science and Utopias*

Chapter 4 (p. 67)

Columbia University Press. New York, New York, USA. 1961

**Peabody, Francis Weld** 1881–1927

American physician

Disease in man is never exactly the same disease in an experimental animal, for in man the disease at once

affects and is affected by what we call the emotional life.

*The Care of the Patient*

The Care of the Patient (p. 48)

Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Persius** 32–64

Roman poet

...check the ailment before it's got to you...

*The Satires of Persius*

Satire Three, l. 67

Anvil Press Poetry. London, England. 1981

**Plato** 428 BCE–347 BCE

Greek philosopher

...to require the help of medicine, not when a wound has to be cured, or on occasion of an epidemic, but just because, by indolence and habit of life such as we have been describing, men fill themselves with waters and winds, as if their bodies were a marsh, compelling the ingenious sons of Asclepius to find more names for diseases, such as flatulence and catarrh; is not this, too, a disgrace? "Yes, he said, they do certainly give very strange and new-fangled names to diseases. "Yes, I said, and I do not believe there were any such diseases in the days of Asclepius.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book III, Section 405 (p. 335)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ray, John** 1627–1705

English naturalist

Diseases are the interests of pleasure.

*A Complete Collection of English Proverbs* (p. 6)

Printed for G. Cowie. London, England. 1813

**Rogers, Will** 1879–1935

American actor and humorist

We were primitive people when I was a kid. There were only a mighty few known diseases. Gunshot wounds, broken legs, toothache, fits, and anything that hurt you from the lower end of your neck down was known as a bellyache.

*The Autobiography of Will Rogers*

Chapter Twelve (p. 151)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

**Sacks, Oliver W.** 1933–

American neurologist and author

Diseases have a character of their own, but they also partake of our character; we have a character of our own, but we also partake of the world's character...

*Awakenings*

Perspectives (p. 229)

Vintage Books. New York, New York, USA. 1990

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

...a disease also is farther on the road to being cured when it breaks forth from concealment and manifests its power.

Translated by Richard M. Gummere

*Ad Lucilium Epistulae Morales* (Volume 1)

Epistle lvi, Section 10 (p. 379)

Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shadwell, Thomas** 1642?–92

English dramatist and poet

Physicians tell us, that in every Age  
Some one particular Disease does rage,  
The Scurvy once, and what you call the Gout,  
But Heaven be prais'd their Reign is almost out...

*The Complete Works of Thomas Shadwell* (Volume 1)

The Sullen Lovers, Epilogue (p. 92)

The Fortune Press. London, England. 1927

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

O, he's a limb, that has but a disease;  
Mortal, to cut it off; to cure it easy.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Coriolanus

Act III, Scene i, l. 296–297

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Diseases desperate grown

By desperate appliance are relieved,  
Or not at all.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Hamlet, Prince of Denmark

Act IV, Scene iii, l. 9–11

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I'll sweat and seek about for eases,

And at that time bequeath you my diseases.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Troilus and Cressida

Act V, Scene x, l. 56–57

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

There is at bottom only one genuinely scientific treatment for all diseases, and that is to stimulate the phagocytes.

*The Doctor's Dilemma*

Act I (p. 28)

Brentano's. New York, New York, USA. 1920

**Simmons, Charles** 1798–1856

American clergyman and litterateur

The diseases and "evils which flesh is heir to," are all the messengers of God, to rebuke us for our sins, and ought so to be regarded.

*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 148)  
Robert Dick. Toronto, Ontario, Canada. 1853

**Smyth, Francis Scott** 1895–1972  
American pediatrician

To know what kind of a person has a disease is as essential as to know what kind of disease a person has.  
*Journal of Medical Education*, Volume 37, 1962

**Straus, Bernard**  
No biographical data available

Almost as fast as one disease is conquered new ones are discovered and sometimes created. We exchange new ones for old. The balance is clearly on the credit side and it is a fact that many of the old scourges, real or imaginary, are gone or are vanishing.  
*Disappearing Diseases*  
*Medical Counterpoint*, Volume 2, 1970

**Sydenham, Thomas** 1624–89  
English physician

...all this is mighty fine! but it won't do — Anatomy — botany — nonsense! Sir, I know an old woman in Covent Garden, who understands botany better; and as for anatomy, my butcher can dissect a joint full and well: — no, young man, all this is stuff; you must go to the bedside, it is there you alone can learn disease!  
*Mems. Maxims, and Memoirs*  
Sir Hans Slone (p. 231)  
Printed for Gallow & Wilson. London, England. 1827

**Thurber, James** 1894–1961  
American writer and cartoonist

If you don't pay no mind to diseases, they will go away.  
*The Thurber Carnival*  
Recollections of the Gas Buggy (p. 36)  
The Modern Library. New York, New York, USA. 1957

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Man seems to be a rickety poor sort of a thing, any way you take him; a kind of British Museum of infirmities and inferiorities. He is always undergoing repairs. A machine that was as unreliable as he is would have no market.  
*Collected Tales, Sketches, Speeches, & Essays 1891–1910*  
Man's Place in the Animal World (p. 213)  
The Library of America. New York, New York, USA. 1992

...man starts in as a child and lives on diseases to the end as a regular diet.  
In Albert Bigelow Paine  
*Mark Twain: A Biography* (Volume 4)  
Chapter CCLII (p. 1362)  
Harper & Brothers Publishers. New York, New York, USA. 1912

**Viereck, George S.** 1884–1962  
No biographical data available  
**Eldridge, Paul**  
No biographical data available

All diseases are curable, provided the patient lives long enough to overcome the initial cause of the complaint.  
*My First Two Thousand Years: The Autobiography of the Wandering Jew*  
Chapter VII (p. 56)  
Sheridan House. New York, New York, USA. 1963

**Virchow, Rudolf Ludwig Karl** 1821–1902  
German pathologist and archaeologist

Ever since we recognized that diseases are neither self-subsistent, circumscribed, autonomous organisms, nor entities which have forced their way into the body, nor parasites rooted on it, but...the course of physiological phenomena under altered conditions...the goal of therapy has had to be the maintenance or the reestablishment of normal physiological conditions.  
Translated by Lelland J. Rather  
*Disease, Life, and Man*  
Standpoints in Scientific Medicine (p. 26)  
Stanford University Press. Stanford, California, USA. 1958

**Young, Arthur** 1741–1820  
English traveler

Catch the disease, that we may show our skill in curing it!  
*The Adventures of Emmera* (Volume 2)  
Letter 26 (p. 115)  
Printed for W. Nicoll. London, England. 1768

**Zinsser, Hans** 1878–1940  
American bacteriologist

Infectious disease is one of the few genuine adventures left in the world.  
*Rats, Lice and History* (p. 13)  
Little, Brown & Company. Boston, Massachusetts, USA. 1935

## DISINFECTANT

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Soap and water and common sense are the best disinfectants.  
In Evan Esar  
*20,000 Quips and Quotes*  
Doubleday. Garden City, New York, USA. 1968

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

But if men cannot live on bread alone, still less can they do so on disinfectants.

*Science and the Modern World*  
Chapter IV (p. 87)  
The Macmillan Company. New York, New York, USA. 1929

## DISORDER

**Dürrenmatt, Friedrich** 1921–90  
Swiss playwright and novelist

I simply can't stand disorder. Really it was my love of order that made me become a physicist...

Translated by James Kirkup  
*The Physicists*  
Act One (p. 18)  
Grove Press, Inc. New York, New York, USA. 1964

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

So we now have to talk about what we mean by disorder and what we mean by order.... Suppose we divide the space into little volume elements. If we have black and white molecules, how many ways could we distribute them among the volume elements so that white is on one side and black is on the other? On the other hand, how many ways could we distribute them with no restriction on which goes where? Clearly, there are many more ways to arrange them in the latter case. We measure "disorder" by the number of ways that the insides can be arranged, so that from the outside it looks the same. The logarithm of that number of ways is the entropy. The number of ways in the separated case is less, so the entropy is less, or the "disorder" is less.

*Feynman Lectures on Physics* (Volume 1)  
46–5  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA.  
1963

**McCabe, Joseph** 1867–1955  
English rationalist writer and ex-Franciscan priest

Today we know not only that there is a terrible amount of disorder in the heavens — great catastrophes or conflagrations occur frequently — but evolution gives us a perfectly natural explanation of such order as there is. No distinguished astronomer now traces "the finger of God" in the heavens; and astronomers ought to know best.

*The Story of Religious Controversy*  
Chapter V (p. 86)  
Publisher undetermined

**Melville, Herman** 1819–91  
American novelist

There are some enterprises in which a careful disorderliness is the true method.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 82 (p. 267)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ziman, John M.** 1925–2005  
English Physicist

"Disorder" is not mere chaos; it implies defective order...

*Models of Disorder*  
Chapter 1 (p. 1)  
Cambridge University Press. Cambridge England. 1979

## DISPERSAL

**Zimmerman, E. C.** 1932–  
No biographical data available

We must recognize that it is abnormal conditions that account for much overseas dispersal. It is not the soft, gentle trade wind — it is the irresistible hurricane that is the key.

In J. Linsley Gressitt (ed.)  
*Pacific Basin Biogeography*  
Pacific Basin Biogeography: A Summary Discussion (p. 478)  
Bishop Museum Press. Honolulu, Hawaii, USA. 1963

So many continents and land bridges have been built in and across the Pacific by biologists that, were they all plotted on a map, there would be little space left for water. Whenever a particularly puzzling problem arises, the simplest thing seems to be to build a continent or bridge, rather than to admit defeat at the hands of nature, or to consider the data at hand inadequate for solving the problem. Most of the land bridges suggested to account for the distribution of certain plants and animals in the Pacific create more problems than they solve. If the central and eastern Pacific ever included large land areas and land bridges, there should be some indication of the consequent peculiar development of the fauna and floras, but there is no such evidence.

*Distribution and Origin of Some Eastern Oceanic Insects*  
*American Naturalist*, Volume LXXVI, Number 764, 1942 (p. 282)

## DISSECTION

**Barbellion, Wilhelm Nero Pilate** 1889–1919  
English author

Dissected the Sea Urchin (*Echinus esculentus*). Very excited over my first view of Aristotle's Lantern. These complicated pieces of animal mechanism never smell of musty age — after aeons of evolution. When I open a Sea Urchin and see the Lantern, or dissect a Lamprey and cast eyes on the branchial basket, such structures strike

me as being as finished and exquisite as if they had just a moment before [they had] been tossed me fresh from the hands of the Creator. They are fresh, young, they smell new.

*The Journal of a Disappointed Man*

November 3, 1908 (p. 19)

George H. Doran Company. New York, New York, USA. 1919

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

As if a man should be dissected,

To see what part is disaffected.

*The Poetical Works of Samuel Butler* (Volume 1)

Part II, Canto I, l. 505–506)

Bell & Daldy. London, England. 1835

**Flaubert, Gustave** 1821–90

French novelist

Dissection. An outrage upon the majesty of death.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Pope, Alexander** 1688–1744

English poet

Life following life through creatures you dissect,

You lose it in the moment you detect.

*The Complete Poetical Works*

Moral Essays, Epistle I, l. 29–30

Houghton Mifflin Company. New York, New York, USA. 1903

**Wordsworth, William** 1770–1850

English poet

Sweet is the lore which Nature brings;

Our meddling intellect

Mis-shapes the beauteous form of things: —

We murder to dissect.

*The Complete Poetical Works of William Wordsworth*

The Tables Turned, The Thorn

Crowell. New York, New York, USA. 1888

## DISTANCE

**Braithwaite, William Stanley** 1878–1962

Editor and literary critic

Just where that star above

Shines with a cold, dispassionate smile —

If in the flesh I'd travel there,

How many, many a mile!

*Lyrics of Life and Love*

Distances

H. B. Turner. Boston, Massachusetts, USA. 1904

**Coblentz, Stanton**

No biographical data available

Our race has want of sages such as these,

Whose measuring-rods are light-years, and who say

That points a million trillion leagues away

Are only as our next-door galaxies.

Astronomers

*Sky & Telescope*, Volume III, Number 10, August 1940 (p. 12)

**Heidmann, Jean** 1923–2000

French-born astronomer

The distances we are going to embrace are so enormous that galaxies will appear as tiny toys, infinitesimal as the dust-specks dancing in the sunbeam in the crack of the curtain.

Translated by Maureen Schaeffer and Ann Boesgaard

*Extragalactic Adventure: Our Strange Universe*

Chapter 2 (p. 20)

Cambridge University Press. Cambridge, England. 1982

**Jeffers, Robinson** 1887–1962

American poet

I strain the mind to imagine distances

That are not in man's mind...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

Pleasures (p. 473)

Stanford University Press. Stanford, California. USA. 1988

## DISTILL

**Levi, Primo** 1919–87

Italian writer and chemist

Distilling is beautiful. First of all, because it is a slow, philosophic, and silent occupation, which keeps you busy but gives you time to think of other things, somewhat like riding a bike. Then, because it involves a metamorphosis from liquid to vapor (invisible), and from this once again to liquid; but in this double journey, up and down, purity is attained, an ambiguous and fascinating condition, which starts with chemistry and goes very far. And finally, when you set about distilling, you acquire the consciousness of repeating a ritual consecrated by the centuries, almost a religious act, in which from imperfect material you obtain the essence, the usia, the spirit, and in the first place alcohol, which gladdens the spirit and warms the heart.

*The Periodic Table*

Potassium (pp. 57–58)

Schocken Books. New York, New York, USA. 1984

**Sedwizoj, Michal**

No biographical data available

Such therefore is the Distiller, the Maker of all things, in whose hands is this Distillatory, according to the example of which all Distillations have been invented by Philosophers; which thing the most High God himself out of pity, without doubt, hath inspired into the Sons of Men: and he can, when it is his Holy Will, either extinguish the Central Fire, or break the Vessel, and then there will be an end of all.

*A New Light of Alchymy* (pp. 94–95)  
Printed by A. Clark. London, England. 1674

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Hast thou not learned me how to make perfumes? Distil?  
Preserve?

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Cymbeline  
Act I, Scene v, l. 13  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## DISTRIBUTION

### Author undetermined

An exterminator made this contribution On rats arriving  
in random profusion “I know nothing of math, Probabili-  
ty of stats, But I handle ‘em with Poisson distributions.”

In Arnold O. Allen  
*Probability, Statistics, and Queueing Theory with Computer Science  
Applications* (p. 86)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer, and statistician

The primary objects of the Gaussian Law of Error were  
exactly opposed, in one sense, to those to which I applied  
them. They were to get rid of, or to provide a just allow-  
ance for errors. But these errors or deviations were the  
very thing I wanted to preserve and to know about.

*Memories of My Life*  
Chapter XX (p. 305)  
Methuen & Company Ltd. London, England. 1908

It has been objected... that I pushed the application of the  
Law of Frequency of Error somewhat too far. I may have  
done so...; but I am sure that, with the evidence before  
me, the applicability of that law is more than justified  
within...reasonable limits.

*Natural Inheritance*  
Schemes of Distribution and of Frequency (p. 44)  
Macmillan & Company Ltd. London, England. 1889

**Geary, R. C.**  
No biographical data available

Normality is a myth; there never has, and never will be,  
a normal distribution.

Testing for Normality  
*Biometrika*, Volume 34, 1947 (p. 241)

**Hamming, Richard W.** 1915–88  
American mathematician

If the prior distribution, at which I am frankly guessing,  
has little or no effect on the result, then why bother; and  
if it has a large effect, then since I do not know what I am

doing how would I dare act on the conclusions drawn?

*The Art of Probability for Scientists and Engineers*  
Chapter 8 (p. 298)  
Westview Press. Boulder, Colorado, USA. 1991

**Harris, Sidney**  
No biographical data available

Which Bernoulli do you wish to see — “Hydrodynamics”  
Bernoulli, “Calculus” Bernoulli. “Geodesic” Bernoulli.  
“Large Numbers” Bernoulli or “Probability” Bernoulli?  
*What’s So Funny About Science*  
Caption to Cartoon

**Kneale, W.**  
No biographical data available

A misunderstanding of Bernoulli’s theorem is respon-  
sible for one of the commonest fallacies in the estimation  
of probabilities, the fallacy of the maturity of chances.  
When a coin has come down heads twice in succession,  
gamblers sometimes say that it is more likely to come  
down tails next time because “by the law of averages”  
(whatever that may mean) the proportion of tails must be  
brought right some time.

*Probability and Induction*  
Part III, subsection 29 (p. 140)  
At The Clarendon Press. Oxford, England. 1949

**Lewis, Don**  
No biographical data available

**Burke, C. J.**  
No biographical data available

It has become increasingly apparent over a period of  
several years that psychologists, taken in the aggregate,  
employ the chi-square test incorrectly.

The Use and Misuse of the Chi-Square Test  
*Psychological Bulletin*, Volume 46, Number 6, November 1949 (p. 433)

**May, Robert M.**  
No biographical data available

I would therefore urge that people be introduced to  
[the logistic equation] early in their mathematical edu-  
cation. This equation can be studied phenomenologi-  
cally by iterating it on a calculator, or even by hand. Its  
study does not involve as much conceptual sophistica-  
tion as does elementary calculus. Such study would  
greatly enrich the student’s intuition about nonlinear  
systems. Not only in research but also in the everyday  
world of politics and economics, we would all be bet-  
ter off if more people realized that simple nonlinear  
systems do not necessarily possess simple dynamical  
properties.

Simple Mathematical Models with very Complicated Dynamics  
*Nature*, Volume 261, Number 5560, June 10, 1976 (p. 467)

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

We know not to what are due the accidental errors, and precisely because we do not know, we are aware they obey the law of Gauss. Such is the paradox.

*The Foundations of Science*

Science and Method, Book I

Chapter IV, Section VI (p. 406)

The Science Press. New York, New York, USA. 1913

**Pynchon, Thomas** 1937–

American novelist

She's almost got it; nearly understands his Poisson equation...

*Gravity's Rainbow*

Part 1 (p. 54)

The Viking Press. New York, New York, USA. 1973

But a hard-on, that's either there, or it isn't. Binary, elegant. The job of observing it can even be done by a student.

*Gravity's Rainbow*

Part 1 (p. 84)

The Viking Press. New York, New York, USA. 1973

## DIVERGENCE

**Lillich, Robert**

No biographical data available

Divergence B, it's plain to see, is zero.

I think they've got it, I think they've got it!

And del dot D is always rho, you know.

I think they've got it, I think they've got it!

My Fair Physicist, I Think They've Got It

*The Physics Teacher*, Volume 6, Number 9 December 1968 (p. 490)

## DIVERSITY

**Minelli, A.**

No biographical data available

Despite the vagaries of systematists, there are, in a taxonomic sense, many dense clusters of biotic diversity.

*Biological Systematics: The State of the Art* (p. 185)

Chapman & Hall. London, England. 1993

## DIVINE INTELLIGENCE

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

No rational order of divine intelligence unites species. The natural ties are genealogical along contingent pathways of history.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Eight, Chapter 32 (p. 424)

Random House, Inc. New York, New York, USA. 1995

## DIVISION

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

It is known that there is an infinite number of worlds, but that not every one is inhabited. Therefore, there must be a finite number of inhabited worlds. Any finite number divided by infinity is as near to nothing as makes no odds, so if every planet in the Universe has a population of zero then the entire population of the Universe must also be zero, and any people you may actually meet from time to time are merely the products of a deranged imagination.

*The Original Hitchhiker Radio Script*

Fit the Fifth (p. 102)

Harmony Books. New York, New York, USA.

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

Can you do Division? Divide a loaf by a knife — what's the answer to that?

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter IX (p. 253)

The Modern Library. New York, New York, USA. 1936

**Kemble, William H.**

No biographical data available

Allow me to introduce you to my particular friend Mr. George O Evans.... He understands Addition, Division, and Silence.

*New York Sun*, 20 June 1872

**Mr. Silva**

Fictional character

You've got so many refinements. I don't think you need to worry about your failure at long division. I mean, after all, you got through short division, and short division is all that a lady ought to be called on to cope with...

*Baby Doll*

Film (1956)

## DNA

**Baum, Harold**

No biographical data available

The primary sequence of proteins

Is coded with DNA

One sense strand of the double helix

Coiled antiparallel way.

(Introns and exons, changes post-transcriptional, and all Glycosylations, don't alter such basics at all.)

*The Biochemists' Handbook*

Protein Biosynthesis (Tune: My Bonnie Lies Over the Ocean)

Van Nostrand Company, Inc. Princeton, New Jersey, USA. 1961

**Boulding, Kenneth E.** 1910–93  
English economist and social scientist

DNA was the first three-dimensional Xerox machine.  
In Richard P. Beilock (ed.)  
*Beasts, Ballads, and Bouldingisms: A Collection of Writings*  
Evolution, Ecology, and Spaceship Earth (p. 160)  
Transaction Books. New Brunswick, New Jersey, USA. 1980

**Crick, Francis Harry Compton** 1916–2004  
English molecular biologist, physicist, and neuroscientist

Nowadays most people know what DNA is, or if they don't know it must be a dirty word, like "chemical" or "synthetic."

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 6 (p. 63)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Dawkins, Richard** 1941–  
English ethologist, evolutionary biologist, and popular science writer

We are digital archives of the African Pliocene, even of Devonian seas; walking repositories of wisdom out of the old days. You could spend a lifetime reading in this ancient library and die unseated by the wonder of it.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 10 (p. 256)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

The potentiality of mind must be present in the egg and the sperm and in the DNA molecules. But it does not follow that eggs and sperms themselves have minds. A stone has in it a potentiality to become a statue, but it does not follow that every stone has a statue concealed in it.

*The Biology of Ultimate Concern*  
Chapter 2 (p. 30)  
The New American Library, Inc. New York, New York, USA. 1967

**Dulbecco, Renato** 1914–  
Italian-born American virologist

In the evolution of life DNA created the brain because devices were needed for sensing the environment: prey had to be identified, predators avoided, a mate located.

*The Design of Life*  
Chapter 17 (p. 339)  
Yale University Press. New Haven, Connecticut, USA. 1987

**Dunne, Dominick** 1925–  
American writer

The fact is, although DNA testing may be as foolproof as fingerprinting, it doesn't cause excitement. It's difficult to respond to. It's like advanced math, brilliant but boring, astonishing but passionless. It made everyone eager

to move on to the next phase of the trial, which consisted of autopsy pictures...

If the Glove Fits  
*Vanity Fair*, August 1995

**Jukes, Thomas Hughes** 1906–99  
American molecular biologist

Slowly the molecules enmeshed in ordered asymmetry. A billion years passed, aeons of trial and error.

The life message took form, a spiral, a helix, repeating itself endlessly, swathed in protein, nurtured by enzymes, sheltered in membranes, laved by salt water, armored with lime.

*Molecules and Evolution* (p. iii)  
Columbia University Press, New York, New York, USA. 1966

**Thomas, Lewis** 1913–93  
American physician and biologist

The greatest single achievement of nature to date was surely the invention of DNA. We have had it from the very beginning, built into the first cell to emerge, membranes and all, somewhere in the soupy waters of the cooling planet.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
The Wonderful Mistake (p. 27)  
The Viking Press. New York, New York, USA. 1979

The capacity to blunder slightly is the real marvel of DNA. Without this special attribute, we would still be anaerobic bacteria and there would be no music.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
The Wonderful Mistake (p. 28)  
The Viking Press. New York, New York, USA. 1979

## DWARF PLANET: PLUTO

### Author undetermined

In a little cluster of orbs which scampers across the sidereal abyss under the name of the solar system there are, let it be known, nine instead of a mere eight, worlds. The presence of a ninth planet in the retinue of the Sun, long suspected, was definitely announced here today.

Associated Press dispatch  
*New York Times*, March 14, 1930

**Hoyt, William Graves** 1921–  
American journalist and author

The planet was named Pluto, of course, the first two letters of the name as well as its planetary symbol of the superimposed letters "P" and "L" standing for the initials of Percival Lowell's name.

*Lowell and Mars*  
Chapter 14 (p. 280)  
University of Arizona Press. Tucson, Arizona, USA. 1976



## E

e

### Berrett, Wayne

It had to be e,  
nonintegral e,  
I looked around  
Until I found  
A base that would do.  
To differentiate  
or to integrate,  
One that would not  
Carry along  
Some ugly weight.  
Some bases I know  
Are Simpler to state,  
A snap to invert,  
Exponentiate,  
But they wouldn't do.  
For no other base can fit math so well,  
With all its digits I love it still!  
It had to be e,  
Irrational e,  
It had to be e!  
It Had to Be e  
*Mathematics Magazine*, Volume 68, Number 1, February 1995 (p. 15)

### Brewster, G. W.

$2(5/2)^{2/5} = e$   
*The Mathematical Gazette*, Volume 25, Number 263, February 1941  
(p. 49)

### Klein, Felix 1849–1925

German mathematician

The definition of e is usually, in imitation of the French models, placed at the very beginning of the great text books of analysis, and entirely unmotivated, whereby the really valuable element is missed, the one which mediates the understanding, namely, an explanation of why precisely this remarkable limit is used as base and why the resulting logarithms are called natural.

Translated by E.R. Hedrick and C.A. Noble  
*Elementary Mathematics from an Advanced Standpoint*  
Part Third, Chapter I, Section 3 (p. 146)  
Dover Publications. New York, New York, USA. 1939

### Teller, Edward 1908–2003

Hungarian-born American nuclear physicist

### Teller, Wendy

No biographical data available

...the first nine digits after the decimal can be remembered by  $e = 2.7(\text{Andrew Jackson})2$ , or  $e = 2.718281828$ ...because

Andrew Jackson was elected President of the United States in 1828. For those good in mathematics on the other hand, this is a good way to remember their American History.

*Conversations on the Dark Secrets of Physics*  
Chapter 6 (p. 87, fn)  
Plenum Press. New York, New York, USA. 1991

$$E = mc^2$$

### Chase, Stuart 1888–1985

American economist and engineer

The Atomic Age is built on Einstein's equation  $E = mc^2$ , where m is the mass of the atom, and c is the speed of light (186,000 miles per second). You square that, and out of the atom comes quite a bit of energy.

New Energy for a New Age  
*Saturday Review*, January 22, 1955 (p. 14)

## EAR WAX

### Flaubert, Gustave 1821–90

French novelist

Cerumen. Human wax. Should not be removed: it keeps insects from entering the ears.

*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

## EARTH, DEATH OF

### Darwin, Charles Robert 1809–82

English naturalist

[Consider] the view now held by most physicists, namely, that the sun with all the planets will in time grow too cold for life, unless indeed some great body dashes into the sun, and thus gives it fresh life. Believing as I do that man in the distant future will be a far more perfect creature than he now is, it is an intolerable thought that he and all other sentient beings are doomed to complete annihilation after such long-continued slow progress.

*The Autobiography of Charles Darwin, 1809–1882: With Original Omissions Restored*  
Religious Beliefs (p. 92)  
Harcourt, Brace. New York, New York, USA. 1959

## EARTHQUAKE

### Addison, Joseph 1672–1719

English essayist, poet, and statesman

I remember when (Britain) was shaken with an earthquake some years ago, there was an impudent mountebank who sold pills which (as he told the country people) were very good against an earthquake.

*The Works of the Right Honourable Joseph Addison, A New Edition, with Notes* (Volume 2)

*The Tatler*  
Number 243 (p. 418)  
Printed for T. Cadell and W. Davies. London, England. 1811

**Ager, Derek** 1923–98  
Geologist

The [tectonic] history of any one part of the earth, like the life of a soldier, consists of long periods of boredom and short periods of terror.

In Stephen Gould  
*The Panda's Thumb: More Reflections in natural History*  
Chapter 17 (p. 185)  
W.W. Norton & Company, Inc. New York, New York, USA. 1980

**Audubon, John James** 1785–1851  
West Indian-born American ornithologist and artist

...like every other person, I knew of earthquakes by description. But what is description compared with the reality?

*Ornithological Biography* (Volume 1)  
The Earthquake (p. 239)  
Adam Black. Edinburgh, Scotland. 1831

### Author undetermined

What powerful hand with force unknown,  
Can these repeated tremblings make?  
Or do the imprison'd vapours groan?  
Or do the shores with fabled Tridents shake?  
Ah no! the tread of impious feet,  
The conscious earth impatient bears;  
And shudd'ring with the guilty weight,  
One common grave for he bad race prepares.

In Bruce A Bolt  
*Earthquakes: A Primer*  
Chapter 4 (p. 53)  
W. H. Freeman. San Francisco, California, USA. 1978

**Blount, Sir Thomas Pope** 1649–97  
English author

Earthquakes are too evident Demonstrations of the Hollowness of the Earth, being the dreadful Effects or Consequences of it; for if the Body of the Earth was sound and compact, there would be no such thing in Nature as an Earthquake.

*A Natural History*  
Observations Concerning Earthquakes (p. 403)  
Printed for R. Bentley. London, England. 1693

**Boscowitz, Arnold**  
Fench writer

No evil is without its remedy, but against the earthquake there is no protection.

*Earthquakes*  
Earthquakes (p. 5)  
G. Routledge. London, England. 1890

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

When Poseidon shakes his finger, waves quiver through the rocks in all directions from the point of origin.

*Parade of the Living*  
Part I, Chapter VIII (p. 95)  
Coward-McCann, Inc. New York, New York, USA. 1930

**Darwin, Charles Robert** 1809–82  
English naturalist

A bad earthquake at once destroys the oldest associations: the earth, the very emblem of solidity, has moved beneath our feet like a thin crust over a fluid; — one second of time has created in the mind a strange idea of insecurity, which hours of reflection would not have produced.

*The Voyage of The Beagle*  
Chapter XIV (p. 302)  
Heron Books. 1968

**Dyer, John** 1700?–58  
Welsh poet

Disparting towers  
Trembling all precipitate down dash'd,  
Rattling around, loud thundering to the moon.

In Edward Thomas (ed.)  
*The Poems of John Dyer*  
The Ruins of Rome, l. 40  
T.F. Unwin. London, England. 1903

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

We learn geology the morning after the earthquake, on ghastly diagrams of cloven mountains, upheaved plains, and the dry bed of the sea.

*Ralph Waldo Emerson: Essays and Lectures*  
The Conduct of Life  
Considerations by the way (p. 1088)  
The Library of America. New York, New York, USA. 1983

**Esar, Evan** 1899–1995  
American humorist

[Earthquake] A topographical error.  
*Esar's Comic Dictionary*  
Earthquake  
Doubleday. Garden City, New York, USA. 1983

**King, Ben** 1857–94  
Poet

De eyarfquak e a-shakin'  
Jes' a short time ago  
Was Belzabub a-pullin'  
Out de clinkers down below.

*Ben King's Verse*  
De Eyarfquak  
Forbes & Company. Chicago, Illinois, USA. 1903

**Lyell, Sir Charles** 1797–1875  
English geologist

...it must have appeared almost as improbable to the earlier geologists, that the laws of earthquakes should one day throw light on the origin of mountains, as it must to the first astronomers, that the fall of an apple should assist in explaining the motions of the moon.

*Principles of Geology* (Volume 3)  
Chapter I (p. 5)  
John Murray. London, England. 1830

**Lynch, John Joseph**  
No biographical data available

Which would you rather have, a bursting planet or an earthquake here and there?  
*New York Times*, 5 December 1963

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

...day after day has there been a succession of earthquake shocks, that, as the plutonic paroxysm increases in intensity, become stronger and more frequent, and the mountain-waves roll outwards in ever-widening circles, to rise and fall in distant and solitary seas, or to break in long lines of foam on nameless islands unknown to the geographer.

*Sketch-book of Popular Geology*  
Lecture Third (p. 109)  
William P. Nimmo & Company. Edinburgh, Scotland. 1880

**Miller, Jr., Walter M.** 1923–96  
American science fiction writer

From the scourge of the earthquake,  
*O Lord, deliver us.*  
*A Canticle for Leibowitz*  
Part I, Chapter 2  
Bantam Books. New York, New York, USA. 1997

**Milne, Alan Alexander** 1882–1956  
English poet, children's writer, and playwright

"It is snowing still," said Eeyore gloomily.  
"So it is."  
"And freezing."  
"Is it?"  
"Yes," said Eeyore. "However," he said, brightening up a little, "we haven't had an earthquake lately."  
*The Complete Tales & Poems of Winnie-the-Pooh*  
The House at Pooh Corner (p. 175)  
Dutton Children's Books. New York, New York, USA. 2001

**Muir, John** 1838–1914  
American naturalist

It is always interesting to see people in dead earnest, from whatever cause, and earthquakes make everybody earnest.  
*Our National Parks*

Chapter VIII (p. 264)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...a low muffled underground rumbling and a slight rustling of the agitated trees, as if, in wrestling with the mountains, Nature were holding her breath.

*Our National Parks*  
Chapter VIII (p. 262)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Riley, James Whitcomb** 1849–1916  
American poet

Then — sudden — did the earth moan as it slept,  
And start as one in evil dreams, and toss  
Its peopled arms up, as the horror crept.

*The Complete Works of James Whitcomb Riley*, (Volume 5)  
The Earthquake  
P.F. Collier & Son Company. New York, New York, USA. 1916

I kin hump my back and take the rain,  
And I don't kneer how she pours;  
I kin keep kind o'ca'm in a thunder-storm,  
No matter how loud she roars;  
I hain't much skeered o' the lightnin',  
Ner I hain't sich awful shakes  
Afeared o' *cyclones* — but I don't want none  
O' yer dad-burned old earthquakes!

*The Complete Works of James Whitcomb Riley*, (Volume 5)  
A Fall-Crick View of the Earthquake  
P.F. Collier & Son Company. New York, New York, USA. 1916

**Schreiber, Hermann**  
No biographical data available

**Schreiber, Georg**  
No biographical data available

The earth bears us unwillingly upon her back. We carve into her in order to sink the foundations for our houses and now and again she shakes herself and with a brief shudder tumbles these houses about as if they were children's blocks.

Translated by Richard and Clara Winston  
*Vanished Cities*  
Part One (p. 3)  
Alfred A. Knopf. New York, New York, USA. 1962

**Schwartz, David**  
No biographical data available

They aren't little puppies. They are big, biting dogs and they each get unleashed every few hundred years.

*The National Geographic*  
In Rick Gore  
Living With California's Faults, April 1995 (p. 28)

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Some say the Earth was feverous and did shake.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)

Macbeth

Act II, Scene iii, l. 65

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Diseased nature oftentimes breaks forth

In strange eruptions; oft the teeming earth

Is with a kind of colic pinch'd and vex'd

By the imprisoning of unruly wind

Within her womb; which, for enlargement striving,

Shakes the old beldame earth, and topples down

Steeple and moss-grown towers.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The First Part of King Henry the Fourth

Act III, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

DON PEDRO: Thou wilt quake for this shortly.

BENEDICT: I look for an earthquake then.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Much Ado About Nothing

Act I, Scene ii

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaler, Nathaniel Southgate** 1841–1906

American geologist

Human society is organized for a stable earth: its whole machinery supposes that while the other familiar elements of air and water are fluctuating and trustworthy, the earth affords a foundation which is firm. Now and then this implied compact with nature is broken, and the ground trembles beneath our feet. At such times we feel a painful sense of shipwrecked confidence: we learn how very precious to us was that trust in the earth which we gave without question. If the disturbance be of a momentary and unimportant kind, we may soon forget it, as we forget the rash word of a friend; if it be violent, we lose one of the substantial goods of life, our instinctive confidence in the earth beneath our feet.

*Aspects of the Earth: A Popular Account of Some Familiar Geological Phenomena*

The Stability of the Earth (pp. 1–2)

Charles Scribner's Sons. New York, New York, USA. 1889

**Shelley, Percy Bysshe** 1792–1822

English poet

With hue like that when some great painter dips

His pencil in the gloom of earthquake and eclipse.

*The Complete Poetical Works of Percy Bysshe Shelley*

Revolt of Islam Canto V, Stanza 23

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Silone, Ignazio** 1900–78

Italian novelist and journalist

An earthquake achieves what the law promises but does not in practice maintain — the equality of all men.

In Richard H S Crossman (ed.)

*The God That Failed*

Part I, Ignazio Silone (p. 92)

Harper & Brothers, New York, New York, USA. 1949

**Stukeley, William** 1687–1765

English antiquary

When so great and unusual a phenomenon, as an earthquake, and that repeated, happens among us; it will naturally excite a serious reflexion in every one that is capable of thinking.

*The Philosophy of Earthquakes, Natural and Religious*

To Martin Folkes (p. 5)

C. Corbet. London, England. 1750

## The Bible

You have made the land quake and caused it to split open; repair its ruins, for it is shattered.

*The Revised English Bible*

Psalm 60:2–3

Oxford University Press, Inc. Oxford, England. 1989

The mountains skipped like rams, the hills like lambs of a flock.

*The Revised English Bible*

Psalm 114:4

Oxford University Press, Inc. Oxford, England. 1989

At that moment the curtain of the temple was torn in two from top to bottom. The earth shook, rocks split...

*The Revised English Bible*

Matthew 27:51

Oxford University Press, Inc. Oxford, England. 1989

...after the wind there was an earthquake; but the Lord was not in the earthquake!

*The Revised English Bible*

I Kings 19:11

Oxford University Press, Inc. Oxford, England. 1989

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

I will set it down here as a maxim that the operations of the human intellect are much accelerated by an earthquake. Usually I do not think rapidly — but I did upon this occasion. I thought rapidly, vividly, and distinctly. With the first shock of the five, I thought — “I recognize that motion — this is an earthquake.” With the second, I thought, “What a luxury this will be for the morning papers.” With the third shock, I thought, “Well my boy, you had better be getting out of this.” Each of these thoughts was only the hundredth part of a second in passing through my mind. There is no incentive to rapid reasoning like an earthquake. I then sidled out toward the middle of the street — and I may say that I sidled out with some degree of activity, too. There is nothing like an earthquake to hurry a man when he starts to go anywhere.

The Great Earthquake in San Francisco

*New York Weekly Review*, 11/25/1865

**Wordsworth, William** 1770–1850  
English poet

All things have second birth;  
The earthquake is not satisfied at once.  
*The Complete Poetical Works of William Wordsworth*  
Resolution and Independence  
Crowell. New York, New York, USA. 1888

## ECHINODERMATA

**Cuppy, Will** 1884–1929  
American humorist and critic

For anyone who has ever considered the bizarre panoply that composes the Echinodermata, it is difficult to lose sight of the fact that echinoderms are strange. Their ontogenetic twists and turns of symmetry, absence of certain familiar organ systems, and presence of some less familiar systems might tempt one to imagine an extraterrestrial origin for the Echinodermata. The very strangeness of the Echinodermata is partly responsible for the dedication that specialists in the group feel. We revel in their weirdness.

In C.R.C. Paul and A.B. Smith (eds.)  
*Evolutionary Dissent: A Review of "Echinoderm Phylogeny and Evolutionary Biology"*  
*Paleobiology*, Volume 15, 1989

## ECLIPSE

**Archilochus** 710 BCE–676 BCE  
Greek mercenary

Nothing can be surprising any more or impossible or miraculous, now that Zeus, father of the Olympians has made night out of noonday, hiding the bright sunlight, and...fear has come upon mankind. After this, men can believe anything, expect anything. Don't any of you be surprised in future if land beasts change places with dolphins and go to live in their salty pastures, and get to like the sounding waves of the sea more than the land, while the dolphins prefer the mountains.

In F. Richard Stephenson  
*Historical Eclipses and Earth's Rotation*  
Chapter 10 (p. 338)  
Cambridge University Press. Cambridge, England. 1997

**Baily, Francis**  
No biographical data available

...there was at the same time something in its singular and wonderful appearance that was appalling and I can readily imagine that uncivilised nations may occasionally have become alarmed and terrified at such an object.

Some Remarks on the Total Eclipse of the Sun on July 8<sup>th</sup>, 1842  
*Memoirs of the Royal Astronomical Society*, Volume 15, 1845 (p. 6)

**Caithness, James Balharrie**  
No biographical data available

I watched the shadow of our globe  
Pass sheer across the moon,  
She sadly donned the somber robe,  
But glad emerging, soon  
Cast all its dismal folds aside,  
Bright through the heavens again to ride.  
*Pastime Poems*  
An Eclipse of the Moon (Second Version)  
E. Macdonald. London, England. 1924

## Chinese ode

For the moon to be eclipsed  
Is but an ordinary matter.  
Now that the sun had been eclipsed  
How bad it is!  
In Bertrand Russell  
*The ABC of Relativity*  
Chapter IV (p. 35)  
George Allen & Unwin Ltd. London, England. 1958

**Dillard, Anne** 1945–  
American poet, essayist, novelist, and writing teacher

Seeing a partial eclipse bears the same relation to seeing a total eclipse as kissing a man does to marrying him, or as flying in an airplane does to falling out of an airplane.  
*Teaching a Stone to Talk: Expeditions and Encounters*  
Total Eclipse (p. 89)  
Harper & Row, Publishers. New York, New York, USA. 1982

**Donne, John** 1572–1631  
English poet and divine

How great love is, presence best try all makes,  
But absence tryes how long this love will bee;  
To take a latitude,  
Sun, or starres, are fitliest view'd  
At their brightest, but to conclude  
Of Longitudes, what other way have wee,  
But to marke when, and where the darke  
eclipses bee?  
In Eric Rogers  
*Astronomy for the Inquiring Mind*  
Chapter 2 Facts and Early Progress (p. 33)  
Princeton University Press. Princeton, New Jersey, USA. 1982

**Flammarion, Camille** 1842–1925  
French astronomer and author

Eclipses, like comets, have always been interpreted as the indication of inevitable calamities. Human vanity sees the finger of God making signs to us on the least pretext, as if we were the end and aim of universal creation.  
*Popular Astronomy: A General Description of the Heavens*  
Book II, Chapter IX (p. 180)  
Chatto & Windus. London, England. 1894

**Joslin, Rebecca R.**

No biographical data available

Now eclipses are elusive and provoking things...visiting the same locality only once in centuries. Consequently, it will not do so to sit down quietly at home and wait for one to come, but a person must be up and doing and on the chase.

*Chasing Eclipses: The Total Solar Eclipses of 1905, 1914, 1925* (pp. 1–2)  
Walton Advertising & Printing. Boston, Massachusetts, USA. 1929

**Keill, John** 1671–1721

Scottish mathematician and natural philosopher

There is nothing in Astronomy which shews the great Sagacity of Human Understanding, and its deep Penetration, more than a clear Explication of the Suddain Disappearings of the Sun and the Moon, that is, of their Eclipses; and the accurate Predictions when they are to come to pass, which the Astronomers can now foretell almost to a Minute.

*An Introduction to the True Astronomy*

Lecture XI (p. 109)

Printed for Bernard Lintot. London, England. 1721

**Millay, Edna St. Vincent** 1892–1950

Poet and playwright

Cold of the sun's eclipse

When cocks crow for the first time hapless, and dogs in kennel howl

Abandoning the richly-stinking bone,  
And the star at the edge of the shamed and altered sun  
shivers alone,

And over the pond the bat but not the swallow dips  
And out comes the owl.

*Collected Poems*

No Earthly Enterprise

Harper. New York, New York, USA. 1956

**Pasachoff, Jay M.**

Astronomer

Some people see a partial eclipse and wonder why others talk so much about a total eclipse. Seeing a partial eclipse and saying that you have seen an eclipse is like standing outside an opera house and saying that you have seen the opera; in both cases, you have missed the main event.

In Donald H. Menzel and Jay M. Pasachoff

*A Field Guide to the Stars and Planets* (2<sup>nd</sup> edition, revised and enlarged) (p. 409)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1983

**Pindar, Paean IX**

No biographical data available

Beam of the Sun!

What wilt thou be about, far-seeing one,

O mother of mine eyes, O star supreme,

In time of day

Reft from us? Why, O why has thou perplexed

The might of man,

And wisdom's way,

Rushing forth on a darksome track?

In Cecilia Payne-Gaposchkin

*Introduction to Astronomy*

Chapter VI (p. 134)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1954

**Plato** 428 BCE–347 BCE

Greek philosopher

...people may injure their bodily eye by observing and gazing on the sun during an eclipse, unless they take the precaution of only looking at the image reflected in the water, or in some similar medium.

In *Great Books of the Western World* (Volume 7)

*Phaedo*

Section 99 (p. 242)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Why do the rains, the tempests themselves seem to us to come by chance, so that many persons find it quite natural to pray for rain or shine, when they would think it ridiculous to pray for an eclipse?

*The Foundations of Science*

Science and Method, Book I

Chapter IV, Section II (p. 398)

The Science Press. New York, New York, USA. 1913

**The Bible**

On that day, says the Lord God, I shall make the sun go down at noon and darken the earth in broad daylight.

*The Revised English Bible*

Amos 8:9

Oxford University Press, Inc. Oxford, England. 1989

I shall set portents in the sky and on earth, blood and fire and columns of smoke. The sun will be turned to darkness and the moon to blood before the coming of the great and terrible day of the Lord.

*The Revised English Bible*

Joel 2:30–31

Oxford University Press, Inc. Oxford, England. 1989

**Wordsworth, William** 1770–1850

English poet

High on her speculative tower

Stood Science waiting for the hour

When Sol was destined to endure

That darkening of his radiant face

Which Superstition strove to chase,

Erewhile, with rites impure.

*The Complete Poetical Works of William Wordsworth*

The Eclipse of the Sun

Crowell. New York, New York, USA. 1888

**Zirker, Jack B.**

Astronomer

I look up. Incredible! It is the eye of God. A perfectly black disk, ringed with bright spiky streamers that stretch out in all directions.

*Total Eclipses of the Sun* (p. vi)

Van Nostrand Reinhold. New York, New York, USA. 1984

**ECOLOGIST****Adams, Charles C.** 1873–1955

American ecologist

Ecology has no aim, but ecologists have. The problems of the ecologist are not fundamentally different from those of any other kind of naturalist. The superficial differences in aim are due to the different points of views, or methods of approach, rather than to any essential difference in the character of the problem.

*Guide to the Study of Animal Ecology*

Chapter I (p. 1)

The Macmillan Company. New York, New York, USA. 1913

**ECOLOGY****Allaby, (John) Michael** 1933–

Freelance science writer

Ecology is rather like sex — every new generation likes to think they were the first to discover it.

*The Times (London)*, 6 October 1989

**Berry, Richard James Arthur** 1867–1962

English anatomist

**Bradshaw, A. D.**

No biographical data available

Ecology lacks an agreed theoretical core and is therefore easily destabilized and subject to intellectual fashion.

In R.J. Berry, T.J. Crawford and G.M. Hewitt (eds.)

*Genes in Ecology*

Genes in the Real World (p. 431)

Blackwell Scientific Publications. Oxford, England. 1992

Ecology and genetics have always been uneasy bedfellows, despite their intrinsic complementarity; genetics is about what exists, ecology is about how it exists.

In R.J. Berry, T.J. Crawford and G.M. Hewitt (eds.)

*Genes in Ecology*

Genes in the Real World (p. 431)

Blackwell Scientific Publications. Oxford, England. 1992

**Borland, Hal** 1900–78

American writer

The pond and the wetlands are a world unto themselves. The adventurer there, be he novice or veteran, will be

aware of ancient beginnings and insistent change. There he will see those subtle interrelationships of life which the specialist calls ecology.

*Beyond Your Doorstep: A Handbook to the Country*

Chapter 5 (p. 103)

Alfred A. Knopf. New York, New York, USA. 1962

**Elton, Charles S.** 1900–91

English biologist

At a time when ecology and genetics are each racing swiftly towards one new concept after another, yet with little contact of thought between the two subjects, there may be some advantage in surveying, if only synoptically and in preliminary fashion, the largely uncharted territory between them.

In G.R. de Beer (ed.)

*Evolution: Essays on Aspects of Evolutionary Biology Presented to Professor E.S. Goodrich on his Seventieth Birthday*

Animal Numbers and Adaptation (p. 127)

Clarendon Press. Oxford, England. 1938

...there is more ecology in the Old Testament or the plays of Shakespeare than in most of the zoological textbooks ever printed.

*Animal Ecology*

Chapter II (p. 7)

Sidgwick & Jackson, Ltd. London, England. 1927

**Foreman, Dave** 1947–

American environmentalist

But, damn it, I am an animal. A living being of flesh and blood, storm and fury. The oceans of the Earth course through my veins, the winds of the sky fill my lungs, the very bedrock of the planet makes my bones. I am alive! I am not a machine, a mindless automaton, a cog in the industrial world, some New Age android. When a chain saw slices into the heartwood of a two-thousand-year-old Coast Redwood, it's slicing into my guts. When a bulldozer rips through the Amazon rain forest, it's ripping into my side. When a Japanese whaler fires an exploding harpoon into a great whale, my heart is blown to smithereens. I am the land, the land is me.

*Confessions of an Eco-Warrior*

Chapter 1 (pp. 4–5)

Harmony Books. New York, New York, USA. 1991

**Haeckel, Ernst** 1834–1919

German biologist and philosopher

[Ecology is] the science of relations between organisms and their environment.

In Anna Bramwell

*Ecology in the 20<sup>th</sup> Century: A History*

Chapter 3 (p. 40)

Yale University Press. New Haven, Connecticut, USA. 1989

**Herbert, Frank** 1920–86

American science fiction writer

The thing the ecologically illiterate don't realize about an ecosystem... is that it's a system. A System! A system maintains a certain fluid stability that can be destroyed by a misstep in just one niche. A system has order, a flowing from point to point. If something dams that flow, order collapses. The untrained might miss that collapse until it was too late. That's why the highest function of ecology is the understanding of consequences.

Enveloped in absolute mystery,  
And without extra charge  
I will give you at large  
A Lesson in Natural History.

*Dune*

Appendix I (p. 402)

Chilton Book Company. Radnor, Pennsylvania, USA. 1965

**Kühnert, Franz** 1852–1918

No biographical data available

The protection of an animal or of a plant will be ineffectual so long as we do not also preserve that organism's conditions of life.

In Philippe Diolé

Translated by J.F. Bernard

*The Errant Ark: Man's Relationship with Animals*

Chapter Three (p. 69)

G.P. Putnam's Sons. New York, New York, USA. 1974

**Osborn, Fairfield** 1887–1969

American conservationist

There is no risk in making the flat statement that in a world devoid of other living creatures, man himself would die. This fact — call it a theory if you will — is far more provable than the accepted theory of relativity. Involved in it is, in truth, another kind of principle of relativity — the relatedness of all living things.

*Our Plundered Planet* (p. 60)

Grosset & Dunlap, Publishers. New York, New York, USA. 1951

**Sontag, Susan** 1933–2004

American critic and writer

Guns have metamorphosed into cameras in this earnest comedy, the ecology safari, because nature has ceased to be what it had always been — what people needed protection from. Now nature — tamed, endangered, mortal — needs to be protected from people. When we are afraid, we shoot. But when we are nostalgic, we take pictures.

*On Photography*

In Plato's Cave (p. 15)

Farrar, Straus & Giroux. New York, New York, USA. 1973

**Stevenson, Adlai E.** 1900–65

American political leader and diplomat

We travel together, passengers on a little space ship, dependent upon its vulnerable reserves of air and soil, committed for our safety to its security and peace, preserved

from annihilation only by the care, the work, and, I will say, the love we give our fragile craft. We cannot maintain it half fortunate, half miserable, half confident, half despairing, half slave to the ancient enemies of mankind, half free in a liberation of resources undreamed of until this day. No craft, no crew, can travel safely with such vast contradictions. On their resolution depends the survival of us all.

Speech

United Nations Economic and Social Council, Geneva, Switzerland,

July 9, 1965

**Tansley, A. G.** 1917–

English ecologist

Every genuine worker in science is an explorer, who is continually meeting fresh things and fresh situations, to which he has to adapt his material and mental equipment.

This is conspicuously true of our subject, and is one of the greatest attractions of ecology to the student who is at once eager, imaginative, and determined. To the lover of prescribed routine methods with the certainty of "safe" results the study of ecology is not to be recommended.

*Practical Plant Ecology: A Guide for Beginners in Field Studies of Plant Communities* (p. 97)

George Allen & Unwin Ltd. London, England. L1923

**Ward, Barbara** 1914–81

English author and educator

We cannot cheat on DNA. We cannot get round photosynthesis. We cannot say I am not going to give a damn about phytoplankton. All these tiny mechanisms provide the preconditions of our planetary life. To say we do not care is to say in the most literal sense that "we choose death."

In Maurice F. Strong (ed.)

*Who Speaks For Earth?*

Speech for Stockholm (p. 31)

W.W. Norton & Company, Inc. New York, New York, USA. 1973

**Wiener, Norbert** 1894–1964

American mathematician

For the more we get out of the world the less we leave, and in the long run we shall have to pay our debts at a time that may be very inconvenient for our survival.

*The Human Use of Human Beings*

Chapter II (p. 46)

Da Capo Press. New York, New York, USA. 1988

**Wilson, Edward O.** 1929–

American biologist and author

A civilization able to envision God and to embark on the colonization of space will surely find the way to save the integrity of this planet and the magnificent life it harbors.

*The Future of Life*

Chapter 7 (p. 189)

Alfred A. Knopf. New York, New York, USA. 2002



**ECONOMIST**

**Marshall, Alfred** 1842–1924  
English economist

Greedy then as the economist must be for facts, he must not be content with mere facts. Boundless as must be his gratitude to the great thinkers of the historic school, he must be suspicious of any direct light that the past is said to throw on the problems of the present.

In A.C. Pigou (ed.)  
*Memorials of Alfred Marshall*  
Chapter VI (p. 171)  
Macmillan & Company, Limited. London, England. 1925

**ECOSYSTEM**

**Margalef, Ramón** 1919–2004  
Spanish ecologist

Evolution cannot be understood except in the frame of ecosystems.

*Perspectives in Ecological Theory*  
Lecture 4 (p. 81)  
The University of Chicago Press. Chicago, Illinois, USA. 1968

**EDIFICE**

**Frege, Friedrich Ludwig Gottlob** 1848–1925  
German logician

Hardly anything more unfortunate can befall a scientific writer than to have one of the foundations of his edifice shaken after the work is finished.

In Peter Geach and Max Black  
*Translations from the Philosophical Writings of Gottlob Frege*  
Frege on Russell's Paradox (p. 214)  
Basil Blackwell. Oxford, England. 1952

**EDUCATION**

**Bridgman, Percy Williams** 1882–1961  
American physicist

I for one am not willing to admit that a man has been liberally educated for a free society who has not learned to view instinctively the doings of men against the background of the potentialities of the future rather than of the incoherencies of the past.

*Reflections of a Physicist*  
Chapter 32 (p. 568)  
Philosophical Library. New York, New York, USA. 1950

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist  
O ye! who teach the ingenious youth of nations,  
Holland, France, England, Germany, or Spain,  
I pray ye flog them upon all occasions,

It mends their morals, never mind the pain.

*The Complete Poetical Works of Byron*  
Don Juan  
Canto II, Stanza 2  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Campbell, Norman R.** 1880–1948  
English physicist and philosopher

If scientific education today is unsuited for those who are to make science their life work, it is even less suited for those to whom it is merely to be part of a general education. Men of science complain of the lack of a wide appreciation of scientific knowledge; what else can they expect if they offer to the world only the dry bones of knowledge from which the breath has departed? Nothing could be better adapted than the ordinary school course, with its tedious insistence on bare and uninspiring fact, to kill any rising enthusiasm. It is most important certainly, to impress the student with the nature of scientific truth and with the possibility of definite, positive knowledge concerning the material world. . . . But to insist on the truth of science and to neglect its meaning is to aggravate the evil which we seek to cure. . . .

*Physics: The Elements*  
Chapter VIII (p. 226)  
At The University Press. Cambridge, England. 1920

**Conklin, Edwin Grant** 1863–1952  
American zoologist

Education is habit-forming rather than information; illumination rather than indoctrination, inspiration rather than compulsion.

*Science in the World Crisis*  
*The American Biology Teacher*, Volume 1, Number 8, May 1939 (p. 206)

**Deller, Jr., J. R.**  
No biographical data available

Education is the process of telling smaller and smaller lies.

Tom, Dick, and Mary Discover the DFT  
*IEEE Signal Processing Magazine*, April 1994 (p. 36)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

Education never ends, Watson. It is a series of lessons with the greatest for the last.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes (Volume 2)*  
The Adventure of the Red Circle (p. 697)  
Wings Books. New York, New York, USA. 1967

**Huxley, Thomas Henry** 1825–95  
English biologist

The great benefit which a scientific education bestows, whether as training or as knowledge, is dependent upon the extent to which the mind of the student is

brought into immediate contact with the facts — upon the degree to which he learns the habit of appealing directly to Nature.

*Collected Essays* (Volume 8)

A Lobster; or, The Study of Zoology (p. 219)

Macmillan & Company Limited. London, England. 1904

That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a clear, cold, logic engine, with all its parts of equal strength and in smooth working order; ready, like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of Nature and of the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of Nature or of art, to hate all vileness, and to respect others as himself.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 86)

Macmillan & Company Limited. London, England. 1904

I am the last person to question the importance of genuine literary education, or to suppose that intellectual culture can be complete without it. An exclusively scientific training will bring about a mental twist as surely as an exclusively literary training. The value of the cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that the Scientific College would turn out none but lopsided men.

*Collected Essays* (*Science and Culture*)

Address 1880

Opening of Mason College

### **Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

What, after all, is education but a subtle, slowly-affected change, due to the action upon us of the Externals; of the written record of the great minds of all ages, of the beautiful and harmonious surroundings of nature and of art, and of the lives, good or ill, of our fellows — these alone educate us, these alone mould the developing minds.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (p. 95)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

If the license to practice meant the completion of his education how sad it would be for the practitioner, how distressing to his patients! More clearly than any other the physician should illustrate the truth of Plato's saying that education is a life-long process.

The Importance of Post-Graduate Study

*Lancet*, Volume 2, 1900

A man cannot become a competent surgeon without a full knowledge of human anatomy and physiology, and the physician without physiology and chemistry flounders along in an aimless fashion, never able to gain any accurate conception of disease, practicing a sort of pop-gun pharmacy, hitting now the malady and again the patient, he himself not knowing which.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Teaching and Thinking (p. 121)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

### **Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

What the world needs is a fusion of the sciences and the humanities. The humanities express the symbolic, poetic, and prophetic qualities of the human spirit. Without them we would not be conscious of our history; we would lose our aspirations and the grace of expression that move men's hearts. The sciences express the creative urge in man to construct a universe which is comprehensible in terms of the human intellect. Without them, mankind would find itself bewildered in a world of natural forces beyond comprehension, victims of ignorance, superstition and fear.

Commencement Address

Engineering & Science, California Institute of Technology

June 1954

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

BIRON: What is the end of study? let me know?

KING: Why, that to know, which else we should not know.

BIRON: Things hid and barr'd, you mean, from common sense?

KING: Ay, that is study's godlike recompense.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Love's Labor's Lost

Act I, Scene i, l. 55–58

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

What does education often do? It makes a straight-cut ditch of a free-meandering brook.

*The Journal of Henry D. Thoreau* (Volume 2)

Undated (p. 83)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

In education, as elsewhere, the broad primrose path leads to a nasty place.

*The Aims of Education and Other Essays*

Chapter I (p. 7)

The Macmillan Company. New York, New York, USA. 1959

## EFFECT

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The phenomena of nature are most often enveloped by so many strange circumstances, and so great a number of disturbing causes mix their influence, that it is very difficult to recognize them. We may arrive at them only by multiplying the observations or the experiences, so that the strange effects finally destroy reciprocally each other.

*A Philosophical Essays on Probabilities*

Chapter IX (p. 73)

Dover Publications, Inc. New York, New York, USA. 1951

## EFFICIENT

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

If one is obliged to be efficient about everything the best that can be achieved is a moderate measure of competence.

*Of Men and Galaxies*

Motives and Aims of the Scientist (pp. 13–14)

University of Washington Press. Seattle, Washington, USA. 1964

## EGG

**Diderot, Denis** 1713–84

French encyclopedist and philosopher of materialism

Do you see this egg? With this you can topple every theological theory, every church or temple in the world.

Translated by Jean Stewart and Jonathan Kemp

*Diderot: Interpreter of Nature*

D'Alembert's Dream

Conversation between d'Alembert and Diderot (p. 57)

International Publishers. New York, New York, USA. 1938

**Harvey, William** 1578–1657

English physician

Everything from an egg.

*De Generatione Animalium*

Frontispiece

Printed by James Young. London, England. 1653

## EL NIÑO

**Maddox, John Royden** 1925–

Welsh chemist and physicist

The El Niño phenomenon [is] the geophysicists' equivalent of the universal solvent.

Great Greenhouse in the Sky?

*Nature*, Volume 306, 1983 (p. 221)

## ELECTRICITY

**Arago, Francois** 1786–1853

French physicist

Thunder in the hands of nature is electricity in the hands of physicists.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1875*

Eulogy of Alexander Volta (p. 120)

Government Printing Office. Washington, D.C. 1876

**Barry, Dave** 1947–

American humor columnist

Electricity is actually made up of extremely tiny particles, called electrons, that you cannot see with the naked eye unless you have been drinking. Electrons travel at the speed of light, which in most American homes is 110 volts per hour. This is very fast. In the time it has taken you to read this sentence so far, an electron could have traveled all the way from San Francisco to Hackensack, New Jersey, although God alone knows why it would want to. The five main kinds of electricity are alternating current, direct current, lightning, static, and European. Most American homes have alternating current, which means that the electricity goes in one direction for a while, then goes in the other direction. This prevents harmful electron buildup in the wires.

*The Taming of the Screw*

Chapter 3 (p. 12)

Rodale Books. New York, New York, USA. 2000

## de Cisternay Dufay, Charles Francois

Chance has thrown my way another principle, more universal and remarkable...which casts a new Light on the subject of electricity. This principle is that there are two distinct Electricities, very different from each other; one of these I call vitreous Electricity; the other resinous Electricity. The first is that of Glass, Rock-Crystal, Precious Stones, Hair of Animals, Wool, and many other bodies. The second is that of Amber, Copal, Gum-Lac, Silk, Thread, Paper, and a vast number of other substances. The characteristic of these two Electricities is that a body of the Vitreous Electricity, for example, repels all such as are of the same Electricity; and on the contrary, attracts all those of the resinous electricity. ... This Principle very naturally explains why the ends of Thread, of Silk or Wool recede from one another in the form of a Pencil or Broom when they have acquired an electrick Quality.

*Philosophical Transactions of the Royal Society of London*, Volume 38, 1734 (p. 258)

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

I am somewhat exhausted; I wonder how a battery feels when it pours electricity into a non-conductor?

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Adventure of the Dying Detective (p. 442)

Wings Books. New York, New York, USA. 1967

**Faraday, Michael** 1791–1867

English physicist and chemist

Such is...the progress which electricity has made in the last thirty years: chemistry and magnetism have successively acknowledged its overruling influence: and it is probable that every effect depending upon the powers of inorganic matter, and perhaps most of those related to vegetable and animal life, will ultimately be found subordinate to it.

*Experimental Researches in Electricity* (Volume 1)

Eleventh Series, 1161 (p. 360)

Richard & John Edward Taylor. London, England. 1839–1855

Electricity is often called wonderful, beautiful; but it is so only in common with the other forces of nature. The beauty of electricity or of any other force is not that the power is mysterious, and unexpected, touching every sense at unawares in turn, but that it is under law, and that the taught intellect can even now govern it largely. The human mind is placed above, and not beneath it, and it is in such a point of view that the mental education afforded by science is rendered super-eminent in dignity, in practical application and utility; for by enabling the mind to apply the natural power through law, it conveys the gifts to God to man.

In Bence Jones

*The Life and Letters of Faraday* (p. 404)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1870

**Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

The electrical matter consists of particles extremely subtle, since it can permeate common matter, even the densest metals, with such ease and freedom as not to receive any perceptible resistance.

Quoted in *Nobel Lecture (Physics)*

Robert A. Millikan

The Electron and the Light-Quant from the Experimental Point of View (p. 54)

Dangerous, therefore, is it to take shelter under a tree, during a thundergust. It has been fatal to many, both men and beasts.

In I. Bernard Cohen

*Benjamin Franklin's Experiments*

Letter V

Letter to John Mitchell

April 29, 1749 (p. 209)

Harvard University Press. Cambridge, Massachusetts, USA. 1941

In going on with these Experiments, how many pretty systems do we build, which we soon find ourselves oblig'd to destroy! If there is not Use discover'd of Electricity, this, however, is something considerable, that it may help to make a vain Man humble.

In I. Bernard Cohen

*Benjamin Franklin's Experiments*

Chapter III, Section I

Letter to Peter Collinson

August 14, 1747 (p. 63)

Harvard University Press. Cambridge, Massachusetts, USA. 1941

**Freke, John** 1688–1756

Surgeon

I think it is a great pity that the word electricity should ever have been given to so wonderful a phenomenon, which might properly be considered as the first principle in nature. Perhaps the word vivacity might not have been an improper one.

*Essay to Shew the Cause of Electricity*

Appendix (p. 59)

Printed for W. Innys. London, England. 1746

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

Is it a fact — or have I dreamed it — that by means of electricity the world of matter has become a great nerve, vibrating thousands of miles in a breathless point of time? Rather, the round globe is a vast head, a brain instinct with intelligence...

*The House of Seven Gables*

The flight of Two Owls (p. 264)

Oxford University Press, Inc. Oxford, England. 1998

**Thomson, Sir Joseph John** 1856–1940

English physicist

The progress of electrical science has greatly been promoted by speculation as to the nature of electricity.

*Electricity and Matter*

Chapter I (p. 1)

Yale University Press. New Haven, Connecticut, USA. 1912

**Thurber, James** 1894–1961

American writer and cartoonist

...her own mother lived the latter years of her life in the horrible suspicion that electricity was dripping invisibly all over the house. It leaked, she contended, out of empty sockets if the wall switch had been left on.

*The Thurber Carnival*

The Car We Had to Push (p. 186)

The Modern Library. New York, New York, USA. 1957

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

I see very well that this assumption of two imponderable fluids of opposite qualities is a rather complicated

and artificial machinery and that the mathematical language of Clerk Maxwell's theory expresses the laws of the phenomena very simply and very truly with a much smaller number of hypothetical implications. But I confess I should really be at a loss to explain, without the use of mathematical formulas, what he considers a quantity of electricity and why such a quantity is constant, like that of a substance.

*The Modern Development of Faraday's Conception of Electricity*

Faraday Lecture

Delivered before the Fellows of the Chemical Society in London on April 5, 1881

## ELECTROCARDIOGRAM

### Kraus, Jack

ELECTROCARDIOGRAM: ticker tape.

*Quote, the Weekly Digest*, February 5, 1967 (p. 117)

## ELECTRON

### Allison, G. Burgess 1951–

Attorney

When you're dealing with electrons, it's pretty hard to tell one from the other.

*Law Practice Management*

Volume 9, 1994 (p. 14)

### Author undetermined

There were many electrons like this one in flight,  
But obeying Coulomb, they made small approach and then

Rapidly went apart. And the reason was that only

At rest could they repel one another,

But never attract!

In V. Grigoryev and G. Myakishev

*The Forces of Nature*

Chapter 7, The Song of the Electron (p. 239)

Mir. Moscow, Russia. 1971

There was a jolly electron —

alternately bound and free —

Who toiled and spun from morn to night,

no snark so lithe as he...

In Bernard Jaffe

*Crucibles: The Story of Chemistry*

Jolly Electron, Chapter XIV (p. 215)

Dover Publications. New York, New York, USA. 1976

Nature herself does not even know which way the electron is going to go.

In Richard Feynman

*The Character of Physical Law*

Chapter 6 (p. 147)

British Broadcasting Company. London, England. 1965

### Ball, Philip 1962–

English science writer

...in the water molecule, oxygen hogs the electrons like a selfish lover stealing most of the duvet.

*Life's Matrix: A Biography of Water*

Part Two, Chapter 6 (p. 169)

Farrar, Straus & Giroux. New York, New York, USA. 2000

### Benchley, Robert 1889–1945

American humorist and critic

The protons are positive and the electrons are negative, and, of the two, I am sure that the electrons are nicer.

*Benchley Lost and Found: 39 Prodigal Pieces*

Atom Boy! (p. 81)

Dover Publications. New York, New York, USA. 1970

### Birkeland, Kristian 1867–1917

Norwegian physicist

Space is filled with electrons and flying electric ions of all kinds.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 5 (p. 169)

Random House, Inc. New York, New York, USA. 1991

### Born, Max 1882–1970

German-born English physicist

It was through [Heisenberg's classic paper on the Uncertainty Principle] that the revolutionary character of the new conception became clear. It showed that not only the determinism of classical physics must be abandoned, but also the naive concept of reality which looked upon the particles of atomic physics as if they were very small grains of sand. At every instant a grain of sand has a definite position and velocity. This is not the case with an electron.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1954

The Statistical Interpretation of Quantum Mechanics (p. 262)

World Scientific Publishing Company. Singapore. 1998

### Bragg, Sir William Henry 1862–1942

English physicist

...an electron springs into existence.

Electrons and Ether Waves

*Scientific Monthly*, Volume XIV, February 1922, Number 8 (p. 156)

### Davisson, Clinton 1881–1958

American physicist

We think we understand the regular reflection of light and x-rays — and we should understand the reflections of electrons as well if electrons were only waves instead of particles. It is rather as if one were to see a rabbit climbing a tree, and were to say, "well that is rather a strange for a rabbit to be doing, but after all there is really nothing to get excited about. Cats climb trees — so that if the rabbit were only a cat, we would understand its behavior perfectly."

Quoted by Anthony French and Edwin Taylor  
*An Introduction to Quantum Physics* (p. 54)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Dingle, Herbert** 1890–1978  
 English astrophysicist

He thought he saw electrons swift  
 Their charge and mass combine.  
 He looked again and saw it was  
 The cosmic sounding line.  
 The population then, said he,  
 Must be 1079.

In Sir Arthur Eddington  
*The Expanding Universe*  
 Chapter IV Section IV (p. 113)  
 The University Press. Cambridge. 1933

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

The electron, as it leaves the atom, crystallises out  
 of Schrödinger's mist like a genie emerging from his  
 bottle.

*The Nature of the Physical World*  
 Chapter IX (p. 199)  
 The Macmillan Company. New York, New York, USA. 1930

An electron could never decide how large it ought to be  
 unless there existed some length independent of itself for  
 it to compare itself with.

*Mathematical Theory of Relativity*  
 Chapter V (p. 155)  
 At the University Press. Cambridge, England. 1954

An electron is no more (and no less) hypothetical than  
 a star.

*New Pathways in Science*  
 Chapter I, Section V (p. 21)  
 The Macmillan Company. New York, New York, USA. 1935

...an electron would not know how large it ought to be  
 unless there existed independent lengths in space for it to  
 measure itself against.

*The Mathematical Theory of Relativity*  
 Chapter V (p. 155)  
 At The University Press. Cambridge, England. 1930

**Einstein, Albert** 1879–1955  
 German-born physicist

...I should not want to be forced into abandoning strict  
 causality without defending it more strongly than I have  
 so far. I find the idea quite intolerable that an electron ex-  
 posed to radiation should choose of its own free will not  
 only its moment to jump off, but also its direction. In that  
 case I would rather be a cobbler, or even an employee in  
 a gaming-house, than a physicist.

In Ronald W. Clark  
*Einstein: The Life and Times*  
 Letter to M. Born, April 29, 1924 (p. 211)  
 The World Publishing Company. New York, New York, USA. 1971

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

**Leighton, Robert B.** 1919–97  
 American physicist

**Sands, Matthew L.** 1919–  
 American physicist

It is the fact that the electrons cannot all get on top of  
 each other that makes tables and everything else solid.

*The Feynman Lectures on Physics* (Volume 3)  
 Chapter 2–4 (p. 2–7)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Fournier d'Albe, E. E.**  
 No biographical data available

We may therefore, without in the least interfering with  
 the efficiency of the electron... imagine it to be a veritable  
 microcosm.

*The Electron Theory*  
 Chapter XVI (p. 288)  
 Longman, Green & Company. New York, New York, USA. 1906

**Frankel, Felice** 1945–  
 Science photographer

**Whitesides, George M.**  
 American chemist

Electrons know two verbs: seek and avoid. They seek  
 the positive charges of atomic nuclei; they avoid the  
 negative charges of other electrons. That is almost all  
 they know.

*On the Surface of Things: Images of the Extraordinary in Science*  
 Microelectrodes (p. 99)  
 Chronicle Books. San Francisco, California, USA. 1997

**Gamow, George** 1904–68  
 Russian-born American physicist

To keep order and preserve the properties, I never permit  
 more than two electrons to follow the same track; a  
 ménage a trios always gives a lot of trouble, you know.

*Mr. Tompkins in Paperback*  
 Chapter 10 (p. 115)  
 At The University Press. Cambridge, England. 1965

**Gibson, Charles R.** 1870–1931  
 No biographical data available

...an electron is a real particle of negative electricity.

In Frederick Houk Law  
*Science in Literature*  
 Autobiography of an Electron (p. 253)  
 Harper & Brothers Publishers. New York, New York, USA. 1929

**Glashow, Sheldon L.** 1932–  
 American physicist

Much as a pitched baseball is given a spin about its  
 axis, so also does the electron spin about. However,

the microscopic quantum mechanical electron behaves very differently from a baseball. Baseballs can be old, new, clean, dirty, and can differ from one another in myriad ways. On the other hand, all electrons are absolutely identical to one another. There is a subtler difference as well. Baseballs may spin rapidly, slowly, or in the case of a knuckleball, not at all. Every electron in the universe (about  $10^{80}$  of them!) is spinning at exactly the same rate. The magnitude of electron spin is an intrinsic and immutable characteristic of the electron. Only the axis about which the electron spins can be changed.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 3 (p. 56)

Warner Books. New York, New York, USA. 1988

### **Harrison, Edward Robert** 1919–2007

English-born American cosmologist

But electrons do not move in clear-cut orbits like revolving celestial bodies. They dance, and the atom is a ballroom. The electrons perform stately waltzes, weave curvaceous tangos, jitter in spasmodic quicksteps, and rock to frenetic rhythms. They are waves dancing to a choreography composed differently for each kind of atom.

*Masks of the Universe*

Chapter 8 (p. 123)

Macmillan Publishing Company. New York, New York, USA. 1985

### **Hoffmann, Banesh** 1906–86

Mathematician and educator

No longer could an electron roam fancy free wherever it wished but, more like a trolley car than a bus, it must keep strictly to the tracks laid down by Bohr...

*The Strange Story of the Quantum*

Chapter V (p. 54)

Dover Publications, Inc. New York, New York, USA. 1959

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The hard sphere...has always a definite position in space; the electron apparently has not. A hard sphere takes up a very definite amount of room; an electron — well it is probably as meaningless to discuss how much room an electron takes up as it is to discuss how much room a fear, an anxiety, or an uncertainty takes up.

In Lincoln Barnett

*The Universe and Dr. Einstein*

Chapter 3 (p. 22)

William Sloane Associates. New York, New York, USA. 1948

The electrons may now be pictured as octopus-like structures with tentacles or “tubes of force” sticking out from it in every direction.

*Physics and Philosophy*

Chapter IV (p. 122)

Dover Publications, Inc. New York, New York, USA. 1981

### **Lederman, Leon** 1922–

American high-energy physicist

The “naked” electron is an imaginary object cut off from the influences of the field, whereas a “dressed” electron carries the imprint of the universe.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 7 (p. 280)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### **Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

Cynthia was like the high-frequency electrons which he learned to handle in the laboratory — the sort which at a pressure of half a million volts will kiss the experimenter’s lips without burning them.

*White Lightning*

Chapter 3 (p. 15)

Covici-McGee. Chicago, Illinois, USA. 1933

...he had fallen head over heels in love...we might say that he had yielded as easily as zinc yields its electrons to copper, plating it round and defending it forever.

*White Lightning*

Chapter 30 (p. 130)

Covici-McGee. Chicago, Illinois, USA. 1933

### **Lewis, Gilbert Newton** 1875–1946

American chemist

...see all electrons are alike, and presumably leave no trail behind them, we cannot say that atom A loses an electron to atom B and atom C to atom D, but only that Atoms A and C have each lost an electron and atoms B and D have each gained one.

Valence and Tau Tomerism

*Journal of the American Chemical Society*, Volume 35, 1913 (pp. 1448–1455)

### **Lindley, David** 1956–

English astrophysicist and author

To argue whether the electron is really a wave or a particle is futile: an electron is an electron, and it behaves as an electron behaves. The observer may sometimes perceive wave properties in that behavior, and sometimes particle properties, and that, as Keats said, is all ye know, and all ye need to know. If we ask for more, what we are really asking for is a direct, metaphysical understanding of the nature of the electron, as if we could grasp its “true” nature with our minds and obtain some understanding of it beyond the scope of physical experimentation.

*The End of Physics: The Myth of a Unified Theory*

Part I, Chapter 2 (p. 75)

Basic Books. New York, New York, USA. 1993

### **Lodge, Sir Oliver** 1851–1940

English physicist

Electrons have come into existence somehow. The subject of origins usually lies outside science.

The Ether and Electrons

*Supplement to Nature*, Volume 112, Number 2805, August 4, 1923 (p. 191)

**Millikan, Robert Andrews** 1868–1953

American physicist

The chemists in America has in general been content with what I have called a loafer electron theory. He has imagined the electrons sitting around on dry goods boxes at every corner [viz. the cubic atom], ready to shake hands with, or hold on to similar loafer electrons in other atoms.

Atomism in Modern Physics

*Journal of the Chemical Society*, 1924 (p. 1411)

The word “electron” was first suggested in 1891 by Dr. G. Johnstone Stoney as a name for the “natural unit of electricity,” namely, that quantity of electricity which must pass through a solution in order to liberate at one of the electrodes one atom of hydrogen or one atom of any univalent substance.

*The Electron*

Chapter II (p. 25)

The University of Chicago Press. Chicago, Illinois, USA. 1924

Indeed, nothing more beautifully simplifying has ever happened in the history of science than the whole series of discoveries culminating about 1914 which finally brought practically universal acceptance of the theory that the material world contains but two fundamental entities, namely, positive and negative electrons, exactly alike in charge, but differing widely in mass, the positive electron — now usually called a proton — being 1850 times heavier than the negative, now usually called simply the electron.

*Time, Matter and Values*

Chapter II (p. 46)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1932

A prominent literary writer recently spoke of the electron as “only the latest scientific hypothesis which will in its turn give way to the abra-ca-da-bra of tomorrow.”

*Nobel Lectures, Physics 1922–1941*

Nobel lecture for award received in 1923

The Electron and the Light-Quant from the Experimental Point of View (p. 55)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

If we ask, for instance, whether the position of the electron remains the same, we must say “no”; if we ask whether the electron’s position changes with time we must say “no”; if we ask whether it is in motion, we must say “no.”

*Science and the Common Understanding*

Chapter 3 (p. 40)

Simon & Schuster. New York, New York, USA. 1953

**Pauli, Wolfgang** 1900–58

Austrian-born physicist

The whole thing [quantum leap] seems a myth...but this is not supposed to happen with the electron: instead the frequency of vibration of the emitted light is said to lie somewhere between the orbital frequency before the mysterious jump and the orbital frequency after the jump. All this is sheer madness.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 3 (p. 36)

Harper & Row, Publishers. New York, New York, USA. 1971

**Poincaré, Lucien** 1862–1920

French physicist

The electron has conquered Physics, and many worship the new idol rather blindly.

*The New Physics and Its Evolution*

Chapter XI (p. 324)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

**Rutherford, Ernest** 1871–1937

English physicist

It seems to me that you would have to assume that the electron knows beforehand where it is going to stop.

*Rutherford at Manchester*

Letter to Niels Bohr, March 20, 1913 (p. 127)

W.A. Benjamin Inc. New York, New York, USA. 1963

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

...this is the obvious way of registering the fact, that we never experiment with just one electron or atom or (small) molecule. In thought-experiments we sometimes assume that we do; this invariably entails ridiculous consequences... In the first place it is fair to state that we are not experimenting with single particles, any more than we can raise Ichthyosauria in the zoo. We are scrutinizing records of events long after they have happened.

Are There Quantum Jumps?

*British Journal for the Philosophy of Science*, Volume 3, 1952 (p. 109)

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

...why the men who believe in electrons should regard themselves as less credulous than the men who believed in angels is not apparent to me.

In Homer D. Swander

*Man and the Gods: Three Tragedies*

Saint Joan, Preface, The Real Joan Is Not Marvellous for Us (p. 133)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

**Standen, Anthony**

Anglo-American science writer



...nothing will do for Mr. Average Citizen but to stuff himself full of electrons, protons, neutrons, neutrinos, genes, chromosomes, glands, hormones, potassium, chloride, high-octane gasoline, ultrasonic vibrations, and the theory of relativity.

*Science Is a Sacred Cow*

Chapter I (p. 26)

Dutton. New York, New York, USA. 1950

**Sullivan, John William Navin** 1886–1937

Irish mathematician

The electron is not, for example, an enduring something that can be tracked through time. Its mathematical description does not involve that degree of definiteness. Any picture we form of the atom errs, as it were, by excess of solidity. The mathematical symbols refer to entities more indefinite than our pictorial imagination, limited as it is by experience of “gross matter,” can construct.

*The Bases of Modern Science*

Chapter XI (pp. 252–253)

Doubleday, Doran & Company, Inc. Garden City, New Jersey, USA. 1929

**Thomson, Sir George Paget** 1892–1975

English physicist

The goddess of learning is fabled to have sprung full-grown from the brain of Zeus, but it is seldom that a scientific conception is born in its final form, or owns a single parent. More often it is the product of a series of minds, each in turn modifying the ideas of those that came before, and providing material for those that come after. The electron is no exception.

*Nobel Lectures, Physics 1922–1941*

Nobel lecture for award received in 1937

Electronic Waves (p. 397)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

One may picture the free electron...as something like a gossamer spider floating through the air at the center of a number of radiating filaments which control its flight as the air wafts them about, or as they are caught by solid objects.

In Bernard Jaffe

*Crucibles: The Story of Chemistry*

Chapter XVI (p. 254)

Dover Publications. New York, New York, USA. 1976

An electron is like an able guerrilla leader who occupies a wide area with rumors of his presence, but when he strikes, he strikes with his whole force.

Electron Optics

*Nature*, Volume 129, Number 3246, 16 January 1932 (p. 82)

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

How can it be that electrons exhibit wave and particle properties at the same time?... The quantum state

represents a novel state of matter that cannot be described in the old-fashioned way. It exhibits features that do not occur with objects in our ordinary experience. This is why we must use more abstract terms when we describe atomic reality. It may seem incredible to the noninitiated that an electron behaves in certain situations like a wave and in others like a particle.

In A.P. French and P.J. Kennedy (eds.)

*Niels Bohr: A Centenary Volume*

Niels Bohr, The Quantum, and the World (pp. 24–25)

Harvard University Press. Cambridge, Massachusetts, USA. 1985

**Wheeler, John Archibald** 1911–

American physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

That an electron here has the same mass as an[other] electron...is also a trivality or a miracle. It is a trivality in quantum electrodynamics because it is assumed rather than derived. However, it is a miracle on any view that regards the universe as being from time to time “reprocessed.” How can electrons at different times and places in the present cycle of the universe have the same mass if the spectrum of particle masses differs between one cycle of the universe and another?...

Are particles of the same pattern identical in any one cycle of the universe because they give identically patterned views of the same universe? No acceptable explanation for the miraculous identity of particles of the same type has ever been put forward. That identity must be regarded, not as a trivality, but as a central mystery of physics.

*Gravitation*

Part X, Chapter 44 (p. 1215)

W.H. Freeman & Company. San Francisco, California, USA. 1973

Even with the lowly electron one must participate before one can give any meaning whatsoever to its position or its momentum. Is this firmly established result the tiny tip of a giant iceberg?... Great as was the crisis of 1911, today gravitational collapse confronts physics with its greatest crisis ever. At issue is the fate, not of matter alone, but of the universe itself... No more revolutionary views of man and the universe has one ever been driven to consider seriously than those that come out of pondering the paradox of collapse, the greatest crisis of physics of all time.

In Charles W. Misner et al

*Gravitation*

Part X, Chapter 44 (p. 1198)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The electrons seems to be borrowing the character which some people have assigned to the Mahatmas of Tibet.

*Science and the Modern World*

Chapter II (p. 53)

The Macmillan Company. New York, New York, USA. 1929

**Wolf, Fred Alan** 1934–

American theoretical physicist, writer, and lecturer

...the electron seems to be aware of its own existence. It interacts with itself like any little self-abusive boy behind locked doors. When it does this it generates infinities — an infinite amount of energy, for example. But when mother-physicist comes home and opens the atomic door and observes the electron, the little angel is peacefully obeying the rules of the universe.

*Parallel Universes*

Chapter 6 (pp. 69–70)

Simon & Schuster. New York, New York, USA. 1988

## ELEGANCE

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

In a word, the sentiment of mathematical elegance is naught else than the satisfaction due to some, I know not just what, adaptation between the solution just found and the needs of our mind, and it is because of this adaptation itself that the solution becomes an instrument to us.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (pp. 126–127)

Government Printing Office. Washington, D.C. 1910

## ELEMENT

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

It seems not absurd to conceive that at the first production of mixed bodies, the universal matter whereof they among other parts of the universe consisted, was actually divided into little particles of several sizes and shapes variously moved.

*The Sceptical Chymist*

The First Part, Proposition I (p. 30)

Dawsons of Pall Mall. London, England. 1965

...I now mean by elements...certain Primitive and Simple, or perfectly unmingled bodies; which not being made of any other bodies, or of one another, are the Ingredients of which all those call'd perfectly mixt Bodies are immediately compounded, and into which they are ultimately resolved...

*The Sceptical Chymist*

The Sixth Part (p. 350)

Dawsons of Pall Mall. London, England. 1965

**Browne, B. P.**

No biographical data available

Every chemical element is regarded as having a distinct nature of its own, which nature, moreover, determines all its activities.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 7 (p. 96)

Longmans. London, England. 1967

**Clarke, F. W.**

No biographical data available

If, despite Mendeléeff's recent demurrer, we assume that the elements have been evolved from one primordial form of matter, their relative abundance becomes suggestive.

*Bulletin of the Philosophical Society of Washington*, Volume 11, 1889 (p. 131)

**Cowper, William** 1731–1800

English poet

Some say that in the origin of things,  
When all creation started into birth,  
The infant elements receiv'd a law  
From which they swerve not since.

*The Poetical Works of William Cowper*

The Task

Book 6

John W. Lovell Company. New York, New York, USA. No date

**Crookes, Sir William** 1832–1919

English chemist and physicist

These elements perplex us in our researches, baffle us in our speculations and haunt us in our very dreams. They stretch like an unknown sea before us, mocking, mystifying, and murmuring strange revelations and possibilities.

In C. Baskerville

The Elements: Verified and Unverified,

*Scienc*, New Series, Volume 19, Number 472, 15 January 1904 (p. 93)

To discover a new element is a very fine thing but if you could decompose an element and tell us what it is made of — that would be a discovery indeed worth making.

*British Association Report*

1887 (p. 559)

**Davidson, John** 1857–1909

Scottish poet

Fleet Street was once a silence in the ether.  
The carbon, iron, copper, silicon,  
Zinc, aluminum vapours, metalloids,  
Constituents of the skeleton and shell  
Of Fleet Street — of the woodwork, metalwork,  
Brickwork, electric apparatus, drains  
And printing-presses, conduits, pavement, road —  
Were at the first unelemented space,  
Imponderable tension in the dark  
Consummate matter of eternity.

*Fleet Street*, 1. 54–62  
Mitchell, Kennerley. New York, New York, USA. 1909

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

What connection do the books show between the fifty or sixty chemical elements and the historical eras?

*Ralph Waldo Emerson: Essays and Lectures*  
Essays: First Series  
History (p. 256)  
The Library of America. New York, New York, USA. 1983

The four-quarters of the globe are no longer Europe, Asia, Africa and America, but Carbon, Oxygen, Hydrogen, and Nitrogen.

*The Works of Ralph Waldo Emerson* (Volume 3)  
Farming (p. 303)  
Harper & Brothers. New York, New York, USA. 1925

**Empedocles of Acragas** ca. 490 BCE–430 BCE  
Greek pre-Socratic philosopher

...I shall tell you of a double process. At one time it increased so to be a single One out of Many; at another time it grew apart so as to be Many out of One — Fire and Water and Earth and the boundless height of Air... these things alone exist, and running through one another they become different things at different times, and are ever continuously the same.

In Kathleen Freeman  
*Ancilla to the Pre-Socratic Philosophers*  
Section 31. Empedocles of Acragas, 17 (pp. 53–54)  
Harvard University Press. Cambridge, Massachusetts, USA. 1956

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

I am convinced that the spectrum of all chemical elements can be obtained...from quantum theory in a unique manner without physics by boneheaded calculation.

In Keith Hannabuss  
*An Introduction to Quantum Theory*  
Letter to Pascual Jordan, July 28, 1926 (p. 235)  
Oxford University Press, Inc. Oxford, England. 1997

**Huxley, Thomas Henry** 1825–95  
English biologist

When we know that living things are formed of the same elements as the inorganic world, that act and react upon it, bound by a thousand ties of natural piety, is it probable, nay is it possible, that they and they alone, should have no order in their seeming disorder, no unity in their seeming multiplicity, should suffer no explanation by the discovery of some central and sublime law of mutual connection?

*Collected Essays* (Volume 2)  
*Darwiniana*  
The Darwin Hypothesis (p. 13)  
Macmillan & Company Ltd. London, England. 1904

**Keats, John** 1795–1821  
English Romantic lyric poet

...To watch the abysm-birth of elements.  
*The Complete Poetical Works and Letters of John Keats*  
Endymion  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Kirkpatrick, Clifford** 1898–1970  
American sociologist

The stars are flaming crucibles in which dancing electrons are combined and recombined as the elements take form in a process of cosmic alchemy.

*Religion in Human Affairs*  
Chapter XVI (p. 454)  
John Wiley & Sons, Inc. New York, New York, USA. 1929

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

All that can be said upon the number and nature of elements is, in my opinion, confined to discussions entirely of a metaphysical nature. The subject only furnishes us with indefinite problems, which may be solved in a thousand different ways, not one of which, in all probability, is consistent with nature. I shall therefore only add upon this subject, that if, by the term elements, we mean to express those simple and indivisible atoms of which matter is composed, it is extremely probable we know nothing at all about them; but, if we apply the term elements, or principles of bodies, to express our idea of the last point which analysis is capable of reaching, we must admit, as elements, all the substances into which we are capable, by any means, to reduce bodies by decomposition.

*Elements of Chemistry in a New Systematic Order*  
Preface of the Author (p. xxiv)  
Printed for William Creech. Edinburgh, Scotland. 1790

**Lewis, Edwin Herbert** 1866–1938  
American rhetorician, novelist, and poet

She ran over the list of elements and was astonished to find them arranged in a sort of musical scale. Each octave began with a sharp metallic clang and then became less metallic. She wondered why some great composer had not perceived this and written a symphony about it. In the evenings she began to improvise on the little old rosewood piano. When her fingers went flickering upward into the treble with soft murmurs or bright passion, and her delighted old father would ask her what she was playing, she would answer, "Oh, only oxygen."

*White Lightning*  
Chapter 74  
Covici-McGee. Chicago, Illinois, USA. 1923

**Moissan, Henri** 1852–1907  
French chemist

The search for an element is always captivating.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 438)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

### Montague, James J.

No biographical data available

The fact that Raphael was a whizz

At graphic composition

Was not at all because of his

Inordinate ambition.

Success, despite its practiced eye,

Would doubtless have defied him,

His greatness was created by

The elements inside him.

What's the Use of Worrying?

*Industrial and Engineering Chemistry: News Edition*, Volume 10,  
Number 20, 20 October 1932 (p. 257)

### Pallister, William Hales 1877–1946

Canadian physician

Within the atom is a whirling world,

A complex system in a vortex hurled:

Electrons charged with forces negative

Revolve around the protons positive

In varied spheres, in varied numbers, too,

Yet with a maximum of ninety-two

Designs, known as the elements to you

And proved by spectrum study to be true.

*Poems of Science*

Men and the Stars, Within the Atom (p. 51)

Playford Press. New York, New York, USA. 1931

### Rutherford, Ernest 1871–1937

English physicist

### Soddy, Frederick 1877–1956

English radiochemist

If elements heavier than uranium exist it is probable that they will be radioactive. The extreme delicacy of radioactivity as a means of chemical analysis would enable such elements to be recognized even if present in infinitesimal quantity. It is therefore to be expected that the number of radio-elements will be augmented in the future, and that considerably more than three at present recognized exist in minute quantity.

*Philosophical Magazine*, Volume 6, 1903 (p. 5:576)

### Sacks, Oliver W. 1933–

American neurologist and author

Thinking of all the malodorous sulfur compounds and the atrocious smell of selenium and tellurium compounds, I decided that these three elements formed an olfactory as well as a chemical category, and thought of them thereafter as the “stinkogens.”

*Uncle Tungsten, Memories of a Chemical Boyhood*

Chapter 8 (p. 89)

Alfred A. Knopf. New York, New York, USA. 2001

### Shapley, Harlow 1885–1972

American astronomer

Our studies of the universe show the uniformity of its chemical structure and generally of its physical laws. We are made of the same stuff as the stars, so when we study astronomy we are in a way only investigating our remote ancestry and our place in the universe of star stuff. Our very bodies consist of the same chemical elements found in the most distant nebulae, and our activities are guided by the same universal rules.

The Star Stuff That Is Man

*New York Times*, August 11, 1929

## ELEMENT: ALUMINUM

### Verne, Jules 1828–1905

French novelist

Aluminum cried his three colleagues in chorus.

“Unquestionably, my friends. This valuable metal possesses the whiteness of silver, the indestructibility of gold, the tenacity of iron, the fusibility of copper, the lightness of glass. It is easily wrought, it is very widely distributed, forming the base of most of the rocks, is three times lighter than iron, and seems to have been created for the express purpose of furnishing us with the material for our projectile.”

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter VII (p. 40)

A.L. Burt Company. New York, New York, USA. 1890

It is easily worked; it is widely spread in nature, alumina forming the bases of most rocks; it is three times lighter than iron; in short, it seems to have been created expressly to furnish material for our projectile!

*From Earth to the Moon*

Chapter VII (p. 50)

Barnes & Nobel Publishing. New York, New York, USA. 2005

## ELEMENT: ANTIMONY

### Renaudot, Eusébe 1646–1720

French theologian

We, the undersigned Doctors of medicine of the Faculty of Paris, certify to all to whom it may concern, that the qualities of antimony are recognized by us to be very useful for the cure of a number of illnesses. We certify this on the basis of long usage and continued experience. Further we declare that this remedy which has for so long been charged with having a poisonous malignity has many rare virtues and that a physician can successfully employ it to combat a great number of diseases provided that he uses it with a prudence and discretion.

In Allen G. Debus

*The French Paracelsians*

Chapter 3 (p. 97)  
Cambridge University Press. Cambridge, England. 1991

**Valentinus, Basilius** 1394?–?  
Alchemist

But antimony, like mercury, can best be compared to a round circle without end...and the more one investigates it, by suitable means, the more one discovers in it and learns from it; it cannot be mastered, in short, by one person alone because of the shortness of human life.

In Mary Elvira Weeks  
*The Discovery of the Elements* (p. 95)  
Journal of Chemical Education. Easton Pennsylvania, USA. 1956

## ELEMENT: ARGON

**Strutt, John William (Lord Rayleigh)** 1842–1919  
English physicist

Indeed, I have seen some indications that the anomalous properties of argon are brought as a kind of accusation against us. But we had the very best intentions in the matter. The facts were too much for us, and all that we can do now is apologize for ourselves and for the gas.  
*Royal Institution Proceedings*, Volume 14, 1895 (p. 524)

## ELEMENT: ARSENIC

**Valentinus, Basilius** 1394?–?  
Alchemist

For smelter fumes have I been named.  
I am an evil, poisonous smoke.  
But when from poison I am freed,  
Through art and sleight of hand,  
Then can I cure both man and beast,  
From dire disease oft times direct them;  
But prepare me correctly, and take great care  
That you faithfully keep watchful guard over me;  
For else am I poison, and poison remain,  
That pierces the heart of many a one.

In Mary Elvira Weeks  
*The Discovery of the Elements* (p. 20)  
Journal of Chemical Education. Easton Pennsylvania, USA. 1956

## ELEMENT: BISMUTH

**Calvino, Italo** 1923–1985  
Italian writer and novelist

“Now a bismuth isotope is going to come out!” I said hastily, watching the newborn elements crackle froth from the crucible of a “supernova” star. “Let’s bet!”

Translated by William Weaver  
*Cosmocomics*  
How Much Shall We Bet? (p. 88)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1965

## ELEMENT: CARBON

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

You will die but the carbon will not...[but] will return to the soil, and there a plant may take it up again in time, sending it once more on a cycle of plant and animal life.  
Biography of an Atom — and the Universe  
*New York Times*, 13 October 1968

**Darwin, Erasmus** 1731–1802  
English physician and poet

Hence sable coal his massy couch extends;  
And stars of gold that sparkle pyrite blends;  
Hence dull-eyed naphtha pours his pitchy streams,  
And jet uncolour’d drinks the solar beams.

*The Botanic Garden*  
Part I, Canto II, VI, l. 349–352  
Jones & Company. London, England. 1825

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

Somewhere, somehow, sometime, in the mysterious chemistry of carbon, the long march toward the talking animal had begun.

*The Immense Journey*  
The Secret of Life (p. 198)  
Random House, Inc. New York, New York, USA. 1957

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

...life exists in the universe only because the carbon atom possesses certain exceptional properties.

*The Mysterious Universe*  
Chapter I (p. 9)  
The Macmillan Company. New York, New York, USA. 1932

**Prout, William** 1785–1850  
English physician and chemist

...it is perhaps difficult to say what is most wonderful; but we have often thought that the Deity has displayed a greater stretch of power, in accommodating to such an extraordinary variety of changes, a material so unpromising and so refractory as charcoal, and in finally uniting it with the human mind, than was requisite for the creation of the human mind itself.

*Chemistry, Meteorology, and the Function of Digestion Considered With Reference to Natural Theology*  
Book III, Chapter I (pp. 442–443)  
William Pickering. London, England. 1834

## ELEMENT: CHLORINE

**Fabre, Jean-Henri** 1823–1915  
French entomologist and author

Air, nitrogen, oxygen, hydrogen, carbonic-acid gas, and carbon monoxide are gases that not even the sharpest eyes can see; and most other gases are of like character in this respect, so that gases as a class are thought of by us as invisible. Now, however, we have a gas that is as subtle and impalpable as the others and yet can be seen very well.

*The Wonder Book of Chemistry*

Chlorine

A. & C. Boni. New York, New York, USA. 1930

## ELEMENT: COBALT

**Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

Like most men he loved blue, and what he chiefly loved was a soft cobalt blue saturated with white light, as in petals of forget-me-not.

*White Lightning*

Chapter 27

Covici-McGee. Chicago, Illinois, USA. 1923

## ELEMENT: GOLD

**Geoffroy the Elder** 1672–1731

French chemist

...the most valuable and most precious of all Metals is the most useless in Physick, except when considered as an Antidote to Poverty.

*A Treatise of the Fossil, Vegetable and Animal Substances That Are Made Use of In Physik*

Printed for W. Innys & R. Manby. London, England. 1736

**Jonson, Ben** 1573?–1637

English dramatist and poet

Aye, for 'twere absurd to think  
That Nature in the Earth bred gold,  
Perfect in the instant.

*The Alchemist*

Act II, Scene 3, l. 139–141

Yale University Press. New Haven, Connecticut, USA. 1974

**Muir, John** 1838–1914

American naturalist

Even in Congress a sizable chunk of gold, carefully concealed, will outtalk and outfight all the nation on a subject like forestry...

Gold, gold, gold! How strong a voice that metal has!

*Our National Parks*

Chapter X (p. 361)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Gold, the grand attraction that lights the way into all kinds of wilderness and makes rough places smooth.

*Steep Trails*

Chapter XVII (p. 216)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

...for the strangely exciting stuff (gold) makes the timid bold enough for anything and the lazy destructively industrious.

*Our National Parks*

Chapter I (p. 11)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## ELEMENT: HYDROGEN

**Calvino, Italo** 1923–1985

Italian writer and novelist

When I was a kid, the only playthings we had in the whole universe were the hydrogen atoms, and we played with them all the time, I and another youngster my age whose name was Pfwfp.

What sort of games? That's simple enough to explain. Since space was curved, we sent the atoms rolling along its curve, like so many marbles, and the kid whose atom went farthest won the game.

Translated by William Weaver

*Cosmicomics*

Games Without End (p. 63)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

**Dalton, John** 1766–1844

English chemist and physicist

No new creation or destruction of matter is within the reach of chemical agency. We might as well attempt to introduce a new planet into the solar system, or to annihilate one already in existence, as to create or destroy a particle of hydrogen.

*New System of Chemical Philosophy* (Volume 1)

Part I, Chapter III (p. 212)

R. Bickerstaff. London, England. 1810

## ELEMENT: IODINE

**Pallister, William Hales** 1877–1946

Canadian physician

When you insist on living far inland  
And do not get your fish-food from the sea;  
When you forsake the ocean and the sand  
And cease to feed the fish you used to be;  
Perhaps you do not fully understand,  
If you disclaim your race,  
You'll get a funny-face.  
So satisfy your iodine demand.

*Poems of Science*

De Ipsa Natura, Iodine (p. 221)

Playford Press. New York, New York, USA. 1931

**ELEMENT: LEAD****Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Lead is the humblest of the metals; it is always put where it is invisible — and where it is indispensable. It is put on the keels of boats, where nobody can see it and everybody relies on it. It is put in the shrouds of the sea-sunken dead, whom we desire to see no more.

*Lunacy and Letters*

The Love of Lead (pp. 158–159)

Sneed &amp; Ward, Inc. New York, New York, USA. 1958

**ELEMENT: MERCURY****Darwin, Erasmus** 1731–1802

English physician and poet

On vermil beds in Idria's mighty caves

The living silver rolls its ponderous waves.

*The Botanic Garden*

Part I, Canto II, VII, l. 405–406

Jones &amp; Company. London, England. 1825

**Flaubert, Gustave** 1821–90

French novelist

Mercury. Kills the patient with the disease.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Waite, A. E.**

No biographical data available

It is a fluid

but does not moisten,

and runs about,

though it has no feet.

*The Hermetic and Alchemical Writings of Aureolus Phillipus Theophrastus*

Volume 1 (p. 136)

J. Elliott &amp; Company. London, England. 1954

**ELEMENT: NITROGEN****Crookes, Sir William** 1832–1919

English chemist and physicist

The fixation of nitrogen is vital to the progress of civilized humanity, and unless we can class it among the certainties to come, the great Caucasian race will cease to be the foremost in the world, and will be squeezed out by the races to whom wheat bread is not the staff of life.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 23 (p. 421)

Longmans. London, England. 1967

**Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

There were persons in the faculty who were conscious of nitrogen, but the Riches were not. They were literary and easily deceived. They took their nitrogen as it came, and really thought it was peas and beans and eggs. They never stopped to think that they were constantly inhaling and exhaling nitrogen without brushing a single electron off its surface.

*White Lightning*

Chapter 7 (p. 39)

Covici-McGee. Chicago, Illinois, USA. 1923

**Slosson, Edwin E.** 1865–1929

American chemist and journalist

For nitrogen plays a double role in human economy. It appears like Brahma in two aspects, Vishnu the Preserver and Siva the Destroyer.

In Bernard Jaffe

*New World of Chemistry*

Chapter 17 (p. 225)

Silver, Burdett &amp; Company. New York, New York, USA. 1935

**ELEMENT: OXYGEN****Darwin, Erasmus** 1731–1802

English physician and poet

When air's pure essence joins the vital flood,

And with phosphoric acid dyes the blood,

Your virgin trains the transient heat dispart,

And lead the soft combustion round the heart...

*The Botanic Garden*

Part I, Canto I, VIII, l. 400–402

Jones &amp; Company. London, England. 1825

**Fridovitch, Irwin**

No biographical data available

Oxygen is toxic! We, whose lives depend upon a considerable supply of oxygen do not easily comprehend its toxicity. Our apparent comfort at the ambient level of oxygen is due to elaborate defenses against its very considerable toxicity.

Oxygen Is Toxic

*BioScience*, Volume 27, Number 27, July 1977 (p. 462)**Priestley, Joseph** 1733–1804

English theologian and scientist

On the 8<sup>th</sup> of this month I procured a mouse, and put it into a glass vessel, containing two ounce-measures of the air from mercurius calcinatus. Had it been common air, a full-grown mouse, as this was, would have lived in it about a quarter of an hour. In this air, however, my mouse lived a full hour; and though it was taken out seemingly dead, it appeared to have been only exceedingly chilled; for, upon being held to the fire, it presently revived, and appeared not to have received any harm from the experiment.

*Experiments and Observations on Different Kinds of Air* (Volume 2)  
Book IV, Part I, Section I  
Discovery of Oxygen (p. 115)  
Thomas Pearson. Birmingham, England. 1790

**Traube, Moritz** 1826–94  
German physiological chemist

Truly, the history of oxygen is the history of life!  
In W. Coleman  
*Biology in the Nineteenth Century: Problems of Form, Function, and Transformation*  
Chapter VI Function: The Animal Machine (p. 135)  
John Wiley & Sons, Inc. New York, New York, USA. 1971

## ELEMENT: PHOSPHORUS

**Darwin, Erasmus** 1731–1802  
English physician and poet

Or mark with shining letters Kunckel's name  
In the pale phosphor's self-consuming flame.  
*The Botanic Garden*  
Part I, Canto I, V, l. 231–2  
Jones & Company. London, England. 1825

## ELEMENT: RADIUM

**Curie, Marie Sklodowska** 1867–1934  
Polish-born French physical chemist

Radium is not to enrich any one. It is an element; it is for all people.  
*Pierre Curie*  
Introduction (p. 24)  
The Macmillan Company. New York, New York, USA. 1926

It is impossible. It would be contrary to scientific spirit... Physicists always publish their researches completely. If our discovery has a commercial future, that is an accident by which we must not profit. And radium is going to be of use in treating disease.... It seems to me impossible to take advantage of that.

In Eve Curie  
*Madame Curie*  
Chapter XV (p. 204)  
The Literary Guild of America, Inc. New York, New York, USA. 1937

### Horton, F.

No biographical data available  
A radium atom was dying,  
And just ere it burst up for aye,  
Corpuscles, which round it were flying,  
These last dying words heard to say.  
Oh, I am a radium atom.  
The Radium Atom  
*The American Physics Teacher*, Volume 7, Number 3, June 1939 (p. 181)

**Rickard, Dorothy**  
No biographical data available

Little Willie, full of glee,  
Put radium in Grandma's tea.  
Now he thinks it quite a lark  
To see her shining in the dark.  
Source undetermined  
Little Willie

## ELEMENT: SODIUM

**Glashow, Sheldon L.** 1932–  
American physicist

That is why the stove's flame turns yellow when the soup boils over. The table salt in the soup contains sodium, whose dominant spectral lines are bright yellow.  
*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*  
Chapter 3 (p. 50)  
Warner Books. New York, New York, USA. 1988

## ELEMENT: SULPHUR

### Author undetermined

But the most useful of all volcanic productions is native sulphur, in which Mount Etna has been very prolific. It is to this mountain chiefly, therefore, that we are indebted for our beautiful fire-works — our squibs, crackers, Roman candles, serpents, Catherine-wheels, and sky-rockets. Would it had produced nothing more harmful than these! But it has also supplied one of the ingredients of that villainous gunpowder, which has been the means of thrusting so many of our fellow-creatures prematurely out of the world.

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*  
Chapter I  
T. Nelson. London, England. 1890

**Duchesne, Joseph** 1544–1609  
French Paracelsist

For as a man can never make a good closing mortar, of water and sand only, without the mixture of lime, which bindeth the other two together like oile and glue: so Sulphur as the oily substance is the mediator of Salt and Mercurie, and coupleth them both together: neither doth it only couple them to death, but it also represses and temperate the acrimonie of Salt, and the sharpnesse of Mercurie, which is found to bee very much therein.  
In Allen G. Debus  
*The French Paracelsians*  
Chapter 3 (p. 55)  
Cambridge University Press. Cambridge, England. 1991

### Masini, Count Vincenzo

No biographical data available  
Within the rocks, among the thorns,



Between the cliffs, sulfur takes root;  
For gold, silver, copper, iron, and sulfur  
Likewise are plants.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 55)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

### Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910

American writer and humorist

The smell of sulphur is strong, but not unpleasant for a sinner.

*Roughing It* (Volume 2)

Chapter XXXIII (p. 301)

Harper & Brothers. New York, New York, USA. 1899

## ELEMENT: TITANIUM

### Klaproth, Martin Heinrich 1743–1817

German chemist

Whenever no name can be found for a new fossil which indicates its peculiar and characteristic properties (in which situation I find myself at present), I think it best to choose such a denomination as means nothing of itself, and thus can give no rise to any erroneous ideas. In consequence of this, as I did in the case of uranium, I shall borrow the name for this metallic substance from mythology, and in particular from the Titans, the first sons of the earth. I therefore call this new metallic genus TITANIUM.

*Analytical Essays Towards Promoting the Chemical Knowledge of*

*Mineral Substances*

Chapter XIV (p. 210)

T. Cadell. London, England. 1801

## ELEMENT: URANIUM

### Einstein, Albert 1879–1955

German-born physicist

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future.

In Otto Nathan and Heinz Norden (eds.)

*Einstein on Peace*

Letter to F.D. Roosevelt

August 2, 1939

Simon & Schuster. New York, New York, USA. 1960

### Klaproth, Martin Heinrich 1743–1817

German chemist

The number of known metals had been increased by one — from 17 to 18. ... A few years ago we thrilled to hear of the discovery of the final planet by Sir William

Herschel. He calls the new member of our solar system Uranus. I propose to borrow from the honor of that great discovery and call this new element Uranium.

In Lennard Bicknel

*The Deadly Element, the Story of Uranium* (p. 21)

Stein & Day. New York, New York, USA. 1979

### Snow, Charles Percy 1905–80

English novelist and scientist

...Bevill showed us his private dossier of the uranium project. We must not refer to it again by that name, he said: as with other projects of high secrecy, he copied out the “appreciations” in his own hand, keeping no copies: the documents were then mounted in a loose-leaf cover, on which he printed a pet name.

“I’m going to show you my name for this new stunt,” he said, with a smile that was frank, shy and eager. And into that smile there crept the most salacious pleasure that many men show as they talk of secrets.

He turned over the cover, and we saw, painted in bold capitals, the words:

MR TOAD

“That’s what we’ll call it here, if you don’t mind,” he added.

*The New Men* (p. 17)

Charles Scribner’s Sons. New York, New York, USA. 1955

## ELEMENT: ZINC

### Levi, Primo 1919–87

Italian writer and chemist

Zinc, Zinck, zinco: they make tubs out of it for laundry, it is gray and its salts are colorless, it is not toxic, nor does it produce striking chromatic reactions; in short, it is a boring metal.

*The Periodic Table*

Zinc (p. 33)

Schocken Books. New York, New York, USA. 1984

## ECLIPSE

### Author undetermined

The sky is an immense place where everything moves in its own way. Some go faster than others, some turn around themselves while they are going around the sun and each other. Sometimes the fast ones catch up with the slow ones and that is an eclipse. Also, when the moon gets in the way we can’t see the sun, and that is an eclipse too and everybody talks about it.

That is an important eclipse.

Reported by little girl who visited the Hayden Planetarium

*The Sky*, Volume 3–4, December 1939 (p. 25)

**ELLIPSE**

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

A circle no doubt has a certain appealing simplicity at the first glance, but one look at a healthy ellipse should have convinced even the most mystical of astronomers that that the perfect simplicity of the circle is akin to the vacant smile of complete idiocy. Compared to what an ellipse can tell us, a circle has nothing to say.

*The Handmaiden of the Sciences* (p. 26)  
The Williams & Wilkins Company, Baltimore, Maryland, USA. 1937

**Feynman, Richard P.** 1918–88  
American theoretical physicist

I prefer to give you a demonstration that it's an ellipse in a completely strange, unique, [and] different way than you are used to. I am going to give what I will call an elementary demonstration. [But] "elementary" does not mean easy to understand. "Elementary" means that very little is required to know ahead of time in order to understand it, except to have an infinite amount of intelligence.

In David L. Goodstein and Judith R. Goodstein  
*Feynman's Lost Lecture: The Motion of Planets Around the Sun*  
The Motion of Planets Around the Sun, (March 13, 1964) (p. 148)  
W.W. Norton & Company, New York, New York, USA. 1996

**ELLIPTIC FUNCTION**

**Bellman, Richard** 1920–84  
Applied mathematician

The theory of elliptic functions is the fairyland of mathematics. The mathematician who once gazes upon this enchanting and wondrous domain crowded with the most beautiful relations and concepts is forever captivated.

*A Brief Introduction to Theta Functions*  
Foreword (p. vii)  
Holt, Rinehart & Winston, New York, New York, USA. 1961

**EMERGENCE**

**Holland, John** 1929–  
American computer scientist

It is unlikely that a topic as complicated as emergence will submit meekly to a concise definition, and I have no such definition.

*Emergence: From Chaos to Order*  
Chapter 1 (p. 3)  
Addison-Wesley Publishing, Inc. Reading, Massachusetts, USA. 1998

**EMOTION**

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

...the eyes of the investigator have neither laughter nor tears. In the actual work of science, emotion is dangerous.

*The System of Animate Nature* (Volume 1)  
Lecture I (p. 28)  
William & Norgate, London, England. 1920

**ENERGY**

**Aston, Francis W.** 1877–1945  
English physicist and chemist

Should the research worker of the future discover some means of releasing this [atomic] energy in a form which could be employed, the human race will have at its command powers beyond the dreams of science fiction; but the remote possibility must always be considered that the energy once liberated will be completely uncontrollable and by its intense violence detonate all neighboring substances. In this event the whole of the hydrogen on the earth might be transformed at once and the success of the experiment published at large to the universe as a new star.

*Nobel Lectures, Chemistry 1922–1941*  
Nobel lecture for award received in 1922  
Mass Spectra and Isotopes (p. 20)  
Elsevier Publishing Company, Amsterdam, Netherlands. 1966

**Bachelard, Gaston** 1884–1962  
French philosopher

The laboratory technician has succeeded in implementing by means of the atomic pile the Einsteinian principle of inertia of energy.

In Paul Arthur Schlipp (ed.)  
*Albert Einstein: Philosopher-Scientist*  
The Philosophic Dialectic of the Concepts of Relativity, V (pp. 577–578)  
The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Barrow, John D.** 1952–  
English theoretical physicist

**Silk, Joseph** 1943–  
Cosmologist

[Virtual particle pairs] are predicted to have a calculable effect upon the energy levels of atoms. The effect expected is minute — only a change of one part in a billion, but it has been confirmed by experimenters.

In 1953 Willis Lamb measured this excited energy state for a hydrogen atom. This is now called the Lamb shift. The energy difference predicted by the effects of the vacuum on atoms is so small that it is only detectable as a transition at microwave frequencies. The precision of microwave measurements is so great that Lamb was able to measure the shift to five significant figures. He subsequently received the Nobel

Prize for his work. No doubt remains that virtual particles are really there.

*The Left Hand of Creation* (pp. 65–66)

J.M. Dent & Sons. London, England. 1993

**Bishop, Morris** 1893–1973

American scholar and writer

Come, little lad; come, little lass,

Your docile creed recite:

“We know that Energy equals Mass

By the Square of the Speed of Light.”

*A Bowl of Bishop: Museum Thoughts, and Other Verses*

$E = MC^2$

Dial Press. New York, New York, USA. 1954

**Blake, William** 1757–1827

English poet, painter, and engraver

Energy is eternal delight.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell, The Voice of the Devil, #3

University of California Press. Berkeley, California, USA. 1982

Energy is the only life...and Reason is the bound or outward circumference of Energy.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell, The Voice of the Devil, #2

University of California Press. Berkeley, California, USA. 1982

**Born, Max** 1882–1970

German-born English physicist

The release of nuclear energy is an event comparable to the first fire kindled by prehistoric man — though there is no modern Prometheus but teams of clever yet less heroic fellows, useless as inspiration for epic poetry...

*The Restless Universe*

Postscript (p. 309)

Dover Publications, Inc. New York, New York, USA. 1951

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Even though we can't see them, we know that these virtual particles are “really there” in empty space because they leave a detectable trace of their activities. One effect of virtual photons, for example, is to produce a tiny shift in the energy levels of atoms. They also cause an equally tiny change in the magnetic moment of electrons. These minute but significant alterations have been very accurately measured using spectroscopic techniques.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*

Chapter 3 (p. 32)

Basic Books. New York, New York, USA. 1994

In the everyday world, energy is always unalterably fixed; the law of energy conservation is a cornerstone of classical physics. But in the quantum microworld, energy can appear and disappear out of nowhere in a spontaneous and unpredictable fashion.

*God and the New Physics*

Chapter 11 (p. 162)

Simon & Schuster. New York, New York, USA. 1983

**Dickens, Charles** 1812–70

English novelist

“Then idiots talk,” said Eugene, leaning back, folding his arms, smoking with his eyes shut, and speaking slightly through his nose, “of Energy. If there is a word in the dictionary under any letter from A to Z that I abominate, it is energy.”

*Our Mutual Friend*

Chapter 3 (p. 34)

Hurd & Houghton. New York, New York, USA. 1866

**Durant, William James** 1885–1981

American historian and essayist

We see matter and we miss energy; we think that we know what matter is; but when at the heart of the atom we find energy, we are bewildered, and our categories melt away.

*The Story of Philosophy* (2<sup>nd</sup> edition) (p. 494)

Garden City Publishing, Inc. New York, New York, USA. 1933

**Dyson, Freeman J.** 1923–

American physicist and educator

We do not know how the scientists of the next century will define energy or in what strange jargon they will discuss it. But no matter what language the physicists use they will not come into contradiction with Blake. Energy will remain in some sense the lord and giver of life, a reality transcending our mathematical descriptions. Its nature lies at the heart of the mystery of our existence as animate beings in an inanimate universe.

Energy in the Universe

*Scientific American*, Volume 224, Number 3, 1971 (p. 51)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

It is natural that our senses should have developed faculties for perceiving some of these intrinsic distinctions of the possible states of the world around us. I prefer to think of matter and energy, not as agents causing the degrees of curvature of the world, but as parts of our perceptions of the existence of the curvature.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter V (p. 92)

At The University Press. Cambridge, England. 1921

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

Energy has mass and mass represents energy.

*The Evolution of Physics*

The Time-Space Continuum (p. 197)  
Simon & Schuster. New York, New York, USA. 1961

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Coal is a portable climate. It carries the heat of the tropics to Labrador and the polar circle; and it is the means of transporting itself withersoever it is wanted. Watt and Stephenson whispered in the ear of mankind their secret, that a half-ounce of coal will draw two tons a mile, and coal carries coal, by rail and by boat, to make Canada as warm as Calcutta, and with its comfort brings its industrial power.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Wealth (p. 990)

The Library of America. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

There is a fact, or if you wish, a law governing all natural phenomena that are known to date. There is no known exception to this law — it is exact as far as we know. The law is called the conservation of energy. It states that there is a certain quantity, which we call energy, that does not change in the manifold changes which nature undergoes. That is a most abstract idea, because it is a mathematical principle; it says that there is a numerical quantity which does not change when something happens.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 4–1 (p. 4–1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

One of the most impressive discoveries was the origin of the energy of the stars, that makes them continue to burn. One of the men who discovered this was out with his girl friend the night after he realized that nuclear reactions must be going on in the stars in order to make them shine. She said, “Look at how pretty the stars shine!” He said, “Yes, and right now I am the only man in the world who knows why they shine.” She merely laughed at him. She was not impressed with being out with the only man who, at that moment, knew why stars shine. Well, it is sad to be alone, but that is the way it is in this world.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 3–4 (p. 3–7)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

It is important to realize that in physics today, we have no knowledge of what energy is.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 4–1 (p. 4–2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Gamow, George** 1904–68

Russian-born American physicist

Atome prreemorrriale!

All-containeeng Atome!

Deesolved eento fragments excedeengly small.

Galaxies formeeng,

Each wiz prrimal energy!

*Mr. Tompkins in Paperback*

Chapter 6 (p. 57)

At The University Press. Cambridge, England. 1965

**Guth, Alan** 1947–

American physicist

It is said that there’s no such thing as a free lunch. But the universe is the ultimate free lunch.

In Stephen W. Hawking

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 8 (p. 129)

Bantam Books. Toronto, Ontario, Canada. 1988

**Hammond, Allen Lee**

No biographical data available

**Metz, William D.**

No biographical data available

A point about solar energy that government planners seem to have trouble grasping is that it is fundamentally different from other energy sources. Solar energy is democratic. It falls on everyone and can be put to use by individuals and small groups of people. The public enthusiasm for solar is perhaps as much a reflection for this unusual accessibility as it is a vote for the environmental kindness and inherent renewability of energy from the sun.

Solar Energy Research: Making Solar After the Nuclear Model?

*Science*, Volume 197, Number 4300, July 15, 1977 (p. 241)

**Hawking, Stephen William** 1942–

English theoretical physicist

And where did the energy come from to create this matter? The answer is that it was borrowed from the gravitational energy of the universe. The universe has an enormous debt of negative gravitational energy, which exactly balances the positive energy of the matter. During the inflationary period the universe borrowed heavily from its gravitational energy to finance the creation of more matter...The debt of gravitational energy will not have to be paid until the end of the universe.

*Black Holes and Baby Universes and Other Essays*

Chapter Nine (p. 97)

Bantam Books. New York, New York, USA. 1987

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Energy. I am energy. Sublime and meaningless Energy.

I stream in floods across the empty ocean

Of space, where island-universes float,

Each like a little lonely boat.

*The Captive Shrew and Other Poems of a Biologist*

Matter, Energy, Time and Space (p. 65)

Harper &amp; Brothers. New York, New York, USA. 1933

**Huxley, Thomas Henry** 1825–95

English biologist

...naught endures save the flow of energy and the rational order which pervades it.

*Collected Essays* (Volume 9)

Evolution and Ethics (p. 50)

Macmillan &amp; Company Ltd. London, England. 1904

**Johnson, George** 1952–

American science writer

The weapons laboratory of Los Alamos stands as a reminder that our very power as pattern finders can work against us, that it is possible to discern enough of the universe's underlying order to tap energy so powerful that it can destroy its discoverers or slowly poison them with its waste.

*Fire in the Mind: Science, Faith, and the Search For Order*

Conclusion: The Ruins of Los Alamos (p. 326)

Alfred A. Knopf. New York, New York, USA. 1995

**Joly, John** 1857–1933

Irish physicist and geologist

The rolled-up crust of the earth is still rich in energy borrowed from earlier times, and the slow but mighty influences of denudation and deposition are forever at work. And so, perchance, in some remote age the vanished Gondwana Land, the lost Atlantis, may once again arise, the seeds of resurrection even now being sown upon their graves from the endless harvests of pelagic life.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

Uranium and Geology (pp. 382–83)

Government Printing Office. Washington, D.C. 1909

**Joule, James Prescott** 1818–89

English physicist

You see, therefore, that living force may be converted into heat, and that heat may be converted into living force, or its equivalent attraction through space. All three, therefore — namely, heat, living force, and attraction through space (to which I might also add light, were it consistent with the scope of the present lecture) — are mutually convertible into one another. In these conversions nothing is ever lost. The same quantity of heat will always be converted into the same quantity of living force. We can

therefore express the equivalency in definite language applicable at all times and under all circumstances.

In E.C. Watson

Joule's Only General Exposition of the Principle of Conservation of Energy

"On Matter, Living Force and Heat" (1847)

*American Journal of Physics*, Volume 15, Number 5,

September–October 1947 (p. 388)

**Lemaître, Abbé Georges** 1894–1966

Belgian astronomer and cosmologist

If we go back in the course of time we must find fewer and fewer quanta, until we find all the energy of the universe packed in a few or even in a unique quantum.

The Beginning of the World from the Point of View of Quantum Theory

*Nature*, Volume 127, Number 3210, May 9, 1931 (p. 706)**Lilienthal, David E.** 1899–1981

American businessman and Tennessee Valley Authority administrator

Atomic energy bears the same duality that has faced man from time immemorial, a duality expressed in the Book of Books thousands of years ago: "See, I have set before thee this day life and good and death and evil...therefore choose life...."

*This I Do Believe* (pp. 144–145)

Harper &amp; Row. New York, New York, USA. 1949

**Lindsay, R. Bruce** 1900–85

American physicist

Of all the concepts or constructs of physics, energy, by its unifying capacity, has proved by all odds to be the most significant and successful. Its domain of application had indeed by now far transcended physics and covers all branches of science...it is the physical construct which has proved to contain the greatest meaning for all aspects of human life.

In R. Bruce Lindsay (ed.)

*Energy: Historical Development of the Concept*

The Concept of Energy and Its Early Historical Development (p. 13)

Dowden, Hutchinson &amp; Ross. Stroudsburg. 1975

**Meyerson, Emile** 1859–1933

Polish-born French chemist

Energy really is only an integral; now, what we want to have is a substantial definition, like that of Leibniz, and this demand is justifiable to a certain degree, since our very conviction of the conservation of energy rests in great part on this foundation.... And so the manuals of physics contain really two discordant definitions of energy, the first which is verbal, intelligible, capable of establishing our conviction, and false; and the second which is mathematical, exact, but lacking verbal expression.

Translated by Kate Loewenberg

*Identity & Reality*

Chapter VIII (p. 280)

George Allen &amp; Unwin Ltd. London, England. 1930

**Morris, Richard** 1939–2003  
American physicist and science writer

The uncertainty principle implies that particles can come into existence for short periods of time even when there is not enough energy to create them. In effect, they are created from uncertainties in energy. One could say that they briefly “borrow” the energy required for their creation, and then, a short time later, they pay the “debt” back and disappear again. Since these particles do not have a permanent existence, they are called virtual particles.

*The Edges of Science*

Chapter II (p. 24)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

**Moulton, Forest Ray** 1872–1952  
American astronomer

The innumerable members of our galaxy assure us, however, that though the stars may be evaporating, so to speak, like the dew, their energies will in some way be integrated again.

*Astronomy*

Chapter XV (p. 471)

The Macmillan Company. New York, New York, USA. 1931

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

In the last ten years physicists have learned more about the universe than in previous centuries — they have seen a new picture of reality requiring a conversion of our imaginations. The visible world is neither matter nor spirit but the invisible organization of energy.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Foreword (p. 13)

Simon & Schuster. New York, New York, USA. 1982

**Russell, Bertrand** 1872–1970  
English philosopher, logician, and social reformer

As a proposition of linguistics: “Energy” is the name of the mathematical expression in question. . . . As a proposition of psychology: our senses are such that we notice what is roughly the mathematical expression in question, and we are led nearer and nearer to it as we refine upon our crude perceptions by scientific observation.

*The ABC of Relativity*

Chapter XII (p. 113)

George Allen & Unwin Ltd. London, England. 1958

**Rutherford, Ernest** 1871–1937  
English physicist

The energy produced by the breaking down of the atom is a very poor kind of thing. Anyone who expects a source of power from the transformation of these atoms is talking moonshine.

Atom Powered World Absurd, Scientists Told

*New York Herald Tribune*, September 12, 1933

**Sagan, Carl** 1934–96  
American astronomer and author

The total amount of energy from outside the solar system ever received by all the radio telescopes on the planet Earth is less than the energy of a single snowflake striking the ground.

*Cosmos*

Chapter X (p. 261)

Random House, Inc. New York, New York, USA. 1980

**Schuster, Sir Arthur** 1851–1934  
English physicist

Efforts have been made to look on energy as on something which can be labeled and identified through its various transformations. Thus we may feel a certain bit of energy radiating from a coal-fire, and if our knowledge was complete, we ought to be able to fix the time at which that identical bit of energy left the sun and arrived on the surface of the earth, setting up a chemical action in the leaves of the plant from which the coal has been derived. If we push this view to a logical conclusion, it seems to me that we must finally arrive at an atomic conception of energy, which some may consider an absurdity.

*Report of the British Association*

Presidential Address

Section A

1892 (p. 629)

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

Energy, like grammar, should be used correctly; the unjust expenditure of energy or its unjust withholding should cease immediately.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #132 (p. 38)

Definition Press. New York, New York, USA. 1972

**Soddy, Frederick** 1877–1956  
English chemist

Energy, someone may say, is a mere abstraction, a mere term, not a real thing. As you will. In this, as in many another respects, it is like an abstraction no one would deny reality to, and that abstraction is wealth. Wealth is the power of purchasing, as energy is the power of working. I cannot show you energy, only its effects. Abstraction or not, energy is as real as wealth — I am not sure that they are not two aspects of the same thing.

*Science and Life*

Physical Force — Man’s Servant or His Master? (p. 27)

Publisher undetermined. London, England. 1920

**Stallo, John Bernard** 1823–1900  
Russian political leader

In a general sense, this doctrine [conservation of energy] is coeval with the dawn of human intelligence. It is

nothing more than an application of the simple principle that nothing can come from or to nothing...

*The Concepts and Theories of Modern Physics* (pp. 68–69)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

**Steele, Joel Dorman** 1836–86

American educator and textbook writer

The sunbeam comes to the earth as simply motion of ether-waves, yet it is the grand source of beauty and power. Its heat, light, and chemical energy work everywhere the wonder of life and motion. In the growing plant, the burning coal, the flying bird, the glaring lightning, the blooming flower, the rushing engine, the roaring cataract, the pattering rain — we see only varied manifestations of this one protean energy which we receive from the sun.

*Popular Physics*

Chapter VII (p. 188)

American Book Company, New York, New York, USA. 1896

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

A living cell requires energy not only for all its functions, but also for the maintenance of its structure. Without energy life would be extinguished instantaneously, and the cellular fabric would collapse.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1937

Oxidation, Energy Transfer, and Vitamins (p. 440)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

It took us eighteen months to build the first nuclear power generator; it now takes twelve years; that's progress.

In Milton Friedman and Rose Friedman

*Free to Choose: A Personal Statement* (p. 191)

Harcourt, Brace Jovanovich, Inc. New York, New York, USA. 1980

**Tyndall, John** 1820–93

Irish-born British physicist

This law generalizes the aphorism of Solomon, that there is nothing new under the sun, by teaching us to detect everywhere, under its infinite variety of appearances, the same primeval force. To nature, nothing can be added; from nature nothing can be taken away; the sum of her energies is constant.... Waves may change to ripples and ripples to waves, — magnitude may be substituted for number, and number for magnitude, — asteroids may aggregate to suns, suns may resolve themselves into florae and faunae, and florae and faunae melt in air, — the flux of power is eternally the same. It rolls in music throughout the ages, and all terrestrial energy, — the manifestations of life as well as the display of phenomena, are but the modulations of its rhythm.

In Henry Adams

*The Degradation of the Democratic Dogma*

A Letter to American Teachers of History, Chapter I (pp. 144–145)

Peter Smith. New York, New York, USA. 1949

**Umov, N. A.**

No biographical data available

Science has taught people to use the energy concealed in the bowels of the Earth. It must lead man to the treasure-chests of heaven, too, and teach him to accumulate the energy of the Sun's rays.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Moscow, Russia. 1979

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

The universe...has its limited supply of energy, which works in it under ever-varying forms, indestructible, incapable of increase, eternal, and unchangeable like matter.

In Franz Himstedt

*Annual Report of the Board of Regents of the Smithsonian Institution, 1906*

Radioactivity (p. 121)

Government Printing Office. Washington, D.C. 1907

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian and sociologist

...we know now that the atom, that once we thought hard and impenetrable, and indivisible and final and — lifeless — lifeless, is really a reservoir of immense energy.

*The World Set Free*

Prelude, Section 8

Macmillan & Company Ltd. London, England. 1914

## ENERGY STATE

**Free, E. E.**

No biographical data available

Imagine a series of race tracks one inside the other. Imagine these tracks are separated by high board fences. Put a race horse in the outermost track and instruct him to run around it until when he happens to feel like it, he has to jump the inside fence into the next track, run around it for a while, and then jump into the next fence, and so on until he reaches the innermost track of all. If, then you watch this procedure from the field outside the outermost fence, you will not see the horse at all as long as he is running in a single track. The fences hide him. But whenever he jumps from one track into the next, you will see him for an instant as he goes over.

In Bernard Jaffe

*Crucibles: The Story of Chemistry* (pp. 244–245)

Dover Publications. New York, New York, USA. 1976

**ENGINEER****Alger, John R. M.**

American engineer

**Hays, Carl V.**

No biographical data available

The engineer is concerned with creating material objectives to serve human needs. . . . The engineer uses the knowledge and understanding developed by the scientist. In the absence of such knowledge, the engineer proceeds to a schedule by making judicious assumptions about the designs in order to insure successful solutions.

*Creative Synthesis in Design* (p. 2)

Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1964

An inexperienced engineer commonly believes that he can accomplish about twice as much as he can in fact accomplish in a given time.

*Creative Synthesis in Design* (p. 58)

Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1964

The greatest difference between engineers and other professionals is that engineers do not offer a person-to-person service, nor are their services a matter of life, freedom, or property, of deep personal concern. Most engineers thrive on promotion and expansion of business, new inventions, new buildings, and more consumption of goods. Obviously, then, they are tempted to whip up trade, advertise, seek out clients, and promote deals. This spirit leads to competition. Until this is recognized, I see no hope of solving the problem of engineering professional development.

*Ethical Problems in Engineering* (p. 4)

John Wiley & Sons, Inc. New York, New York, USA. 1965

It takes a wise man to give the right answer to a technical question that involves the conflicting rights and desires of a number of people. Yet the engineer is often required to give such an answer and on very short notice.

*Ethical Problems in Engineering* (p. 4)

John Wiley & Sons, Inc. New York, New York, USA. 1965

**Aronin, Ben** 1904–80

Poet and musical talent

I'll carry the story along from here  
And sing you the song of the engineer.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

Adam to Atoms, Scene XV, Ballad of the Engineer — 1840–1865 (p. 89)  
Centennial of Engineering. Chicago, Illinois. 1952

**Arwaker, Edmund** 1712–30

English poet

I learnt t'intrench a Camp, and Bulwarks rear,  
With all the Cunning of an Engineer.

*Pia Desidera*

Book the Second, l. 805

William Andrews Clark Memorial Library. Los Angeles, California, USA. 1972

**Author undetermined**

A good engineer must be of inflexible integrity, sober, truthful, accurate, resolute, discrete, of cool and sound judgment; must have courage to resist and repeal attempts at intimidation, a firmness that is proof against solicitation, flattery, or improper bias of any kind; must take an interest in his work; must be energetic, quick to decide, prompt to act; must be as fair and impartial as a judge on the bench; must have experience in his work and in dealing with men, which implies some maturity of years; and must have business habits and knowledge of accounts. Men who combine these qualities are not to be picked up every day. Still they can be found, and when found, they are worth their price; rather they are beyond price, and their value cannot be estimated by dollars.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.)

*Vocational Guidance in Engineering Lines* (p. 483)

The Mack Printing Company, Easton, Pennsylvania, USA. 1933

. . . whenever an engineer learns something new in technics, it is his bounden duty to put it in writing and see that it is published where it will reach the eyes of his confrères and be always available to them. It is absolutely a crime for any man to die possessed of useful knowledge in which nobody else shares.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.)

*Vocational Guidance in Engineering Lines*

Lines First Edition (p. 10)

The Mack Printing Company, Easton, Pennsylvania, USA. 1933

[Chemical engineers] . . . are not even able to persuade the engineers that we are engineers.

*American Institute of Chemical Engineers Bulletin*, No. 24, 1921 (p. 53)

**Bailey, Philip James** 1816–1902

English poet

Even as when

In planning some steel-rutted road, long years

Dreamed of, — where now the fire-horse ramps, steam-breath'd,

Sweating red coal-drops on his panting path, —

The deep-eyed engineer his level lays

Inscrutable, and anon, the hills with men,

Brood of his brain swarm.

*Festus: A Poem*

Scene XXVIII (p. 472)

George Routledge & Sons, Limited. London, England. 1893

**Baillie, Joanna** 1762–1851

Scottish poet

Some thousand carcasses, living and dead,

Of those who first shall glut the en'my's rage,

Push'd in, pell-mell, by those who press behind

Will rear for us a bridge to mount the breach

Where ablest engineers had work'd in vain.



*Miscellaneous Plays*

Constantine Paleologus, I. 23–27

Garland Publishing, Inc. New York, New York, USA. 1977

**Birchmore, Sue**

No biographical data available

The best scientists are poets, the real engineer is an artist.

In E. Garfield

Creativity and Science

*Current Comments*, Part I, Number 43, 23 October, 1989 (p. 296)**Blough, Roger M.** 1904–85

American industrialists

We do not do ourselves a good turn by becoming panicky at the idea of the mere number of engineers that are being produced in other countries, or by consciously engaging in a technological numbers race.

*American Engineer*, Volume 26, Number 7, July 1956 (p. 5)**Boelter, L. M. K.**

No biographical data available

Engineers participate in the activities which make the resources of nature available in a form beneficial to man and provide systems which will perform optimally and economically.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 9)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Born, Max** 1882–1970

German-born British physicist

The engineer, who has cunningly contrived to make the blind and deaf molecules in their mad, senseless rush drive an engine, may well feel proud of himself.

*The Restless Universe*

Chapter 1 (p. 16)

Dover Publications, Inc. New York, New York, USA. 1951

**Bradley, Duane**

No biographical data available

[Engineers] are men with wings on their minds. These wings are courage and imagination — when an engineer decides that a job is not too big for him, and starts finding a way to do it, he is using his wings.

*Engineers Did It!*

Chapter 1 (p. 8)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1958

**Brandeis, Louis D.** 1856–1941

American lawyer, reformer, and Supreme Court justice

The engineer spoke in figures — a language implying certitude.

In Alfred Lief (ed.)

*The Social and Economic Views of Mr. Justice Brandeis* (p. 141)

Vanguard Press. New York, New York, USA. 1930

**Brome, Alexander** 1620–66

English poet

All trades did shew their skill in this,

Each wise an Engineer:

The Mairesse took the tool in hand,

The maids the stones did bear.

*Rump: or An Exact Collection of the Choycest Poems and songs Relating to the Latest Times*

On the Demolishing the Forts

Printed for Henry Brome. London, England. 1662

**Buchanan, Scott** 1895–1968

American educator and philosopher

Watch the engineer and you will learn many things, but do not ask him about mathematics, unless you want to see quite another thing, how technology and folk-lore get invented and broadcast.

*Poetry and Mathematics*

Chapter 1 (p. 38)

The University of Chicago Press. Chicago, Illinois, USA. 1975

The engineer sings as he works — often he only whistles — and in that singing there is the magic of poetry. The engineer's science, like the sailor's chanty, is good literature.

*Poetry and Mathematics*

Chapter 1 (pp. 38–39)

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

We want a lot of engineers in the modern world, but we do not want a world of engineers. We want some scientists, but we must keep them in their proper place.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

University of London, November 18, 1948 (p. 363)

George Allen &amp; Unwin Ltd. London, England. 1956

**Colclaser, R. G.**

No biographical data available

In many segments of industry, the young man is looked upon first as an engineer and second as an electrical engineer with specific knowledge. Industrial problems do not divide themselves neatly into the areas of electrical, mechanical, chemical, or civil engineering; rather, they are considered as general problems requiring a solution which the young engineer is expected to provide. In the majority of cases he must produce a physical device which will accomplish a desired result. This is not a “textbook” solution but an original, creative effort.

A Design School for the Young Engineer in Industry

*Engineering Education*, March 1968 (p. 812)**Compton, Karl Taylor** 1887–1954

American educator and physicist

For the benefit of society, as well as for the most efficient work of the engineer, it is essential that the engineer... be trained to think not only of his specific engineering projects, but also of their larger significance in the economic and social order.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 49)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

If the engineer is to bring his influence to bear on broad public questions he must approach them, not with technical arrogance, but with sympathetic understanding.

Engineering and Social Progress

*Journal of Engineering Education*, Volume 30, Number 1, September 1939 (p. 14)

### **Cook, Morris L.**

No biographical data available

The more I think of it, the more I feel that the fundamental consideration in the work of an engineer — if he is ever to pull himself out of his present status of being a hired servant — is that he shall make public interest the master test of his work.

In Edwin T. Layton

*The Revolt of the Engineers*

Letter to A.G. Christie, June 9, 1921 (p. 159)

Press of Case Western Reserve University. Cleveland, Ohio, USA. 1971

### **Crichton, Michael** 1942–

American novelist

Let's keep it in perspective, Hammond said. You get the engineering correct and the animals will fall into place...

*Jurassic Park*

The Tour (p. 141)

Alfred A. Knopf. New York, New York, USA. 1990

### **Cross, Hardy** 1885–1959

American professor of civil and structural engineering

It is important that men know that engineers do not build alone with concrete and steel or by formulas and charts, but more than anything else by faith, hope and charity — faith in their methods, their training, in the men with whom they work, faith in humanity, in the worth-while-ness of life; hope that by use of these they may find men, money, materials and methods, not blind wishes but judicious hopes; charity that involves the sympathetic understanding of the human element and willingness.

*Engineers and Ivory Towers*

The Education of an Engineer (p. 59)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

### **Darrow, Karl Kelchner** 1891–1982

American physicist

But here is another who took up the study of physics as soon as he came to college, and continued it all through

his student days, and his career consists in controlling and directing physical phenomena by his knowledge of physical laws, or in designing machines which depend on physical principles. And what does he call himself, and what does the world call him? An electrical engineer or a radio engineer, a designer of lenses or a maker of turbines, a naval engineer or an acoustical engineer, a mechanical engineer or an aerodynamical engineer, and only the census tables could say what else!

*The Renaissance of Physics*

Chapter I (p. 4)

The Macmillan Company. New York, New York, USA. 1936

### **Davis, Chandler** 1926–

American mathematician

Any applied mathematicians — any engineer using mathematics — works sometimes more and sometimes less mathematically. When he is most mathematical he makes least appeal to experience.

*Boston Studies In the Philosophy of Science* (Volume 15)

For Dirk Struk, *Materialist Mathematics* (p. 38)

D. Reidel Publishing Company. Dordrecht, Netherlands.

### **de Beauvoir, Simone** 1908–1986

French author and philosopher

He was living like an engineer in a mechanical world. No wonder he had become dry as a stone.

*The Mandarins*

Chapter 3 (p. 156)

W.W. Norton & Company, Inc. New York, New York, USA. 1999

### **de Camp, L. Sprague** 1907–2000

American science fiction writer

Civilization, as we know it today, owes its existence to the engineers. These are the men who, down the long centuries, have learned to exploit the properties of matter and the sources of power for the benefit of mankind. By an organized, rational effort to use the material world around them, engineers devised the myriad comforts and conveniences that mark the difference between our lives and those of our fore-fathers thousands of years ago. The story of civilization is, in a sense, the story of engineering — that long and arduous struggle to make the forces of nature work for man's good.

*The Ancient Engineers*

Chapter One (p. 1)

Ballantine Books. New York, New York, USA. 1974

### **de Vega, Lope** 1562–1635

Spanish poet and playwright

*Es amor grande ingeniero:*

*Las máquinas de Arquímedes*

*No son encarecimiento*

*Para las que tiene amor.*

Love is a mighty engineer,

Not Archimedes' skill could add

One jot or title to the power  
Of the machines that Love controls.

*La Hermosa Fea*

Act II, Scene 7

Publisher undetermined

### Dean, Jr., Robert C.

No biographical data available

...the job of the engineer is to change the world...

In Daniel V. DeSimone

*Education for Innovation*

Trade-Offs and Constraints (p. 111)

Pergamon Press. New York, New York, USA. 1968

### Defoe, Daniel 1660–1731

English pamphleteer, journalist, and novelist

The Legislators are the Engineers,  
Who when 'tis out of Order make Repairs:  
The People are the Owners, 'twas for them  
The first Inventor drew the ancient Scheme.  
'Tis for their Benefit it works, and they  
The Charges of maintaining it defray:  
And if their Governours unfaithful prove,  
They, Engineers or Managers remove.  
Unkind Contention sometimes there appears  
Between the Managers and Engineers:  
Such Strife is always to the Owners wrong,  
And once it made the Work stand still too long;  
Till William came, and loos'd the Fatal Chain,  
And set the Engineers to work again:  
And having made the wondrous thing complete,  
To Anne's unerring Hand he left the Helm of State.

*Selected Poetry and Prose of Daniel Defoe*

The Mock Mourners, l. 92–107

Holt, Rinehart & Winston. New York, New York, USA. 1968

### DeSimone, Daniel V.

No biographical data available

### Cross, Hardy 1885–1959

American engineer

...an engineer is supposed to be more than a mobile  
repository of knowledge who is adept at attacking single-  
answer problems.

*Education for Innovation*

Introduction (p. 13)

Pergamon Press. New York, New York, USA. 1968

### Dibdin, Charles Isaac Mungo 1768–1833

English songwriter

Goletta's walls, for tactic science fam'd,  
Boast of the age, impregnable proclaim'd,  
No dam afford to stop the raging tide,  
All hearts conjoin'd, and ev'ry nerve applied;  
The bulwerk cracks; the engineer applies  
Incessant art's destructive energies...

*Young Arthur*

Subject VI, Lament, l. 2738–2743

Chadwyck-Healey. Cambridge, England. 1992

### Dieudonné, Jean 1906–92

French mathematician and educator

Engineers, always looking for optimal values for the  
measures of magnitudes which interest them, think of  
mathematicians as custodians of a fund of formulae, to  
be supplied to them on demand.

*Mathematics — The Music of Reason*

Chapter I, Section 1 (p. 7)

Springer-Verlag. Berlin, Germany. 1992

### Dodge, A. Y.

No biographical data available

...many engineers treat all new things pessimistically.

In Joseph Rossman

*Industrial Creativity: The Psychology of the Inventor*

Chapter XIV (p. 220)

University Books. New Hyde Park, New York, USA. 1964

### DuBridge, Lee Alvin 1901–94

American physicist

The scientist or engineer — like every other human being  
— bears also the responsibility of being a useful member  
of his community...and should speak on issues which  
can be addressed with competence — including joining  
hands with other citizens when called to tasks of peace.

In Thomas Hager

*Force of Nature: The Life of Linus Pauling*

Chapter 15 (p. 347)

Simon & Schuster. New York, New York, USA. 1995

### Dumas, Hal S.

No biographical data available

It is the engineer who must always be the link between  
the idea and actuality, between the probable and the prac-  
tical. It is he who makes realities out of dreams. He is in-  
deed the solvent which blends together the many differ-  
ent parts of our great industrial mechanism and produces  
a smoothly working whole.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia:  
1852–1952*

The Telephone Engineer and His Job (p. 750)

Centennial of Engineering. Chicago, Illinois. 1952

It is the job of the engineer to search out the means by  
which the ideas of the inventor can be put to work in the  
service of the public. He also knocks on the door of the  
ivory tower of the pure scientist and calls forth new in-  
ventions to meet the needs and wants of the public.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia:  
1852–1952*

The Telephone Engineer and His Job (p. 751)

Centennial of Engineering. Chicago, Illinois. 1952

**Dunning, John R.**

No biographical data available

How engineers and scientists who daily drink thinly diluted, but treated sewage, and on a rationed basis at that; travel to and from work via arteries of congested, noisy traffic through asphalt jungles of soot and acid-blackened buildings; breathe smog-filled air symptomized by hacking and coughing, and tear-filled eyes, pay exorbitant clothing and home cleaning bills; and see the progressive deterioration of natural beauty; [how they can] continue to tolerate all of these things and more without doing something about it is incomprehensible.

*The Urban Frontier and the Engineer*

Pamphlet distributed by the Office of School Relations, Columbia University

**Durand, William Frederick**

United States Naval Officer

...no one knows better than the engineer the need of discrimination between the sure ground of known data and formal logic, on the one hand — as exemplified, say, by mathematical operations — and acts of judgment on the other; and no one has learned through wider experience than the engineer the need of applying his conclusions in the light of that component part which, of necessity, has been dependent on estimate and judgment.

Residential Address

*Transactions of The American Society of Mechanical Engineers*, Volume 47, 1925

**Dyson, Freeman J.** 1923–

American physicist and educator

A good scientist is a person with original ideas. A good engineer is a person who makes a design that works with as few original ideas as possible. There are no prima donas in engineering.

*Disturbing the Universe*

Chapter 10 (p. 114)

Basic Books, Inc., Publishers. New York, New York, USA. 1979

**Edwards, Llewellyn Nathaniel** 1873–1952

No biographical data available

The engineer historian gathers a need of satisfaction and pleasure in tracing the progress made by predecessors in his art; reviewing their accomplishments; analyzing their solutions of problems; and examining the monuments of their industry and skill. He sees definitely and unmistakably that advances made in a given period have marked the way to greater accomplishments in a succeeding period.

*A Record of History and Evolution of Early American Bridges*

Builders of Bridges (p. xii)

University Press, Orono, Maine, USA. 1936

Engineers bridging chasms wide  
So people may reach the other side;

Dreamers, yes, but does too,  
Developing the strange and new.

*A Record of History and Evolution of Early American Bridges*

Builders of Bridges (p. xi)

University Press, Orono, Maine, USA. 1936

**Egerton, Sarah** 1670–1723

English poet

So some unlucky Engineer  
Does all the fit Materials compound,  
That are in Art or Nature found;  
Will glorious Fire-Works prepare.

*Poems on Several Occasions*

The Advice, Part II, l. 41–44

Chadwyck-Healey, Cambridge, England. 1992

**Eisenhower, Dwight David** 1890–1969

34<sup>th</sup> president of the United States

Engineers build for the future, not merely for the needs of men but for their dreams as well. Thus, inherently, the engineer's work is a fearless optimism that life will go forward, and that the future is worth working for.

*American Engineer*, December 1951 (p. 5)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The machine unmakes the man. Now that the machine is so perfect, the engineer is nobody.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

Society and Solitude

Works and Days (p. 165)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Emmet, William LeRoy** 1859–1941

American electrical engineer

The all-important word to the engineer is WHY, and it is astonishing how few people in the ordinary pursuits of human affairs ever think it worthwhile to trouble themselves about that question, or to make much effort to find out whether the answer suggested will bear analysis.

*The Autobiography of an Engineer*

Chapter XII (p. 226)

The American Society of Mechanical Engineers. New York, New York, USA. 1940

**Evans, Sebastian** 1830–1909

Author

Parapet, buttress, and arch and pier  
Beyond are as sound as ever!  
Now show us thy skill, Sir Engineer,  
For a roadway over the River!

*In the Studio, A Decade of Poems*

A Tale of a Trumpeter, l. 117–120

Macmillan & Company. London, England. 1875

And there we kept pacing to and fro,  
In a frenzy of mute surmising:

Quoth the Engineer in a whisper low:  
“Is the tide in the river rising?”

*In the Studio, A Decade of Poems*

A Tale of a Trumpeter, l. 61–64

Macmillan & Company. London, England. 1875

**Farquhar, George** 1678–1707

Irish dramatist

Rise thou prostrate Engineer, not all thy undermining  
Skill shall reach my Heart.

*The Beaux' Stratagem*

Act V, Scene II (p. 82)

Appleton-Century-Crofts. New York, New York, USA. 1967

**Finch, James Kip** 1883–1967

American engineer

From the earliest days of recorded history the men now known as engineers — civil, chemical and mechanical, mining and metallurgical — have provided for man's unfolding material needs and wants. Engineering has, in fact, not only played an ever increasing role in man's material life, but has had a profound effect on human relations, in shaping modern social, economic, and political aims, ideals, and institutions. Indeed, the promises which engineering and engineered industry offer today stir the hopes, interest, and ambitions of the less-developed nations of the world.

*The Story of Engineering* (p. v)

Doubleday. Garden City, New York, USA. 1960

**Flanders, Ralph E.** 1922–75

English actor and singer

There is an engineering approach to (our) problems. The engineer has an objective. He studies and analyzes the materials with which he has to deal. He acquaints himself with the natural forces which he cannot change, which are more powerful than he is, but to which he must adapt himself so that he may make use of them.

*American Engineer*, November 1952 (p. 6)

**Florman, Samuel C.** 1925–

Author and professional engineer

The civil engineer, with his hands literally in the soil, is existentially wedded to the earth, more so than any other man except perhaps the farmer.

*The Existential Pleasures of Engineering*

Chapter 9 (pp. 121–122)

St. Martin's Press. New York, New York, USA. 1976

Taken as a whole, engineers — and the technologists, craftsmen, and tinkerers from whom they spring — are, and always have been, as decent, moral, and law-abiding a group of men as one could find. Absorbed in their technical pursuits, they are singularly free of the greed, duplicity, and hostility that characterize so many of their fellows and that have caused so much grief.

Comment: Engineers and the End of Innocence

*Technology and Culture*, Volume 10, Number 1, January 1969 (p. 14)

The nation needs engineers who are able to communicate, who are prepared for leadership roles, who are sensitive to the worthy objectives of our civilization and the place of technology within it, and whose creative imaginations are nourished from the richest possible sources — spiritual, intellectual, and artistic. Furthermore, engineers as a group need to preserve their professional self-esteem — and the esteem of the greater community — by guarding against an insensitive mechanical approach to the work they do. And finally, individual engineers deserve the chance to enrich their lives with art, literature, history — the best our civilization has to offer.

*The Civilized Engineer*

Chapter 19 (p. 195)

St. Martin's Press. New York, New York, USA. 1985

...public-safety policies are properly established, not by well-intentioned engineers, but by legislators, bureaucrats, judges, and juries, in response to facts presented by expert advisers.... It would be a poor policy indeed that relied upon the impulse of individual engineers.

*Blaming Technology*

Moral Blueprints (p. 174)

St. Martin's Press. New York, New York, USA. 1981

**Freund, C. J.**

No biographical data available

People are not afraid of engineers, thank goodness, but they are excessively afraid of much that engineers contrive.

*Engineering Education and Freedom from Fear*

*Journal of Engineering Education*, Volume 40, Number 1, September 1949 (p. 11)

Surely there is no greater menace in the world than a superbly competent engineer who is equally content to engage himself to a benefactor of the human race or to some monster of cruelty and vice.

*Engineering Education and Freedom from Fear*

*Journal of Engineering Education*, Volume 40, Number 1, September 1949 (p. 11)

**Freyssinet, E.**

Some people will say that a respect for regulations is essential and that engineers need not check the hypotheses on which they are based. This is a convenient theory, but a false one. Men who draw up regulations can be wrong like other men.

*Cement and Concrete Association Library Translation No. 59*

*The Birth of Prestressing*

London, England. 1956

**Gäbor, Dennis** 1900–79

Hungarian-English physicist

Short of a compulsory humanistic indoctrination of all scientists and engineers, with a “Hippocratic oath” of never using their brains to kill people, I believe that the best makeshift solution at present is to give the alpha-minuses alternative outlets for their dangerous brain-power, and this may well be provided by space research.

*Inventing the Future*

The Future of Uncommon Man (p. 156)  
Secker & Warburg. London, England. 1963

**Galbraith, John Kenneth** 1908–2006  
Canadian-American economist

...the enemy of the market is not ideology but the engineer.

*The New Industrial State*

Chapter III, Section 5 (p. 33)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

**Gillmor, R. E.**

No biographical data available

My observation...is that the engineer feels his professional responsibility to mankind just as much as does the physician and the military man. He does not (always) take an oath as they do, but his sense of professional responsibility is as deep in his heart as any oath could make it.

*American Engineer*, Volume 26, Number 9, September 1956 (p. 5)

**Glegg, Gordon L.**

American engineer

A scientist can discover a new star but he cannot make one. He would have to ask an engineer to do it for him.

In Isaac Asimov

*Isaac Asimov's Book of Science and Nature Quotations* (p. 79)  
Weidenfeld & Nicolson. New York, New York, USA. 1988

**Golder, H. Q.**

No biographical data available

The scientist is interested in the right answer, the engineer in the best answer now.

In Robert F. Legget

*Geology and Engineering*

Forward (p. xii)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1962

**Grace, Eugene G.**

No biographical data available

Thousands of engineers can design bridges, calculate strains and stresses, and draw up specifications for machines, but the great engineer is the man who can tell whether the bridge or the machine should be built at all, where it should be built, and when.

In George C. Beakley

*Careers in Engineering and Technology* (p. 33)  
The Macmillan Company. New York, New York, USA. 1984

**Gruenberg, Benjamin C.**

No biographical data available

Scientific studies develop...the habit of mind that submits every idea to rigid test. Much of the loose thinking in social, political, and economic affairs would be avoided if workers in these fields possessed real training in scientific thinking. The scientist and engineer have built the modern world, and they hold the key to its control and coordination.

*Science and the Public Mind*

Chapter IV (p. 34)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1935

**Hamerton, Philip Gilbert** 1834–94

English artist and writer

Some have iron thews and sinews, some are muscular of mind;

Learned savans, skilful blacksmiths, each are noble in their kind.

But to give the savan's wisdom to the hammer and the shears,

Come those intermediate workers, — England's civil engineers.

*The Isles of Loch Awe and Other Poems of My Youth*

The Britannia Bridge, I. 1–4

W. E. Painter. London, England. 1855

**Herbert, George** 1593–1633

English metaphysical poets

Wit's an unruly engine, wildly striking

Sometimes a friend, sometimes the engineer.

*The Country Parson: the Temple*

The Church Porch, I. 241–2 (p. 129)

Paulist Press. New York, New York, USA. 1981

**Hogben, Lancelot** 1895–1975

English zoologist

This is not the age of pamphleteers. It is the age of the engineers. The spark gap is mightier than the pen. Democracy will not be salvaged by men who can talk fluently, debate forcefully, and quote aptly.

*Science for the Citizen*

Epilogue (p. 1075)

Alfred A. Knopf. New York, New York, USA. 1938

**Hood, Thomas** 1582–98

English poet and editor

John Jones he was a builder's clerk,

On ninety pounds a year,

Before his head was engine-turn'd

To be an engineer!

*The Complete Poetical Works of Thomas Hood*

John Jones: A Pathetic Ballad

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Hoover, Herbert** 1874–1964

31<sup>st</sup> president of the United States

There is the fascination of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings jobs and homes to men. Then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege.

*The Memoirs of Herbert Hoover* (Volume 1)

The Profession of Engineering (pp. 132–133)

The Macmillan Company. New York, New York, USA. 1952

I hope you will forgive my dreadful curiosity, but I should like awfully to know — what is your profession? I replied that I was an engineer. She emitted an involuntary exclamation, and said Why, I thought you were a gentleman!

*The Memoirs of Herbert Hoover* (Volume 1)

The Profession of Engineering (p. 132)

The Macmillan Company. New York, New York, USA. 1952

### Howland, W. E.

No biographical data available

### Wiley, R. B.

No biographical data available

It might be supposed that engineers, who are so largely responsible for the increase in the productive capacity of men and of nations, would be the first to enjoy, or at least to seek to enjoy, the benefits of their own accomplishments; that they would utilize, or seek to utilize in a prolonged period of education, the leisure time made possible by the improvement in productive efficiency which they brought about. That they do not do so is evidence of the need for the enrichment of their education: they don't know what they are missing.

Backsight at a Turning Point

*Civil Engineering*, Volume XI, Number 4, April 1941 (pp. 199–200)

### Huxley, Thomas Henry 1825–95

English biologist

I ask any one who has adopted the calling of an engineer, how much time he lost when he left school, because he had to devote himself to pursuits which were absolutely novel and strange, and of which he had not obtained the remotest conception from his instructors.

Scientific Education: Notes of an After Dinner Speech

*Macmillan's Magazine*, Volume XX, July 1869 (p. 178)

### Jewett, Frank B. 1879–1949

American physicist

Thus in many directions the engineers of the future, in my judgment, must of necessity deal with a much more certain and more intimate knowledge of the materials with which he works than we have been wont to deal with in the past. As a result of this more intimate knowledge his structures will be more refined and his factors of safety in many directions are bound to be less because the

old elements of uncertainty will have in large measure disappeared.

Problems of Engineers

*Science*, Volume 75, 1932

### Johnson, Eric

No biographical data available

Our present day diplomats are engineers and they take less pleasure from the marble fountain in a formal garden than from the sinking of a tube well or construction of an irrigation system.

*American Engineer*, September 1952 (p. 6)

### Johnson, James Weldon 1871–1938

American writer, poet, and statesman

And so we ride

Over land and tide,

Without a thought of fear —

Man never had

The faith in God

That he has in an engineer!

*Fifty Years & Other Poems*

The Word of An Engineer

The Cornhill Company. Boston, Massachusetts, USA. 1917

### Keyser, Cassius Jackson 1862–1947

American mathematician

The characteristic marks of the great engineer will be four: Magnanimity — Scientific Intelligence — Humanity — Action.

*Mathematical Philosophy: A Study of Fate and Freedom*

Science and Engineering (p. 462)

E.P. Dutton & Company. New York, New York, USA. 1922

### Killian, Jr., James R. 1904–88

American manager

...you can be neither an effective scientist, engineer, executive, economist, nor architect without acquiring understanding of our society and of human relationships.

*American Engineer*, Volume 26, Number 5, May 1956 (p. 3)

### Kingsley, Charles 1819–75

English clergyman and author

So give me the political economist, the sanitary reformer, the engineer; and take your saints and virgins, relics and miracles. The spinning-jenny and the railroad, Cunard's liners and the electric telegraph, are to me... signs that we are, on some points at least, in harmony with the universe...

*The Works of Charles Kingsley* (Volume 2)

Yeast, Chapter 5 (p. 82)

Macmillan & Company Ltd. London, England. 1881

### Kipling, Rudyard 1865–1936

British writer and poet

When the Waters were dried an' the Earth did appear,

("It's all one," says the Sapper),  
The Lord He created the Engineer,  
Her Majesty's Royal Engineer,  
With the rank and pay of a Sapper.

*Collected Verse of Rudyard Kipling*

Sappers

Doubleday, Page. Garden City, New York, USA. 1915

### Layton, Jr., Edwin T.

Historian of technology

The engineer is both a scientist and a businessman. Engineering is a scientific profession, yet the test of the engineer's work lies not in the laboratory, but in the marketplace.

*The Revolt of the Engineers*

Chapter 1 (p. 1)

The Press of Case Western University, Cleveland, Ohio, USA, 1971

The cement binding the engineer to his profession was scientific knowledge. All the themes leading toward a closer identification of the engineer with his profession rested on the assumption that the engineer was an applied scientist. It was the cumulative character of scientific knowledge that gave weight to engineers' claims to be the agents of progress and enlightenment.

*The Revolt of the Engineers*

Chapter 3 (p. 58)

The Press of Case Western University, Cleveland, Ohio, USA, 1971

Engineers, as a rule are not and do not pretend to be philosophers in the sense of building up consistent systems of thought following logically from certain premises. If anything, they pride themselves on being hard-headed practical men concerned only with facts, disdaining mere speculation or opinion. In practice, however, engineers do make many assumptions about the nature of the universe, of man, and of society.

*The Revolt of the Engineers* (p. 9) The Press of Case Western University, Cleveland, Ohio, USA, 1971

### Le Corbusier (Charles-Edouard Jeanneret)

1887–1965

Swiss architect and city planner

The Engineer, inspired by the law of Economy and governed by mathematical calculation, puts us in accord with universal law. He achieves harmony.

Translated by Frederick Etchells

*Towards a New Architecture*

Argument (p. 7)

The Architectural Press. London, England. 1965

Working by calculations, engineers employ geometrical forms, satisfying our eyes by their geometry and our understanding of their mathematics; their work is one the direct line of good art.

Translated by Frederick Etchells

*Towards a New Architecture*

Argument (p. 8)

The Architectural Press. London, England. 1965

Engineers fabricate the tools of their time. Everything, that is to say, except houses and moth-eaten boudoirs.

Translated by Frederick Etchells

*Towards a New Architecture*

The Engineer's Aesthetic and Architecture (p. 18)

The Architectural Press. London, England. 1965

Our engineers are healthy and virile, active and useful, balanced and happy in their work. Our architects are disillusioned and unemployed, boastful or peevish. This is because there will soon be nothing more for them to do. We no longer have the money to erect historical souvenirs. At the same time, we have got to wash!

Translated by Frederick Etchells

*Towards a New Architecture*

The Engineer's Aesthetic and Architecture (pp. 18–19)

The Architectural Press. London, England. 1965

Our engineers produce architecture, for they employ a mathematical calculation which derives from natural law, and their works give us the feeling of HARMONY. The engineer therefore has his own aesthetic, for he must, in making his calculations, qualify some of the terms of his equation; and it is here that taste intervenes. Now, in handling a mathematical problem, a man is regarding it from a purely abstract point of view, and in such a state, his taste must follow a sure and certain path.

Translated by Frederick Etchells

*Towards a New Architecture*

The Engineer's Aesthetic and Architecture (p. 19)

The Architectural Press. London, England. 1965

### Lovejoy, Thomas E.

1941–

Tropical biologist

Genetic engineers don't make new genes, they rearrange existing ones.

In Jamie Murphy

*The Quiet Apocalypse*

*Time*, 13 October 1986 (p. 80)

Natural species are the library from which genetic engineers can work.

In Jamie Murphy

*The Quiet Apocalypse*

*Time*, 13 October 1986 (p. 80)

### Mackay, Charles

1814–89

English poet and journalist

Old King Coal was a merry old soul:

Quoth he, "We travel slow;

I should like to roam the wide world round,

As fast as the wild winds blow."

And he call'd for his skilful engineers;

And soon through hills and vales,

O'er rivers wide, through tunnels vast,

The flying trains like lightning pass'd,



On the ribs of the mighty Rails.

*Ballads and Lyrical Poems*

Old King Cole, l. 28–36

Routledge. London, England. 1856

**Mason, William** 1725–97

English poet

Here midway down, upon the nearer bank  
Plant thy thick row of thorns, and, to defend  
Their infant shoots, beneath, on oaken stakes,  
Extend a rail of elm, securely arm'd  
With speculated paling, in such sort  
As, round some citadel, the engineer  
Directs his sharp stockade.

*The English Garden: A Poem*

Book the Second, l. 288–293

Garland Publications. New York, New York, USA. 1982

**McCullough, David** 1933–

American writer

Engineers who read, who paint, who grow roses and collect fossils and write poetry, who fall asleep in lectures, very human-like, even civilized civil engineers are scattered all through the historical record. Civil engineers have been known to go to the theater, yes indeed; they have taken pleasure in good music and fine wine and the company of charming women. There is even historical evidence of the existence among a few civil engineers of a sense of humor.

Civil Engineers Are People

*Civil Engineering*, December 1978 (p. 47)

**Michener, James A.** 1907–97

American novelist

Scientists are men who dream about doing things. Engineers do them...if you want to be an engineer but find you have ten thumbs, you become a scientist.

*Space*

Chapter III (p. 173)

Random House, Inc. New York, New York, USA. 1982

**Mitchell, Margaret** 1900–49

American author

The South produced statesmen and soldiers, planters and doctors, lawyers and poets, but certainly not engineers or mechanics. Let Yankees adopt such low callings.

*Gone With the Wind*

Part Two, Chapter VIII (p. 147)

Macmillan Publishing Company. New York, New York, USA. 1936

**Morison, George S.** 1842–1903

Civil engineer

We are the priests of the new epoch without superstitions.

Address at the Annual Convention

*Transactions of the American Society of Civil Engineers*, June 1895 (p. 483)

Any man who is thoroughly capable of understanding and handling a machine may be called a mechanical engineer, but only he who knows the principles behind that machine so thoroughly that he would be able to design it or adapt it to a new purpose...can be classed as a civil engineer.

Address at the Annual Convention

*Transactions of the American Society of Civil Engineers*, June 1895

**Morley, Christopher** 1890–1957

American writer

Having made up our mind to become an engineer, we thought it would be a mistake not to take advantage of all possible aid.

*The Powder of Sympathy*

Adventures of a Curricular Engineer (p. 82)

Doubleday, Page & Company. Garden City, New York, USA. 1923

**Murray, Robert Fuller** 1863–94

American-born English writer

They went to the north, they went to the south,

And into the west went they,

Till they found a civil, civil engineer,

And unto him did say: "Now tell to us, thou civil engineer,

If this be fit to drink." And they showed him a cup of the town water,

Which was as black as ink.

*Robert F. Murray: His Poems*

A Ballad of the Town Water

Longmans, Green & Company. London, England. 1894

**Pagnol, Marcel** 1895–74

French film director and playwright

*Il faut se méfier des ingénieurs: ça commence par la machine a courdre, ça finit par la bombe atomique.*

One has to look out for engineers — they begin with sewing machines and end up with the atomic bomb.

*critique des critiques*

Chapter 3 (p. 38)

Nagel. Paris, France. 1949

**Petroski, Henry** 1942–

Civil engineer

The engineer no less than the poet sees the faults in his creations, and he learns more from his mistakes and those of others than he does from all the masterpieces created by himself and his peers.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 82)

St. Martin's Press. New York, New York, USA. 1985

Engineers...are not superhuman. They make mistakes in their assumptions, in their calculations, in their conclusions. That they make mistakes is forgivable; that they catch them is imperative. Thus it is the essence of modern engineering not only to be able to check one's own

work, but also to have one's work checked and to be able to check the work of others.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 52)  
St. Martin's Press. New York, New York, USA. 1985

The work of the engineer is not unlike that of the writer. How the original design for a new bridge comes to be may involve as great a leap of the imagination as the first draft of a novel.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 78)  
St. Martin's Press. New York, New York, USA. 1985

**Pickering, William H.** 1910–2004  
New Zealand-born rocket scientist

We need a new kind of engineer, one who can build bridges to society as well as bridges across rivers.

*The Engineer*—1968  
*The Bridge of ETA Kappa Nu*, May 1968 (p. 7)

**Rae, John A.**  
No biographical data available

...the scientist wants to know chiefly for the sake of knowing; the engineer wants to know for the sake of using.

*Science and Engineering in the History of Aviation Technology and Culture*, Fall 1961 (p. 291)

**Rankine, William John Macquorn** 1820–72  
Scottish engineer and physicist

Thus it is that the commonest objects are by science rendered precious; and in like manner the engineer or the mechanic, who plans and works with understanding of the natural laws that regulate the results of his operations, raise to the dignity of a Sage.

*A Manual of Applied Mechanics*  
Preliminary Dissertation on the Harmony of Theory and Practice in Mechanics (p. 11)  
Charles Griffin and Company. London, England. 1877

**Rawnsley, Hardwicke Drummond** 1851–20  
English clergyman and poet

Yet as I watch the marvelous engineer  
Guess at wind-pressure, and on favoring wind  
Send forth at will her silk from stores within,  
One message for men's souls I seem to hear  
“Let others live to eat, I eat to spin,  
Joy's soul is work: God helps the worker's mind!”

*The Spider's Message*  
At a Gilchrist Lecture, 1. 9–14  
Publisher undetermined

**Salisbury, J. Kenneth**  
No biographical data available

One normally tends to catalog engineers either as analyzers or as synthesizers — the analyzers are the appraisers and evaluators; the synthesizers are those who are creative and ingenious in devising new ways of doing

things. This sharp division is somewhat fallacious, however, because there is considerable overlapping.

Qualities Industry Wants in Its Engineers  
*General Electric Review*, May 1952 (p. 17)

**Sand, George (Amantine-Lucile-Aurore Dupin)** 1804–76  
French novelist and feminist

Another places upon his nose a pair of paper or wooden spectacles; he performs the duty of engineer, — comes, goes, makes a plan, looks at the workmen, draws lines, plays the pedant, cries that everything is being ruined, causes the work to be abandoned and resumed at his will, and directs it at great length and as absurdly as possible.

*The Haunted Pool*  
Chapter IV, *The Cabbage*  
Shameless Hussy Press. San Lorenzo, California. 1976

**Seeger, Peggy** 1935–  
American folk singer

When I was a little girl I wished I was a boy  
I tagged along behind the gang and wore my corduroys.  
Everybody said I only did it to annoy  
But I was gonna be an engineer.  
*Recorded by Frankie Armstrong*

**Seely, Bruce E.**  
No biographical data available

We have the man who fires the boiler and pulls the throttle dubbed a locomotive or stationary engineer; we have the woman who fires the stove and cooks the dinner dubbed the domestic engineer, and it will not be long before the barefooted African, who pounds the mud into the brick molds, will be calling himself a ceramic engineer.

SHOT, the History of Technology, and Engineering Education  
*Technology and Culture*, Volume 36, Number 4, October 1995 (p. 744)

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

For 'tis the sport to have the engineer  
Hoist with his own petard.  
*In Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Hamlet, Prince of Denmark  
Act III, Scene iv, l. 206  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Now there is no calculation that an engineer can make as to the behavior of a girder under a strain, of an astronomer as to the recurrence of a comet, more certain than the calculation that under such circumstances we shall be dismembered unnecessarily in all directions by surgeons who believe the operations to be necessary solely because they want to perform them.

*The Doctor's Dilemma*

Preface on Doctors (p. vi)  
Brentano's. New York, New York, USA. 1920

STRAKER: Very nice sort of place, Oxford, I should think, for people that like that sort of place. They teach you to be a gentleman there. In the Polytechnic they teach you to be an engineer or such like.

*Man and Superman: A Comedy and a Philosophy*  
Act II (p. 40)  
The Heritage Press. New York, New York, USA. No date

**Shute, Nevil** 1899–1960  
English novelist

It has been said that an engineer is a man who can do for ten shillings what any fool can do for a pound...

*Slide Rule: The Autobiography of an Engineer*  
Chapter 3 (p. 64)  
William Morow & Company. New York, New York, USA. 1954

**Slichter, Chas. S.**  
No biographical data available

It grates on me to hear mathematics spoken of as a tool. Mathematics is to the engineer a basal science and not a tool. The spirit of that science is of more value to the engineer than the particular things that can be accomplished. The engineer need not be a mathematician, but he needs to think mathematically, and, to my mind, he needs the power of mathematical thought more than skill in manipulating a few mathematical tools in mechanical fashion.

The Teaching of Mathematics to Students of Engineering  
*Science*, Volume 28, Number 713, August 28, 1908 (p. 263)

**Snow, Charles Percy** 1905–80  
English novelist and scientist

Pure scientists have by and large been dim-witted about engineers and applied science. They couldn't get interested. They wouldn't recognize that many of the problems were as intellectually exacting as pure problems, and that many of the solutions were as satisfying and beautiful. Their instinct — perhaps sharpened in this country by the passion to find a new snobbism wherever possible, and to invent one if it doesn't exist — was to take it for granted that applied science was an occupation for second rate minds. I say this more sharply because thirty years ago I took precisely that line myself.

*The Two Cultures and the Scientific Revolution*  
Chapter III (p. 33)  
Cambridge University Press. New York, New York, USA. 1961

...engineers have to live their lives in an organized community, and however odd they are underneath they manage to present a disciplined face to the world.

*Two Cultures and The Scientific Revolution*  
Chapter III (p. 33)  
Cambridge University Press. New York, New York, USA. 1961

**Stalin, Joseph** 1879–1953  
Soviet Russian political leader and general secretary of Communist Party

The writer is an engineer of the human soul.

In John Gunther  
*Inside Russia Today* (p. 284)  
Harper & Row. New York, New York, USA. 1958

**Starkey, W. L.**  
No biographical data available

The engineer knows that it is easier to analyze a machine than it is to design one. Engineering analysis is simpler than engineering synthesis or design.

The Ingredients of Design  
*Mechanical Engineering*, May 1966

**Stassen, Harold E.**  
No biographical data available

The building of a just and durable peace absolutely requires the sustained strength which flows in such a large measure from the work of engineers.

*American Engineer*, Volume 26, Number 3, March 1956 (p. 3)

**Sterrett, The Right Reverend Frank W.**  
No biographical data available

Many a battle has been lost because men lacked confidence in the outcome. That has not been characteristic of the Engineer. He is accustomed to face hard tasks demanding his best. The rebuilding and restoring of an ordered world present such a problem. It seems to me there is a continuing place of dignity for the Engineer of tomorrow.

*American Engineer*, June 1951 (p. 3)

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

With the civil engineer, more properly so called (if anything can be proper with this awkward coinage), the obligation starts with the beginning. He is always the practical man. The rains, the winds and the waves, the complexity and the fitfulness of nature, are always before him. He has to deal with the unpredictable, with those forces (in Smeaton's phrase) that "are subject to no calculation"; and still he must predict, still calculate them, at his peril.

*Records of a Family of Engineers*  
Chapter II, Part III (p. 261)  
Chatto & Windus. London, England. 1912

The engineer was not only exposed to the hazards of the sea; he must often ford his way by land to remote and scarce accessible places, beyond reach of the mail or the post-chaise, even the tracery of the bridle-path, and guided by natives across bog and heather.

*Records of a Family of Engineers*  
Chapter II, Part I (p. 241)  
Chatto & Windus. London, England. 1912

The duty of the engineer is twofold — to design the work, and to see the work done.

*Records of a Family of Engineers*

Chapter II, Part III (p. 265)

Chatto & Windus. London, England. 1912

The engineer of today is confronted with a library of acquired results; tables and formulae to the value of folios full have been calculated and recorded; and the student finds everywhere in front of him the footprints of the pioneers. In the eighteenth century the field was largely unexplored; the engineer must read with his own eyes the face of nature.

*Records of a Family of Engineers*

Chapter I (p. 212)

Chatto & Windus. London, England. 1912

Even the mechanical engineer comes at last to an end of his figures, and must stand up, a practical man, face to face with the discrepancies of nature and the hiatuses of theory.

*Records of a Family of Engineers*

Chapter II, Part III (p. 261)

Chatto & Windus. London, England. 1912

The seas into which his labours carried the new engineer were still scarce charted, the coasts still dark; his way on shore was often far beyond the convenience of any road; the isles in which he must sojourn were still partly savage. He must toss much in boats; he must often adventure on horseback by the dubious bridle-track through unfrequented wildernesses; he must sometimes plant his lighthouse in the very camp of wreckers; and he was continually enforced to the vicissitudes of outdoor life.

*Records of a Family of Engineers*

Chapter I (p. 213)

Chatto & Windus. London, England. 1912

### Thring, Meredith Wooldridge

Engineer

The creative engineer uses his three brains. He uses his intellectual brain as an applied scientist to understand the laws of science and to see that the things which he invents do not break these laws. He uses his emotional brain for the act of invention, and he uses his physical brain — his brain with his hands, feet and body — for the proper understanding of the design of things that will work.

On the Threshold

*Proceedings of the Institution of Mechanical Engineers*, Volume 179, Part I, 1963–64 (p. 1089)

...this type of engineer is the leaven that leavens the whole of the country. If a country has plenty of creative engineers doing real creative work, it moves forward with the times. If it does not, it falls behind, however good all its other people are.

On the Threshold

*Proceedings of the Institution of Mechanical Engineers*, Volume 179, Part I, 1963–64 (p. 1089)

### US Army Corps of Engineers

Let's try!

Motto

### Verne, Jules 1828–1905

French novelist

Our worthy engineer belonged to that class of men whose brain is always on the boil, like a kettle on a hot fire. In some of these brain kettles the ideas bubble over, in others they just simmer quietly.

In Charles F. Horne (ed.)

*Works of Jules Verne* (Volume 9)

The Underground City, Chapter I, Contradictory Letters

F. Tyler Daniels Company. New York, New York, USA. 1911

### Vollmer, James

No biographical data available

No longer can an engineer expect to work in a given specialty for most of his life. Within five years a problem area of broad interest can be completely mined out partly because of the number of miners, and partly because of the sophistication of their equipment.

Engineering, Growing, Steady State, or Evanescent

*The Bridge of ETA Kappa Nu*, Volume 65, Number 4, August 1969

### von Karman, Theodore 1881–1963

Hungarian-born American engineer

The scientist merely explores that which exists, while the engineer creates what has never existed before.

Creativity Is a Task, Not a Trait

*Machine Design*, May 25, 1967

### Walker, Eric A.

American engineer

...the modern engineer's primary concern should be that of designing and creating the things that society needs, and the spark of genius must be nurtured and developed to the maximum extent.

*Report of the World Congress on Engineering Education*

Engineering Education Around the World, Held June 21–25, 1965

...when an engineer goes to work, he is no longer just an analyst of problems but a synthesizer.

Our Tradition-Bound Colleges

*Engineering Education*, October 1969 (p. 89)

### Ward, Edward

Their Engineer his utmost Cunning try'd,  
But found no Skreen could his Approaches hide;  
For all the various Stratagems he us'd,  
Ended thro' Royal Conduct, still confus'd.

*A Fair Shell, BUT a Rotten Kernel*, l. 233–236

Printed for B. Bragge. London, England. 1705

### Whittier, John 1807–92

American poet

Beat by hot hail, and wet with bloody rain,  
The myriad-handed pioneer may pour,  
And the wild West with the roused North combine  
And heave the engineer of evil with his mine.

*The Complete Poetical Works of John Greenleaf Whittier*

To a Southern Statesman

Houghton Mifflin Company. Boston, Massachusetts, USA. 1894

### Wickenden, W. E.

No biographical data available

...man-made machines and the harnessing of natural resources are progressively relieving humanity from the distress of an oppressively heavy physical toil and are affording improved opportunity for the development of mind and spirit. This is the challenging opportunity — and responsibility — of the engineer and his profession.

*American Engineer*, November 1951 (p. 7)

### Wigner, Eugene Paul 1902–95

Hungarian-born American physicist

Part of the art and skill of the engineer and of the experimental physicist is to create conditions in which certain events are sure to occur.

*Symmetries and Reflections*

Chapter 3 (p. 29)

Ox Bow Press, Woodbridge, Connecticut, USA. 1979

### Wine, Harry A.

No biographical data available

It is the engineer's responsibility to take the new research discoveries as they come along and to put them to work for the benefit of man, and to find ways of doing it that industry and the people can afford.

*American Engineer*, February 17–23, 1952 (p. 4)

### Winsor, Dorothy A.

No biographical data available

Engineers tend to prefer saying that they are being convincing rather than persuasive, and the very fact that they choose a different term suggests that, at least for them, persuasion has associations that are not applicable to the relationship between engineers and their readers.

*Writing Like an Engineer: A Rhetorical Education* (p. 3)

Lawrence Erlbaum Associates. Mahwah, New Jersey, USA. 1996

Scientists and engineers may all study physical reality, but the scientist is usually considered successful if he or she has contributed to theory while the engineer is less interested in generating theory for its own sake than in doing whatever is necessary to design and produce useful artifacts. A scientist who does not understand a phenomenon has failed; but an engineer who does not fully understand a device may still be considered successful if the device works well enough. Scientists

and engineers thus operate with different standards for success that affect the way they argue.

*Writing Like an Engineer: A Rhetorical Education* (p. 10)

Lawrence Erlbaum Associates. Mahwah, New Jersey, USA. 1996

### Woodson, Thomas T.

No biographical data available

The engineer uses all the analysis and quantification he can command; but in the end, the decisions are made subjectively; and there is no avoiding it.

*Introduction to Engineering Design* (p. 204)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

...estimation and order-of-magnitude analysis are the hallmarks of the engineer.

*Introduction to Engineering Design* (p. 107)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1966

### Wright, Harold Bell 1872–1944

American writer

It was the last night out. Supper was over and the men, with their pipes and cigarettes, settled themselves in various careless attitudes of repose after the long day... All were strong, clean-cut, vigorous specimens of intelligent, healthy manhood, for in all the professions, not excepting the army and navy, there can be found no finer body of men than our civil engineers.

*The Winning of Barbara Worth*

Chapter V (pp. 86–87)

The Book Supply Company Publishers. Chicago, Illinois, USA. 1911

### Zener, Clarence 1905–93

American physicist

Engineers have traditionally been people who work toward the attainment of practical goals... [I]f a particular task requires the use of some practical goals. If a particular task requires the use of some particular physical phenomenon, then the more he understands this particular phenomenon the better able he will be to reach his goal. However, as an engineer he could not care less about his understanding per se. In contrast, scientists have traditionally been people whose sole drive was to understand the world around them. They could not care less what use was made of this understanding.

*Engineering in the Future*

*Florida Engineer*, October 1965

## ENGINEERING

### MARTIANS BUILD TWO IMMENSE CANALS IN TWO YEARS

Vast Engineering Works Accomplished in an Incredibly Short Time by Our Planetary Neighbors.

Front page headline

*New York Times*, August 27, 1911

### American Society for Engineering Education

The engineering profession is the channel by which science can greatly improve our way of life, provided it assumes the initiative of leadership rather than the passive role of the hired consultant.

*Goals of Engineering Education, the Preliminary Report* (p. 15)  
American Society for Engineering Education. Washington, D.C. 1968

**Asimov, Isaac** 1920–92  
American author and biochemist

Science can amuse and fascinate us all, but it is engineering that changes the world.

*Isaac Asimov's Book of Science and Nature Quotations* (p. 78)  
Weidenfeld & Nicolson. New York, New York, USA. 1988

### Billington, David

No biographical data available

Engineering or technology is the making of things that did not previously exist, whereas science is the discovering of things that have long existed. Technological results are forms that exist only because people want to make them, whereas scientific results are formulations of what exists independently of human intentions.

*The Tower and The Bridge: The New Art of Structural Engineering*  
Chapter 1 (p. 9)  
Princeton University Press. Princeton, New Jersey, USA. 1983

### British Engineer to the Royal Aeronautical Society

Aeroplanes are not designed by science, but by art in spite of some pretense and humbug to the contrary. I do not mean to suggest that engineering can do without science, on the contrary, it stands on scientific foundations, but there is a big gap between scientific research and the engineering product which has to be bridged by the art of the engineer.

In Walter G. Vincenti  
*What Engineers Know and How They Know It*  
Chapter 1 (p. 4)  
The Johns Hopkins University Press. Baltimore. 1990

**Capp, Al** 1909–79  
American comic strip artist

If half the engineering effort and public interest that go into the research of the American bosom had gone into our guided-missile program, we would now be running hot-dog stands on the moon.

*Reader's Digest*, July 1958 (p. 116)

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

The characteristic feature of our age results from the wedding of science and engineering. It is the working together of disciplined curiosity and purposeful ingenuity to create new materials, new forces, and new

opportunities which powerfully affect our manner of living and ways of thinking.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 1)  
Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

Engineering education is the sine qua non of this technical age. Unless it is effective and adequate our type of civilization cannot go forward. To be effective, it must be progressive, for engineering art is not static; it is very dynamic.

*A Scientist Speaks: Excerpts From Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 49)  
Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

The question of engineering should be of interest not only to those of us who are engineers, but to the entire public which lives in an engineering world.

*A Scientist Speaks: Excerpts From Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 49)  
Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

More recently in the development of a program of biological engineering, based upon physical, chemical, and biological operations, a similar attempt has been made to synthesize an appropriate training for the handling of a great variety of biological situations, whether they be in the food industry or in the hospital or medical or biological research fields. I suspect that there may be other directions in which an analogous approach may be made to simplify the educational program and at the same time increase the power acquired by the student.

*A Scientist Speaks: Excerpts From Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 53)  
Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

**Cross, Hardy** 1885–1959  
American professor of civil and structural engineering

Engineering then is not merely a mathematical science. It must be approached with a sense of proportion and aesthetics.

*Engineers and Ivory Towers*  
The Education of an Engineer (p. 64)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

It is customary to think of engineering as a part of a trilogy, pure science, applied science and engineering. It needs emphasis that this trilogy is only one of a triad of trilogies into which engineering fits.... [T]he second is economic theory, finance and engineering; and the third is social relations, industrial relations, engineering. Many engineering problems are as closely allied to social problems as they are to pure science.

*Engineers and Ivory Towers*  
The Education of an Engineer (p. 56)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**DeSimone, Daniel V.**

No biographical data available

**Cross, Hardy** 1885–1959

American professor of civil and structural engineering

Engineering is a profession, an art of action and synthesis and not simply a body of knowledge. Its highest calling is to invent and innovate.

*Education for Innovation*

Introduction (pp. 1–2)

Pergamon Press. New York, New York, USA. 1968

**Elgerd, Olle I.**

No biographical data available

Engineering is an art of simplification, and the rules — when and how to simplify — are a matter of experience and intuition.

In Robert L. Bailey

*Disciplined Creativity for Engineers*

Table 14-1 (p. 433)

Ann Arbor Science Publishers. Ann Arbor, Michigan, USA. 1978

**Emmerson, G. S.**

No biographical data available

Modern scientific principle has been drawn from the investigation of natural laws, technology has developed from the experience of doing, and the two have been combined by means of mathematical system to form what we call engineering.

*Engineering Education: A Social History* (p. 7)

Publisher undetermined

**Emmet, William LeRoy** 1859–1941

American electrical engineer

There may be said to be two kinds of engineering, that which is essentially creative, and that which is practiced in pursuit of known methods.

*The Autobiography of an Engineer*

Chapter XII (p. 224)

The American Society of Mechanical Engineers. New York, New York, USA. 1940

Engineering is to a very large extent dependent upon detail...

*The Autobiography of an Engineer*

Chapter XII (p. 225)

The American Society of Mechanical Engineers. New York, New York, USA. 1940

**Everitt, W. L.**

No biographical data available

It is easier to distinguish between the “scientific function” and the “engineering function” than to distinguish between the man who should be called a scientist and [he] who should be termed an engineer. Many men perform both functions, and do it very well...

In Panel on Engineering Infrastructure

*Engineering Infrastructure Diagramming and Modeling*

Appendix A (p. 73)

National Academy Press. Washington, D.C. 1986

**Ferguson, Eugene S.**

American technological historian

Engineering drawings are expressed in a graphic language, the grammar and syntax of which are learned through use; it also has idioms that only initiates will recognize. And because the drawings are neatly made and produced on large sheets of paper, they exude an air of great authority and definitive completeness.

*Engineering and the Mind's Eye*

Chapter 1 (p. 3)

The MIT Press. Cambridge, Massachusetts, USA. 1992

**Fish, J. C. L.**

No biographical data available

Every engineering structure, with few exceptions, is first suggested by economic requirements; and the design of every part, excepting few, and of the whole is finally judged from the economic standpoint.

*Engineering Economics: First Principles*

Preface (p. v)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1915

**Flinn, Alfred D.**

No biographical data available

In fact “engineering” now often signifies a new system of thought, a fresh method of attack upon the world’s problems the antithesis of traditionalism, with its precedents and dogmas.

*Leadership in Economic Progress*

*Civil Engineering*, Volume 2, Number 4, April 1932 (p. 242)

**Florman, Samuel C.** 1925–

Author and professional engineer

When engineers attempt to write creatively...the results are usually disastrous.

*Engineering and the Liberal Arts: A Technologist's Guide to History,*

*Literature, Philosophy, Art, and Music*

Chapter Four (p. 92)

McGrawHill Book Company, Inc. New York, New York, USA. 1968

Engineering is committed to the prospect of new discoveries, and engineers still look eagerly to ever receding horizons. We are tinkerers at heart; we cannot keep our hands off the world. However, the over-optimism, and perhaps even arrogance, that had been creeping into the engineering view is being replaced by a more thoughtful but still enthusiastic commitment to change.

*The Civilized Engineer*

Chapter 5 (p. 76)

St. Martin's Press. New York, New York, USA. 1985

Engineering is superficial only to those who view it superficially. At the heart of engineering lies existential joy.

*The Existential Pleasures of Engineering*

Chapter 8 (p. 101)

St. Martin's Press. New York, New York, USA. 1976

As engineering becomes increasingly central to the shaping of society, it is ever more important that engineers become introspective. Rather than merely revel in our technical successes, we should intensify our efforts to explore, define, and improve the philosophical foundations of our professions.

*The Civilized Engineer*

Introduction (p. xii)

St. Martin's Press. New York, New York, USA. 1985

...without imagination, heightened awareness, moral sense, and some reference to the general culture, the engineering experience becomes less meaningful, less fulfilling than it should be.

*The Civilized Engineer*

Chapter 2 (p. 24)

St. Martin's Press. New York, New York, USA. 1985

**Friedel, Robert**

No biographical data available

Technology is simply not...largely the province of engineers, and "engineering" is certainly not coextensive with "technology."

Engineering in the 20<sup>th</sup> Century*Technology and Culture*, October 1968, Special Issue (p. 669)**Fung, Y. C. B.** 1919–

Chinese scientist

...for engineering, the method is scientific, the mode is quantitative, the dictum is economy, the concern is human.

In David L. Arm (ed.)

*Journeys in Science: Small Steps, Great Strides*

An Approach to Bioengineering (p. 108)

University of New Mexico Press. Albuquerque, New Mexico, USA.

1967

**Gillette, H. P.**

No biographical data available

Engineering is the conscious application of science to the problems of economic production.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Grinter, L. E.**

No biographical data available

Engineering is far from static, for it is essentially a creative profession.

Report on Evaluation of Engineering Education(1952–1955)

*Journal of Engineering Education*, Volume 46, Number 1, September 1955**Hamilton, L. L.**

No biographical data available

It has been my lot for many years

To read reports by engineers:

Of projects, jobs, and tasks and such

From which I should learn very much.

Alas! alack! I am undid

And maybe soon I'll flip my lid,

Unless someone can help me out

And tell me what they're all about.

They do not mean what they say

But start in the middle and go each way.

The outline is missing, the form is lax

No useful punctuation, or correct syntax.

The object is a secret beautifully kept,

And conclusions avoided in manner adept.

Oh here I go, I've blown my top.

About a thing no one can stop.

Just let me say before I'm muzzled,

I'm not the only one who's puzzled.

Engineer Report

*American Engineer*, Volume 29, Number 6, June 1959 (p. 4)**Hammond, H. P.**

No biographical data available

Throughout the whole fabric of engineering education, therefore, there must be interwoven with instruction in scientific principles...the encouragement of creative talent...

Engineering Education After the War

*Journal of Engineering Education*, Volume 43, Number 9, May 1944

(p. 599)

...the engineering profession clearly cannot isolate itself from this complex of men and functions as a well-defined caste...

Report of Committee on Aims and Scope of Engineering Curricula

*Journal of Engineering Education*, Volume 30, Number 7, March 1940**Hammond, John Hays** 1855–1936

American mining engineer

Chemical engineering more than any other, may be called the engineering of the future. It is the result of an evolution in which most of the other branches have played a part.... The chemical engineer stands today on the threshold of a vast virgin realm; in it lie the secrets of life and prosperity for mankind in the future of the world.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

The Story of Chemical Engineering (p. 176)

Centennial of Engineering. Chicago, Illinois. 1952

**Harris, A. J.**

No biographical data available

The foundation of engineering is knowledge of materials, not, as engineers are so often apt to preach, a knowledge



of mathematics...knowledge of what [materials] are made of, how they are made, how they are shaped, how you fit them together, how they stand up to stress, how they break, how they catch fire, how they react to all the various agencies of ruin which are perpetually nibbling at them, how in due course they fall down.

Architectural Misconceptions of Engineering 3<sup>rd</sup> Series  
*Journal of the Royal Institute of British Architects*, Volume 68 (p. 130)

### Hellmund, R. E.

No biographical data available

Engineering is an activity other than pure manual and physical work which brings about the utilization of the materials and laws of nature for the good of humanity.

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### Hicks, Beatrice Alice 1919–79

American engineer

Women think that an engineer is a man in hip boots building a dam. They don't realize that 95 percent of engineering is done in a nice air-conditioned office.

*Mademoiselle*, 1952

### Holloman, J. Herbert

No biographical data available

There are deeply held feelings that engineering education has become too science-based and has become removed to some degree from the creative act that the engineer or inventor has to perform to bring the results of science and technology to the benefit of society.

In Daniel V. DeSimone  
*Education for Innovation*  
Creative Engineering and the Needs of Society (p. 23)  
Pergamon Press. New York, New York, USA. 1968

... we cannot effectively talk about the needs of engineering until we have reflected on the needs of society.

In Daniel V. DeSimone  
*Education for Innovation*  
Creative Engineering and the Needs of Society (p. 23)  
Pergamon Press. New York, New York, USA. 1968

### Hoover, Herbert 1874–1964

31<sup>st</sup> president of the United States

From the point of view of accuracy and intellectual honesty the more men of engineering background who become public officials, the better for representative government.

*The Memoirs of Herbert Hoover* (Volume 1)  
The Profession of Engineering (p. 133)  
The Macmillan Company. New York, New York, USA. 1952

... engineering without imagination sinks to a trade.

*The Memoirs of Herbert Hoover* (Volume 1)  
The Profession of Engineering (p. 132)  
The Macmillan Company. New York, New York, USA. 1952

### Hoover, T. J.

No biographical data available

### Fish, J. C. L.

No biographical data available

Engineering is the professional and systematic application of science to the efficient utilization of natural resources to produce wealth.

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (p. 8)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

... we may say that we have already considered with disfavor the possibility of the universe having been planned by a biologist or an engineer; from the intrinsic evidence of his creation, the Great Architect of the Universe now begins to appear as a pure mathematician.

*The Mysterious Universe*  
Chapter V (p. 165)  
The Macmillan Company. New York, New York, USA. 1932

### Kiddle, Alfred W.

No biographical data available

Engineering is the art or science of utilizing, directing or instructing others in the utilization of the principles, forces, properties and substances of nature in the production, manufacture, construction, operation and use of things...or of means, methods, machines, devices and structures...

In Ralph J. Smith  
*Engineering as a Career*  
Chapter 2 (p. 7)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### Kipling, Rudyard 1865–1936

British writer and poet

Good mornn, M'Andrew!

Back again?

An' how's your bilge to-day?

Miscallin' technicalities but handlin' me my chair

To drink Madeira wi' three Earls —

the auld Fleet Engineer

That started as a boiler-whelp —

when steam and he were low.

*Collected Verse of Rudyard Kipling*  
McAndrew's Hymn (p. 35)  
Doubleday, Page. Garden City, New York, USA. 1915

### Kirkpatrick, Sidney D.

No biographical data available

Chemical engineering is that branch of engineering concerned with the development and application of manufacturing processes in which chemical or certain physical

changes of material are involved. These processes may usually be resolved into a coordinated series of unit physical operations and unit chemical processes. The work of the chemical engineer is concerned primarily with the design, construction and operation of equipment and plants in which these unit operations and processes are applied. Chemistry, physics and mathematics are the underlying sciences of chemical engineering, and economics its guide in practice.

In Albert B. Newman

Development of Chemical Engineering Education in the United States  
*American Institute of Chemical Engineers Transactions*, Volume 34,  
Number 3a, July 25, 1938 (pp. 6–7)

### Lindsay, S. E.

No biographical data available

Engineering is the practice of safe and economic application of the scientific laws governing the forces and materials of nature by means of organization, design and construction, for the general benefit of mankind.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

### Little, Arthur D.

No biographical data available

Chemical engineering as a science...is not a composite of chemistry and mechanical and civil engineering, but a science of itself, the basis of which is those unit operations which in their proper sequence and coordination constitute a chemical process as conducted on the industrial scale. These operations, as grinding, extracting, roasting, crystallizing, distilling, air-drying, separating, and so on, are not the subject matter of chemistry as such nor of mechanical engineering. Their treatment in the quantitative way...and...the materials and equipment concerned in them is the province of chemical engineering. It is this selective emphasis on the unit operations themselves in their quantitative aspects that differentiates chemical engineering from industrial chemistry, which is concerned primarily with general processes and products.

In Terry S. Reynolds

Special Issue, Defining Professional Boundaries: Chemical Engineering in the Early 20<sup>th</sup> Century

*Technology and Culture*, October 1968 (p. 709)

### Lower, Lennie 1903–47

Australian humorist

Talk of iron! We knew a man who had so much iron that he was full of nuts and bolts. Matter of fact, he lived on nuts and bolted his meals. After he was operated on for appendicitis he had to be riveted. If he wanted to turn around, he had to use a spanner. Threw himself under a

train and wrecked the train. Rusted away after a long and peaceful life, and was pronounced dead by one of the best engineers in the country.

*Here's Another*

Lonely Sardine (p. 102)

Publisher undetermined

### Mailer, Norman 1923–

American author

Physics was sex, conception and the communion of the family — engineering was getting the eggs out on time.  
...physics was love and engineering was marriage.

*Of a Fire on the Moon*

Part II, Chapter I, Section v (p. 178)

Little, Brown and Company. Boston, Massachusetts, USA. 1969

### McCune, Francis K. ?–2000

Nuclear engineer

The characteristics of a productive facility and the signals from a social system furnish very specific facts which must become every bit as much a part of an engineering idea as any technology or scientific principle...

*Elements of Competitive Engineering*

1965 Engineering Deans' Symposium, Pamphlet by General Electric Company. No date

Engineering's prime mission is the creation of technical things and services useful to man.

*Elements of Competitive Engineering*

1965 Engineering Deans' Symposium, Pamphlet by General Electric Company. No date

...at the very core of engineering there is just one thing — an act of creative thought, or in other words the process of having an idea.

*Elements of Competitive Engineering*

1965 Engineering Deans' Symposium, Pamphlet by General Electric Company. No date

### Morison, George S. 1842–1903

Civil engineer

Accurate engineering knowledge must succeed commercial guesses.

Address at the Annual Convention

*Transactions of the American Society of Civil Engineers*, June 1895 (p. 474)

### O'Brien, M. P.

No biographical data available

The activity characteristic of professional engineering is the design of structures, machines, circuits, or processes, or of combinations of these elements into systems or plants and the analysis and prediction of their performance and costs under specified working conditions.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Parsons, William Barclay**

No biographical data available

It is not the technical excellence of an engineering design which alone determines its merit but rather the completeness with which it meets the economic and social needs of its day.

In James Kip Finch

*Engineering and Western Civilization* (p. vii)

Address at the Inauguration of the Columbia Student Chapter of the American Society of Civil Engineers, 1927

**Petroski, Henry** 1942–

Civil engineer

Engineering, like poetry, is an attempt to approach perfection. And engineers, like poets, are seldom completely satisfied with their creations. They notice, even if no one else does, the word that is not quite *le mot juste* or the hairline crack that blemishes the structure.

*To Engineer Is Human: The Role of Failure in Successful Design* (p. 83)  
St. Martin's Press. New York, New York, USA. 1985

**Piaget, Jean** 1896–1980

Swiss psychologist

Engineering — is more pragmatic and less — relatively less — speculative; it is production, operation, and management, as well as research, analysis, planning and design. Its goal is usually a clearly specified utility such as public health, communication, power, transportation, or housing, rather than the attainment of abstract truth.

*Phi Kappa Phi Journal*

In Thomas C. Dean

Challenges in Higher Education

**Rogers, G. F. C.**

Engineer

Engineering refers to the practice of organizing the design and construction [and, I would add, operation] of any artifice which transforms the physical world around us to meet some recognized need.

*The Nature of Engineering: A Philosophy of Technology* (p. 51)

Macmillan & Company Ltd. London, England. 1983

**Scott, Chas F.**

No biographical data available

Engineering is a mode of thinking.

The Aims of the Society

*Engineering Education*, Volume 12, Number 3, November 1921 (p. 103)

**Shewhart, Walter Andrew** 1891–1967

American statistician

The fundamental difference between engineering with and without statistics boils down to the difference between the use of a scientific method based upon the concept of laws of nature that do not allow for chance or

uncertainty and a scientific method based upon the concepts of laws of probability as an attribute of nature.

University of Pennsylvania Bicentennial Conference, September 16–21, 1940

**Smith, R. B.**

No biographical data available

Engineering is the art of skillful approximation; the practice of gamesmanship in the highest form. In the end it is a method broad enough to tame the unknown, a means of combing disciplined judgment with intuition, courage with responsibility, and scientific competence within the practical aspects of time, of cost, and of talent. This is the exciting view of modern-day engineering that a vigorous profession can insist be the theme for education and training of its youth. It is an outlook that generates its strength and its grandeur not in the discovery of facts but in their application; not in receiving, but in giving. It is an outlook that requires many tools of science and the ability to manipulate them intelligently. In the end, it is a welding of theory and practice to build an early, strong, and useful result. Except as a valuable discipline of the mind, a formal education in technology is sterile until it is applied.

Professional Responsibility of Engineering

*Mechanical Engineering*, Volume 86, Number 1, January 1964

Engineering is a method and a philosophy for coping with that which is uncertain at the earliest possible moment and to the ultimate service to mankind. It is not a science struggling for a place in the sun. Engineering is extrapolation from existing knowledge rather than interpolation between known points. Because engineering is science in action — the practice of decision making at the earliest moment — it has been defined as the art of skillful approximation. No situation in engineering is simple enough to be solved precisely, and none worth evaluating is solved exactly. Never are there sufficient facts, sufficient time, or sufficient money for an exact solution, for if by chance there were, the answer would be of academic and not economic interest to society. These are the circumstances that make engineering so vital and so creative.

Engineering Is...

*Mechanical Engineering*, Volume 86, Number 5, May 1964

**Smith, Willard A.**

No biographical data available

Engineering is the science of economy, of conserving the energy, kinetic and potential, provided and stored up by nature for the use of man. It is the business of engineering to utilize this energy to the best advantage, so that there may be the least possible waste.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (pp. 6–7)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Solzhenitsyn, Aleksandr Isayevich** 1918–  
Russian novelist and historian

There are all kinds of engineers. Some of them here have built successful careers selling soda water.

Translated by Thomas P. Whitney

*The First Circle*

Chapter 4 (p. 15)

Harper & Row. New York, New York, USA. 1968

**Spencer-Brown, George** 1923–  
English mathematician and polymath

Doing engineering is practicing the art of the organized forcing of technological change.

Engineer-Scientist

*Electronics*, Volume 32, Number 47, November 20, 1959 (p. 53)

**Sporn, Philip** 1896–1978  
American engineer

The scientist usually works — but very seldom under the pressure of a timetable — in a field of his special interest, in which he has generally chosen to stake out a narrow sector for his own specialization. The engineer, on the other hand, while also operating within the area of his own competence, has to tackle a variety of problems, some of which may be new to him, but to which he has to apply his scientifically based knowledge and skill to produce workable and practical solutions; this work includes economics and involves both analysis and synthesis, generally within a rigid time limit. This is technology and engineering.

*Foundations of Engineering: Cornell College Engineering Lectures,*

*Spring 1963* (pp. 12–13)

The Macmillan Company. New York, New York, USA. 1963

**Steinmetz, Charles Proteus** 1865–1923  
German-American electrical engineer and inventor

Engineering investigations evidently are of no value, unless they can be communicated to those to whom they are of interest.

In John Charles Lounsbury Fish

*The Engineering Method* (p. 290)

Stanford University Press. Standfor, California, USA. 1950

Indeed, the most important part of engineering work — and also of other scientific work — is the determination of the method of attacking the problem, whatever it may be.

In John Charles Lounsbury Fish

*The Engineering Method* (p. 1)

Stanford University Press. Standfor, California, USA. 1950

**Stott, Henry G.**  
American engineer

Engineering is the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race.

In Ralph J. Smith

*Engineering as a Career*

Chapter 2 (p. 6)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1956

**Taylor, E. S.**

American aircraft engine pioneer

The analytical part of an engineering education now seems to be considered the most difficult, most challenging part, while the remainder of engineering is considered to be an exercise of a lower order, conducted in a physical region located nearer the seat of the pants than the brain.

Report on Engineering Design

*Journal of Engineering Education*, Volume 51, Number 8, April 1961 (p. 655)

**The Federated American Engineering Society**

Engineering is the science of controlling the forces and of utilizing the materials of nature for the benefit of man, and the art of organizing and of directing human activities in connection therewith.

*Preamble to Constitution*

**Thring, Meredith Wooldridge**

Engineer

The roots of the tree are pure science...and a peculiar thing coming in here, called aesthetics, about which the architects and some other people are very concerned. The trunk of the tree is called human understanding and, in particular, applied mathematics. The branches of the tree are engineering and the extreme twigs are the growing new fields of engineering in which things are really happening...pure science is the roots which feed the tree but the actual growth of new life comes on the twigs of extremely specialized engineering. Some sort of scheme of knowledge like this is important.

On the Threshold

*Proceedings of the Institution of Mechanical Engineers*, Volume 179, Part I, 1964–65 (pp. 1089, 1091)

**Tredgold, Thomas** 1788–1829

English engineer

[Engineering is the] art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, harbors, moles, breakwaters, and light-houses, and in the art of navigation by artificial power for the purposes of commerce, and in the drainage of cities and towns.

*Institution of Civil Engineers*

Charter 1828

**Waddell, John Alexander Low** 1854–1938

American bridge engineer

**Skinner, Frank W.**

American engineer

Engineering is the science and art of efficient dealing with materials and forces...it involves the most economic design and execution...assuring, when properly performed, the most advantageous combination of accuracy, safety, durability, speed, simplicity, efficiency, and economy possible for the conditions of design and service.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.)

*Vocational Guidance in Engineering Lines*

Chapter II (p. 6)

The Mack Printing Company, Easton, Pennsylvania, USA. 1933

Engineering is more closely akin to the arts than perhaps any other of the professions; first, because it requires the maximum of natural aptitude and of liking for the work in order to offset other factors; second, because it demands, like the arts, an almost selfless consecration to the job; and, third, because out of the hundreds who faithfully devote themselves to the task, only a few are destined to receive any significant reward — in either money or fame.

In J.A.L. Waddell, Frank W. Skinner and Harold E. Wessman (eds.)

*Vocational Guidance in Engineering Lines*

Foreword (p. VI)

The Mack Printing Company, Easton, Pennsylvania, USA. 1933

**Walker, Eric A.**

American engineer

Science aims at the discovery, verification, and organization of fact and information...engineering is fundamentally committed to the translation of scientific facts and information to concrete machines, structures, materials, processes, and the like that can be used by men.

Engineers and/or Scientists

*Journal of Engineering Education*, Volume 51, February 1961 (pp. 419–421)

**Wellington, Arthur Mellen** 1847–1895

Civil engineer

...to define it rudely but not inaptly, [engineering] is the art of doing that well with one dollar which any bungler can do with two after a fashion.

*The Economic Theory of the Location of Railways: An Analysis of the Conditions Controlling the Laying out of Railways to Effect This Most Judicious Expenditure of Capital*

Introduction (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1887

**Winsor, Dorothy A.**

No biographical data available

Engineering is knowledge work. That is, although the goal of engineering may be to produce useful objects, engineers do not construct such object themselves. Rather they aim to generate knowledge that will allow such objects to be built.

*Writing Like an Engineer: A Rhetorical Education* (p. 5)

Lawrence Erlbaum Associates. Mahwah, New Jersey, USA. 1966

**ENLIGHTENMENT****Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Every item of natural history is both a joy to behold and an instrument of our potential enlightenment.

*Leonardo's Mountain of Clams and the Diet of Worms*

Part III, Chapter 9 (p. 204)

Harmon Brown, New York, New York, USA. 1998

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

The wealth and variety of physics itself, the greater wealth and variety of the natural sciences taken as a whole, the more familiar, yet still strange and far wider wealth of the life of the human spirit, enriched by complementary, not at once compatible ways, irreducible one to the other, have a greater harmony. They are the elements of man's sorrow and his splendor, his frailty and his power, his death, his passing, and his undying needs.

*Science and the Common Understanding*

Chapter 5 (p. 82)

Simon & Schuster. New York, New York, USA. 1954

**ENTOMOLOGIST****Cable, George W.** 1844–1925

American author and reformer

When, hypocritically clad in dressing-gown and slippers, I stopped at my guest's inner door and Fontenette opened it just enough to let me enter, I saw, indeed, a wonderful sight. The entomologist had lighted up the room, and it was filled, filled! with gorgeous moths as large as my hand and all of a kind, dancing across one another's airy paths in a bewildering maze or alighting and quivering on this thing and that. The mosquito-net, draping almost from ceiling to floor, was beflowered with them majestically displaying in splendid alternation their upper and under colors, or, with wings lifted and vibrant, tipping to one side and another as they crept up the white mesh, like painted and gilded sails in a fairies' regatta.

*Strong Hearts*

The Entomologist

Chapter X (p. 130)

MSS Information Corporation. New York, New York, USA. 1970

**Cuppy, Will** 1884–1929

American humorist and critic

Entomologists are people who want Ants around. If there are no Ants around, they will go where Ants are.

*How to Attract the Wombat*

The Ant (fn 1, p. 137)

Rinehart & Company, Inc. New York, New York, USA. 1949

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Every traveler is a self-taught entomologist.

*The Autocrat of the Breakfast-Table* (p. 278)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Mattingly, P. F.**

No biographical data available

There is a popular superstition to the effect that museum entomologists devote their time to the fabrication of mommets. These are small, artificially constructed images into which pins are stuck, mainly with a view to making life less tolerable for other entomologists. The museum entomologist calls them species, but they bear little resemblance to the species actually encountered in nature. Such a view is exaggerated, but it may contain a grain of truth. Most of us could probably do more to give our species reality by giving thought to the distributional data available to us than in fact we do.

Towards a Zoogeography of the Mosquitoes

*Systematics Publication*, Volume 4, 1962 (p. 17)

**Victim, A.**

No biographical data available

O gentle reader drop a tear

For one beneath this stone

In life he named 7,000 bugs

To science, all unknown.

Obituary of an Entomologist

*Entomological News*, Volume 13, Number 9, 1902 (p. 297)

**Wheeler, William Morton** 1865–1937

American entomologist

An entomologist no less interested in his fellow men than in the insects may with increasing years of observation find increasing resemblance between the two — some insects seeming almost human and some humans behaving very much like insects.

Translated by William Morton Wheeler

*The Foibles of Insects*

The Physiognomy of Insects (p. 3)

Alfred A. Knopf. New York, New York, USA. 1928

**ENTOMOLOGY****Cable, George W.** 1844–1925

American author and reformer

He had lost life by making knowledge its ultimate end, and was still delving on, with never a laugh and never a cheer, feeding his emaciated heart on the locusts and wild honey of entomology and botany...

*Strong Hearts*

The Entomologist

Chapter III (p. 100)

MSS Information Corporation. New York, New York, USA. 1970

**Evans, Howard Ensign** 1919–2002

Entomologist

If insects were the size of birds, or people the size of mice, “bug watchers” would be as prevalent as bird watchers, and entomologists would command the budget of the Defense Department. But as it is, entomologists have a good deal of trouble explaining what their science is all about, or for that matter how it is spelled.

*The Pleasures of Entomology: Portraits of Insects and the People Who Study them*

Preface (p. 9)

Smithsonian Institution Press. Washington, D.C. 1985

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

I suppose you are an entomologist? — I said with a note of interrogation. — Not quite so ambitious as that, sir. I should like to put my eye on the individual entitled to that name! A society may call itself an Entomological Society, but a man who arrogates such a broad title as that to himself, in the present state of science, is a pretender sir, a dilettante, an imposter! No man can be truly called an entomologist, sir; the subject is too vast for any single human intelligence to grasp.

*The Poet at the Breakfast-Table*

Chapter II (p. 49)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Howard, Leland O.** 1857–1950

American entomologist

People think entomologists have small minds because they interest themselves in small animals.

In Edwin Teale

*Circle of the Seasons*

February 19 (p. 34)

Dodd, Mead & Company. New York, New York, USA. 1953

**Kirby, William** 1759–1850

Clergyman and entomologist

...in the minds of most men...an Entomologist is synonymous with everything futile and childish. [Involved in a] science which, in nine companies out of ten companies with which he may associate, promises to signalise him as an object of pity or contempt.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Preface to the First Edition (p. ix)

Longman, Green, Longman & Roberts. London, England. 1860

**Nash, Ogden** 1902–71

American writer of humorous poetry

He was an eminent etymologist,

which is to say he knew nothing but bugs.

He could tell the Coleoptera from the Lepidoptera,

And the Aphidae and the Katydididae

from the Grasshoptera.

*Verses from 1929 On*

The Strange Case of the Entomologist's Heart  
Little, Brown & Company. Boston, Massachusetts, USA. 1959

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Entomology extends the limits of being in new directions, so that I walk in nature with a sense of greater space and freedom. It suggests, besides, that the universe is not rough-hewn, but perfect in its details.

*Excursions*

Natural History of Massachusetts (p. 42)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1887

**Wood, Robert William** 1868–1955

American physicist

The Plover and the Clover can be told apart with ease,  
By paying close attention to the habit of the Bees,  
For En-to-molo-gists aver, the Bee can be in Clover,  
While Ety-molo-gists concur, there is no B in Plover.

*How to Tell the Birds from the Flowers and Other Wood-Cuts*

The Clover. The Plover (p. 3)  
Dover Publications, Inc. New York, New York, USA. 1959

## ENTROPY

**Clasius, Rudolph** 1822–88

German mathematician

For the present I will confine myself to announcing as a result of my argument that if we think of that quantity which with reference to a single body I have called its entropy, as formed in a consistent way, with consideration of all the circumstances, for the whole universe, and if we use in connection with it the other simpler concept of energy, we can express the fundamental laws of the universe which correspond to the two fundamental laws of the mechanical theory of heat in the following simple form. 1. The energy of the universe is constant. 2. The entropy of the universe tends toward a maximum.

Ueber verschiedene für die Anwendung bequeme Formen der Hauptgleichungen der mechanischen Wärmetheorie  
*Annalen der Physik und Chemie*, Volume 125, 1865

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

An important property of most cellular automata is that their rules are irreversible, *i.e.*, not symmetric in time. They thus escape from the strictures of the second law of thermodynamics, which is based on reversibility in the underlying microscopic dynamics. For this reason...the entropy of automaton states can decrease, and order can spontaneously appear out of disorder.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 5 (p. 67)  
Simon & Schuster. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The direction of time's arrow could only be determined by that incongruous mixture of theology and statistics known as the second law of thermodynamics...

*The Nature of the Physical World*

Chapter XV (p. 338)  
The Macmillan Company. New York, New York, USA. 1930

From the point of view of philosophy of science the conception associated with entropy must I think be ranked as the greatest contribution of the nineteenth century to scientific thought.

*The Nature of the Physical World*

Chapter V (p. 103)  
The Macmillan Company. New York, New York, USA. 1930

**Gamow, George** 1904–68

Russian-born American physicist

Holy Entropy!... It's boiling!

*Mr. Tompkins in Paperback*

Chapter 9 (p. 110)  
At The University Press. Cambridge, England. 1965

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The fabric of the universe weathers, crumbles, and dissolves with age, and no restoration or reconstruction is possible. The second law of thermodynamics compels the material universe to move ever in the same direction along the same road, a road which ends only in death and annihilation.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1929*

The Physics of the Universe (p. 178)  
Government Printing Office. Washington, D.C. 1930

**Jungck, J. R.**

No biographical data available

...entropy will not be the nemesis of evolution; on the contrary, the selection of entropy-driven processes in biological systems has been responsible for the evolution of the sophisticated organization of contemporary biota.

In D.J. Depew and B.H. Weaver (eds.)

*Molecular Evolution: Prebiological and Biological*

Thermodynamics and Self Assembly: An Empirical Example Relating to Entropy and Evolution (p. 107)  
Plenum Press. New York, New York, USA. 1972

**Lappe, Marc** 1943–2005

Author, medical ethicist, and toxicologist

Living organisms are engaged in a constant battle to maintain themselves against the forces of entropy and decay.

*Evolutionary Medicine: Rethinking the Origins of Disease* (p. 51)

Sierra Club Books. San Francisco, California, USA. 1994

**Leacock, Stephen** 1869–1944  
Canadian humorist

All physicists sooner or later say, “Let us call it Entropy...”

*The Boy I Left Behind Me*  
Chapter VI (p. 175)

The Bodley Head. London, England. 1947

**Musser, George**

Nobiographical data available

No demon or mortal has ever challenged the second law of thermodynamics and won.

Taming Maxwell’s Demon

*Scientific American*, Volume 280, Number 2, February 1999 (p. 24)

**Planck, Max** 1858–1947

German physicist

It would be absurd to assume that the validity of the second law depends in any way on the skill of the physicist or chemist in observing or experimenting. The gist of the second law has nothing to do with experiment; the law asserts briefly that there exists in nature a quantity which changes always in the same sense in all natural processes. The proposition stated in this general form may be correct or incorrect; but whichever it may be, it will remain so, irrespective of whether thinking and measuring beings exist on earth or not. . . . The limitations to the law, if any, must lie in the same province as its essential idea, in the observed Nature, and not in the Observer. That man’s experience is called upon in the deduction of the law is of no consequence; for that is, in fact, our only way of arriving at knowledge of natural law. But the law once discovered must receive recognition of its independence, at least in so far as Natural Law can be said to exist independent of Mind. Whoever denies this must deny the possibility of natural science.

*Treatise on Thermodynamics* (p. 106)

Longmans, Green & Company. London, England. 1903

**Sears, Francis Weston** 1898–1975

American physicist

There is no concept in the whole field of physics which is more difficult to understand than is the concept of entropy, nor is there one which is more fundamental.

*Principles of Physics I: Mechanics, Heat, and Sound* (2<sup>nd</sup> edition) (p. 459)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1944

**von Neumann, John** 1903–57

Hungarian-American mathematician

You should call it entropy for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, no one knows what entropy really is, so in a debate you will always have the advantage.

In M. Tribus and E.C. McIrvine

Energy and Information

*Scientific American*, Volume 224, Number 3, 1971 (p. 180)

**Wiener, Norbert** 1894–1964

American mathematician

...the characteristic tendency of entropy is to increase.

As entropy increases, the universe, and all closed systems in the universe, tend naturally to deteriorate and lose their distinctiveness, to move from the least to the most probable state, from a state of organization and differentiation in which distinctions and forms exist, to a state of chaos and sameness.

*The Human Use of Human Beings*

Preface (p. 12)

Da Capo Press. New York, New York, USA. 1988

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

...entropy is an anthropomorphic concept...

Quoted by E.T. Jaynes

Gibbs vs. Boltzmann Entropies

*American Journal of Physics*, Volume 33, Number 5, May 1965 (p. 398)

## ENVIRONMENT

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Not only the pretty birds, but also the predators and reptiles, the ugly and unloved, the organic and inorganic — all belong here, with us, on the same small planet.

In Joseph Wood Krutch

*The Great Chain of Life*

Preface

Houghton Mifflin Company. Boston, Massachusetts, USA. 1977

Mr. Krutch’s contribution...has been his recognition and communication of the discovery that the natural world must be treated as an equal partner. That a world entirely conquered by technology, entirely dominated by industrial processes, entirely occupied by man and machine, would be a world unfit to live in. Perhaps impossible to live in.

In Joseph Wood Krutch

*The Great Chain of Life*

Preface

Houghton Mifflin Company. Boston, Massachusetts, USA. 1977

**Bartram, William** 1739–1823

American naturalist

This world, as a glorious apartment of the boundless palace of the Sovereign Creator, is furnished with an infinite variety of animated scenes, inexpressibly beautiful and pleasing, equally free to the inspection and enjoyment of all his creatures.



*Travels and Other Writings*

Introduction (p. 13)

Library of America. New York, New York, USA. 1996

**Commoner, Barry** 1917–

American biologist, ecologist, and educator

The environment makes up a huge, enormously complex living machine that forms a thin dynamic layer on the earth's surface, and every human activity depends on the integrity and the proper functioning of this machine. Without the photosynthetic activity of green plants, there would be no oxygen for our engines, smelters, and furnaces, let alone support for human and animal life. Without the action of the plants, animals, and microorganisms that live in them, we could have no pure water in our lakes and rivers. Without the biological processes that have gone on in the soil for thousands of years, we could have neither food crops, oil, nor coal. This machine is our biological capital, the basic apparatus on which our total productivity depends. If we destroy it, our most advanced technology will become useless and any economic and political system that depends on it will founder. The environmental crisis is a signal of this approaching catastrophe.

*The Closing Circle: Nature, Man & Technology*

Chapter 2 (pp. 16–17)

Alfred A. Knopf. New York, New York, USA. 1971

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Each cell, each living being has a multipotential biochemical personality but the physiochemical environment determines the one under which it manifests itself.

*Louis Pasteur: Free Lance of Science*

Chapter XIII (p. 383)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1950

The total effect of the environmental crisis cannot be evaluated because it is spread throughout the whole social structure.

*Reason Awake*

Chapter 5 (p. 170)

Columbia University Press. New York, New York, USA. 1970

**Elton, Charles S.** 1900–91

English biologist

It is usual to speak of an animal as living in a certain physical and chemical environment, but it should always be remembered that strictly speaking we cannot say exactly where the animal ends and the environment begins — unless it is dead, in which case it has ceased to be a proper animal at all...

*Animal Ecology*

Chapter IV (p. 34)

Sidgwick &amp; Jackson, Ltd. London, England. 1927

**Gold, Thomas** 1920–2004

Austrian astrophysicist

It is we who live in the extreme environments.

*The Deep Hot Biosphere* (p. v)

Springer-Verlag. New York, New York, USA. 1999

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

Mountains are earth's undecaying monuments.

*The Great Stoneface: And Other Tales of the White Mountains*

Sketches from Memory, the Notch of the White Mountains (p. 68)

Houghton Mifflin Publishers. Boston, Massachusetts, USA. 1889

**Fuller, Sarah Margaret** 1810–50

American journalist

Nature provides exceptions to every rule.

*The Dial*, July 1843**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

A bucketful of water may support ten thousand copepods; but a water snake may require a marsh to himself, as a whale needs league upon league of sea, or a bear the half of a mountainside. It is a question if there be any biologic advantage in mastering your environment when you need such a quantity of it to support you.

*An Almanac for Moderns*

April Sixteenth (p. 29)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Rickover, Hyman G.** 1900–86

American naval nuclear engineer

It is a profound mistake to think of land only in terms of its money values and, however natural it may be for individuals to do this, the nation or state should never do so. It should instead act always to preserve, foster, and cause to be developed to the maximum of its capacity not the monetary, but the real and physical value of every acre of its soil, both rural and urban. This is its educative, esthetic, and, in the fullest and widest sense of the meaning, productive, creative and enduring worth.

Testimony

House Appropriations defense subcommittee, June 19, 1973

**Rousseau, Jean-Jacques** 1712–78

Swiss-French philosopher

It is in man's heart that the life of nature's spectacle exists; to see it, one must feel it.

Translated by Allan Bloom

*Emile*

Book III (p. 169)

Basic Books, Inc. New York, New York, USA. 1979

**Smith, Homer W.**

Renal physiologist

All samples of the fossil record... suggest that some death-dealing enemy, swift, merciless and irresistible, lurked in

every corner of the world. This enemy, we believe, was the medium in which the early vertebrates were undergoing evolution; it was an enemy that pursued them every minute of the day and night, one from which there was no escape though they deployed from Spitsbergen to Colorado — the physical-chemical danger inherent in their new environment: their fresh-water home.

*From Fish to Philosopher*

Chapter III (p. 31)

Little, Brown & Company, Boston, Massachusetts, USA. 1953

### Snyder, Gary 1930–

American poet, essayist, and environmental activist

A properly radical environmentalist position is in no way antihuman. We grasp the pain of the human condition in its full complexity, and add the awareness of how desperately endangered certain key species and habitats have become.... The critical argument now within environmental circles is between those who operate from a human-centered resource management mentality and those whose values reflect an awareness of the whole of nature.

*The Practice of the Wild*

Survival and Sacrament (p. 181)

North Point Press, San Francisco, California, USA. 1990

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

...Nature, even when she is scant and thin outwardly, satisfies us still by the assurance of a certain generosity at the roots.

*The Writings of Henry David Thoreau* (Volume 1)

A Week on the Concord and Merrimac Rivers

Thursday (p. 419)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1893

### Wilson, Edward O. 1929–

American biologist and author

Perhaps the time has come to cease calling it the “environmentalist” view, as though it were a lobbying effort outside the mainstream of human activity, and to start calling it the real-world view.

*The Future of Life*

Chapter 2 (p. 28)

Alfred A. Knopf, New York, New York, USA. 2002

## ENZYME

### Shaw, William R.

No biographical data available

The light of the firefly’s tiny torch at dusk  
 Destroy and build great structures in the realm  
 Of molecules while we with prying eyes  
 And puny instruments attempt to watch,  
 To marvel, and — perhaps — to understand.  
 The Kinetics of Enzyme Catalyzed Reactions, the Enzymes

*The Journal of Chemical Education*, Volume 34, Number 1, January 1951 (p. 22)

## EPILEPSY

### Hippocrates 460 BCE–377 BCE

Greek physician

The disease called Sacred...appears to me to be nowise more divine nor more sacred than other diseases, but has the natural cause from which it originates like other affections. Men regard its nature and cause as divine from ignorance and wonder, because it is not at all like to other disease.

*In Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On the Sacred Disease (p. 154)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## EPILOGUE

### Wilson, David Scofield

No biographical data available

An epilogue is a chance to have an additional say: a say upon, a say over and above, a say around, and a say toward.

*In the Presence of Nature*

Epilogue (p. 187)

University of Massachusetts Press, Amherst. 1978

## EPITAPH

### Kepler, Johannes 1571–1630

German astronomer

I measured the skies, now the shadows I measure  
 Skybound was the mind, Earthbound the body rests.

*Johannes Kepler gesammelte Werke*

Volume 19 (p. 393)

C. H. Beck, Munchen, Germany. 1937

## EQUATION

### Dirac, Paul Adrian Maurice 1902–84

English theoretical physicist

I consider that I understand an equation when I can predict the properties of its solutions, without actually solving it.

In Frank Wilczek and Betsy Devine

*Longing for the Harmonies*

Chapter 13 (p. 102)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

If one is working from the point of view of getting beauty in one’s equation...one is on a sure line of progress.

The Evolution of the Physicist’s Picture of Nature

*Scientific American*, Volume 208, Number 5, May 1963 (p. 47)

...it is more important to have beauty in one's equations that to have them fit experiment.

The Evolution of the Physicist's Picture of Nature  
*Scientific American*, Volume 208, Number 5, May 1963 (p. 47)

**Einstein, Albert** 1879–1955  
German-born physicist

Equations are more important to me, because politics is for the present, but an equation is something for eternity.

In Stephen W. Hawking  
*A Brief History of Time: From the Big Bang to Black Holes*  
Albert Einstein (p. 178)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

Where did we get that [Schrödinger's equation] from? It's not possible to derive it from anything you know. It came out of the mind of Schrödinger.

*The Feynman Lectures on Physics* (Volume 3)  
Chapter 16–5 (p. 16–12)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Gell-Mann, Murray** 1929–  
American physicist

How can it be that writing down a few simple and elegant formulae, like short poems governed by strict rules such as those of the sonnet or the waka, can predict universal regularities of Nature? Perhaps we see equations as simple because they are easily expressed in terms of mathematical notation already invented at an earlier stage of development of the science, and thus what appears to us as elegance of description really reflects the interconnectedness of Nature's laws at different levels.

*Les Prix Nobel. The Nobel Prizes in 1969*  
Nobel banquet speech for award received in 1969  
Nobel Foundation. Stockholm, Sweden. 1970

**Hawking, Stephen William** 1942–  
English theoretical physicist

Each equation, I was told, would halve the sales of the book. But that was okay. Equations are necessary if you are doing accountancy, but they are the boring part of mathematics. Most of the interesting ideas can be conveyed by words or pictures.

*A Brief History of Time: A Reader's Companion*  
Introduction (p. vii)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Hertz, Heinrich** 1857–94  
German physicist

Maxwell's theory is Maxwell's system of equations.

*Electric Waves: Being Researches on the Propagation of Electric Action with Finite Velocity Through Space* (p. 21)  
Macmillan & Company Ltd. London, England. 1893

**Holton, Gerald** 1922–  
Research professor of physics and science history

**Roller, Duane H. D.** ?–1994  
Science historian

Without the clear understanding that equations in physical science always have hidden limitations, we cannot expect to interpret or apply them successfully. For instance, we would continually be tempted to make unwarranted extrapolations and interpolations. We would be in the catastrophic position of a navigator who has to negotiate a rocky channel without having any idea of the length, width, and draft of his ship.

*Foundations of Modern Physical Science*  
Chapter I (pp. 4–5)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**London, Jack** 1876–16  
American author

The difference between the sun's position and the position where the sun ought to be if it were a decent, self-respecting sun is called the Equation of Time.

*The Cruise of the Snark*  
Chapter 14 (p. 244)  
The Macmillan Company. New York, New York, USA. 1911

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

If  $x$  is the population of the United States and  $y$  is the degree of imbecility of the average American, then democracy is the theory that  $x \times y$  is less than  $y$ .

*A Mencken Chrestomathy*  
Chapter XXX (p. 621)  
Alfred A. Knopf. New York, New York, USA. 1949

**Peirce, Benjamin** 1809–80  
American mathematician

Gentlemen, we have not the slightest idea of what this equation means, but we may be sure that it means something very important.

In J.L. Coolidge  
The Number  $e$   
*The American Mathematical Monthly*, Volume 57, Number 9, November 1950 (p. 591)

**Ramanujan, Srinivasa** 1887–1920  
Indian mathematician

An equation for me has no meaning unless it expresses a thought of God.

*The Man Who Knew Infinity: A life of the Genius, ramanujan*

Chapter Two (p. 67)  
Charles Scribner's Sons. New York, New York, USA. 1991

### Saaty, Thomas L.

American mathematician

Equations are the lifeblood of applied mathematics and science.

*Modern Nonlinear Equations*

Preface

Dover Publications, Inc. New York, New York, USA. 1981

### Shaw, George Bernard 1856–1950

Irish comic dramatist and literary critic

Every moment of time dictated and determined the following moment, and was itself dictated and determined by the moment that came before it. Everything was calculable: everything happened because it must; the commandments were erased from the tables of the law; and in their place came the cosmic algebra: the equations of the mathematicians.

*Too True to Be Good, illage Wooing and On the Rocks*

*Too True to Be Good: A Political Extravaganza*

Act III

Constable & Company Ltd. London, England. 1934

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

I do believe in simplicity. When the mathematician would solve a difficult problem he first frees the equation from all encumbrances, and reduces it to its simplest terms.

In William Peterfield Trent

*Cambridge History of American Literature* (Volume 2)

Book II, (Continued) Chapter X, Thoreau (p. 8)

Cambridge University Press. Cambridge, England. 1917–21

### Trautman, Andrzej 1933–

Polish mathematician

It is important to remember that the physical interpretation of the mathematical notions occurring in a physical theory must be compatible with the equations of the theory.

In P.G. Bergmann and V. De Sabbata (eds.)

*Cosmology and Gravitation: Spin, Torsion, Rotation, and Supergravity*

Generalities on Geometric Theories of Gravitation (p. 4)

Plenum Press. New York, New York, USA. 1980

## EQUILIBRIUM

### Author undetermined

Normality factor is that factor which, when added in the correct amount, produces, or tends to produce, equilibrium in a solution.

Class-Room Chemical Emanations

*Journal of Chemical Education*, Volume 3, Number 1, 1926

### Sommerfeld, Arnold 1868–1951

German physicist

Reversible processes are not, in fact, processes at all, they are sequences of states of equilibrium. The processes which we encounter in real life are always irreversible processes.

*Thermodynamics and Statistical Mechanics, Lectures on Theoretical Physics*

Volume V, Translated by J. Kestin (p. 19)

Academic Press. New York, New York, USA. 1956

## EROSION

### Bradley, Jr., John Hodgdon 1898–1962

American geologist

No one can know how much land has already gone down into the stomach of the sea. The waves have been but one among several of its caterers.

*Autobiography of Earth*

Chapter VI (p. 177)

Coward-McCann, Inc. New York, New York, USA. 1935

### Lawson, Andrew C.

Geologist

Geology has to do with many cycles, but the greatest of these is the erosional flow of rock mass from the continents to the sea and the isostatic return flow of equivalent mass from beneath the sea to the land.

The Isostasy of Large Deltas

*Geological Society American Bulletin*, Volume 149, 1938 (p. 416)

### Le Guin, Ursula K. 1929–

American writer of science fiction and fantasy

Watch this, gents. Watch the lady act like a woman. For that's what she did. The well-behaved, quiet, pretty, serene, domestic creature peaceably yielding herself to the uses of man all of a sudden said No. And she spat dirt and smoke and steam.... She swore and belched and farted, threatened and shook and swelled, and then she spoke. They heard her voice two hundred miles away. "Here I go," she said. I'm doing my thing now. Old Nobodaddy you better JUMP.

A Very Warm Mountain

*Parabola*, Volume 5, 1980

## ERROR

### Abel, Reuben 1911–

Writer

We must avoid here two complementary errors: on the one hand that the world has a unique, intrinsic, pre-existing structure awaiting our grasp; and on the other hand that the world is in utter chaos. The first error is that of the student who marveled at how the astronomers could find out the true names of the distant constellations. The second error is that of Lewis Carroll's Walrus who

grouped shoes with ships and sealing wax, and cabbages with kings...

*Man Is the Measure: A Cordial Invitation to the Central Problems of Philosophy*

Chapter 1 (pp. 16–17)

The Free Press. New York, New York, USA. 1976

**Adams, Franklin Pierce** 1881–1960

American columnist and author

If frequently I fret and fume,  
And absolutely will not smile,  
I err in company with Hume,  
Old Socrates and T. Carlyle.

*Tobogganing on Parnassus*

Erring in Company

Doubleday, Page. Garden City, New York, USA. 1913

**Adams, George** 1750–95

English instrument maker

It is of the utmost importance to your real advancement in science, to avoid every source of error, or whatever may lead you to form an erroneous judgment. Now a true judgment can only be obtained by a profound view of nature, and a strict examination into the mutual connections and dependencies of things; you will hence see the necessity of strict and accurate examination, of time to acquire the requisite knowledge, and of attention to comprehend it: for among the various sources of error, we may reckon the precipitation of our judgment and a presumptuous ignorance as the principal.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 27)

Printed by R. Hindmarsh. London, England. 1794

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

An error is the more dangerous in proportion to the degree of truth which it contains.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

December 26, 1852 (p. 43)

A.L. Burt Company, Publishers. New York, New York, USA. 1897

**Anscombe, Francis John** 1918–2001

English-born American statistician

One sufficiently erroneous reading can wreck the whole of a statistical analysis, however many observations there are.

Rejection of Outliers

*Technometrics*, Volume 2, 1960 (p. 226)

**Baker, Henry** 1698–1774

English naturalist

Remember that Truth alone is the Matter that you are in search after; and if you have been mistaken, let not Vanity seduce you to persist in your Mistake.

*The Microscope Made Easy*

Part I, Chapter XV, Cautions in Viewing Objects (p. 62)

Printed for R. Dodsley. London, England. 1743

**Beard, George M.**

No biographical data available

...as quantitative truth is of all forms of truth the most absolute and satisfying, so quantitative error is of all forms of error the most complete and illusory.

Experiments with Living Human Beings

*Popular Science Monthly*, Volume 14, 1879 (p. 751)

**Bernard, Claude** 1813–78

French physiologist

If the facts used as a basis of reasoning are ill-established or erroneous, everything will crumble or be falsified; and it is thus that errors in scientific theories most often originate in errors of fact.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section III (p. 13)

Henry Schuman, Inc. New York, New York, USA. 1927

**Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

The problem of error has preoccupied philosophers since the earliest antiquity. According to the subtle remark made by a famous Greek philosopher, the man who makes a mistake is twice ignorant, for he does not know the correct answer, and he does not know that he does not know it.

Translated by Douglas Scott

*Probability and Certainty*

Chapter 9 (p. 114)

Walker & Company. New York, New York, USA. 1963

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

Science is a very human form of knowledge. We are always at the brink of the known, we always feel forward for what is to be hoped. Every judgment in science stands on the edge of error, and is personal. Science is a tribute to what we can know although we are fallible.

*The Ascent of Man*

Chapter 11 (p. 374)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

For error and mistake are infinite,

But truth has but one way to be i' th' right.

*The Poetical Works of Samuel Butler* (Volume 2)

Miscellaneous Thoughts, I. 114

Bell & Daldy. London, England. 1835

**Cage, Jr., John Milton** 1912–92

An error is simply a failure to adjust immediately from a preconception to an actuality.

*Silence* (p. 170)

Wesleyan University Press. Middletown, Connecticut, USA. 1961

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

No error at all! They were positively steeped in error!

*The Complete Works of Lewis Carroll*

A Tangled Tale (p. 1063)

The Modern Library. New York, New York, USA. 1936

**Chappell, Edwin**

Pepys probably did not much increase his popularity in the Grafton by getting Dartmouth to call for the dead-reckoning from twelve different persons on board, especially as this was done before they sighted land. Their errors were subsequently found to be very considerable — one was as much as seventy leagues out! It is interesting to note that the inference drawn from these discrepancies was that the chart must be wrong, and it was corrected accordingly.

*The Tangier Papers of Samuel Pepys* (p. xxxviii)

Navy Records Society. Volume 73. 1935

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

I prefer, before heaven, to go astray with Plato, your reverence for whom I know, and admiration for whom I learn from your lips, rather than hold true views with his opponents.

Translated by J.E. King

*Cicero in Twenty Eight Volumes (XVIII)*

Tusculanarum Disputationum, I. 17 (p. 47)

Harvard University Press. Cambridge, Massachusetts, USA. 1921

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

It is almost as difficult to make a man unlearn his errors, as his knowledge. Mal-information is more hopeless than non-information; for error is always more busy than ignorance. Ignorance is a blank sheet, on which we may write; but error is a scribbled one, from which we must first erase. Ignorance is contented to stand still with her back to the truth; but error is more presumptuous, and proceeds in the same direction. Ignorance has no light, but error follows a false one. The consequence is, that error, when she retraces her footsteps, has farther to go, before we can arrive at the truth, than ignorance.

*Lacon; or Many Things in a Few Words* (p. 17)

William Gowans. New York, New York, USA. 1849

**Cowper, William** 1731–1800

English poet

Man, on the dubious waves of error toss'd.

*The Poetical Works of William Cowper*

Truth, I. 1

John W. Lovell Company. New York, New York, USA. No date

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

O mathematicians, throw light on this error.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Philosophy (p. 64)

George Braziller. New York, New York, USA. 1958

**Darwin, Charles Robert** 1809–82

English naturalist

...to kill an error is as good a service as, and sometimes even better than, the establishing of a new truth or fact.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)

Letter 752, Darwin to Wilson, March 5, 1879 (p. 422)

D. Appleton & Company. New York, New York, USA. 1903

**Davy, Sir Humphry** 1778–1829

English chemist

Experimental science hardly ever affords us more than approximations to truth; and whenever many agents are concerned we are in great danger of being mistaken.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter II (pp. 69–70)

Smith, Elder & Company. London, England. 1839–1840

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

...statisticians distinguish false positive from false negative errors, sometimes called type 1 and type 2 errors respectively.... There is a type 3 error in which your mind goes totally blank whenever you try to remember which is which of type 1 and type 2.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*

Chapter 7 (p. 171)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

Precision is expressed by an international standard, viz., the standard error. It measures the average of the difference between a complete coverage and a long series of estimates formed from samples drawn from this complete coverage by a particular procedure or drawing, and processed by a particular estimating formula.

On the Presentation of the Results of Sample Surveys as Legal Evidence

*Journal of the American Statistical Association*, Volume 49, Number

268, December 1954 (p. 820)

**Diamond, Solomon** 1906–98

No biographical data available

Error does not carry any recognizable badge, for when we change our point of view, to focus on a different problem, what had been error may become information, and what had been information may become error.

*Information and Error: An Introduction to Statistical Analysis*  
Chapter 1 (p. 7)

Basic Books, Inc. New York, New York, USA. 1959

Here, by the grace of Chance, we've staked a Mean,  
Uncertain marker of elusive Truth.

But have we caught a fan, or trapped a doubt

Within this stretching span of confidence —

A shadow world four standard errors wide,

All swollen by the stint of observation?

For recollect that once in twenty times

The phantom Truth will even lie beyond

That span, in the unending thin-drawn tails

Which point to the infinitude of Error.

*Information and Error: An Introduction to Statistical Analysis*  
Third Interlude (p. 120)

Basic Books, Inc. New York, New York, USA. 1959

### **Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Errors, like straws, upon the surface flow,  
He who would search for pearls must dive below.

*The Poetical Works of Dryden*

All for Love, Prologue

The Riverside Press. Cambridge, Massachusetts, USA. 1949

### **Duncan, Otis Dudley** 1921–

American demographer and sociologist

A mature science, with respect to the matter of errors in variables, is not one that measures its variables without error, for this is impossible. It is, rather, a science which properly manages its errors, controlling their magnitudes and correctly calculating their implications for substantive conclusions.

*Introduction to Structural Equation Models*

Chapter 9 (p. 114)

Academic Press. New York, New York, USA. 1975

### **Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

However we define error, the idea of calculating its extent may appear paradoxical. A science of errors seems a contradiction in terms.

The Element of Chance in Competitive Examinations

*Journal of the Royal Statistical Society*, Volume 53, 1890, (p. 462)

### **Evans, Bergen** 1904–78

Author

No error is harmless.

*The Natural History of Nonsense*

Chapter 19 (p. 274)

Alfred A. Knopf. New York, New York, USA. 1947

### **Fischer, Ernst Peter** 1947–

No biographical data available

The way to wisdom, I explain,

Is easy to express,

To err and err and err again

But less and less and less.

Translated by Elizabeth Oehlkers

*Beauty and the Beast*

Chapter 5 (p. 93)

Plenum Trade. New York, New York, USA. 1999

### **Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The phrase “Errors of the Second Kind”, although apparently only a harmless piece of technical jargon, is useful as indicating the type of mental confusion in which it was coined.

Statistical Methods and Scientific Induction

*Journal of the Royal Statistical Society*, Series B, Number 17, 1955 (p. 73)

### **Froude, James Anthony** 1818–94

English historian and biographer

...no vehement error can exist in this world with impunity...

*Short Studies on Great Subjects* (Volume 1)

Spinoza (p. 394)

Longmans, Green & Company. London, England. 1879

### **Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

### **Sullivan, Arthur** 1842–1900

English composer

SAM: An error? What error?

*The Complete Plays of Gilbert and Sullivan*

The Pirates of Penzance

Act 1 (p. 122)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

### **Girtanner, Christopher** 1760–1800

Chemist and physician

Let us not be attached to systems, but to truth; and when Nature speaks, let us listen to her voice in preference to that of a Stahl or a Lavoissier, a Descartes or a Newton. Whatever may be the result of our experiments, we shall profit by them: as we run the risk of losing nothing but error, let us hasten to subject ourselves to that loss.

Memoir on Azot, and on the Question, Whether it be a simple or a compound Body

*Philosophical Magazine*, Volume VI (p. 337)

### **Goddard, Robert H.** 1882–1945

American physicist

The fact that errors in scientific reasoning are so common should not serve as a discouragement. Every fallacy we

detect can show us where we are at fault, and guide us toward the truth.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things For Granted (p. 66)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

One cannot always be right in our complex world; no dishonor attends an incorrect choice among plausible outcomes drawn from a properly constructed argument.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Six, Chapter 23 (p. 299)

Random House, Inc. New York, New York, USA. 1995

Great thinkers are never passive before facts. They ask questions of nature; they do not follow her humbly. They have hopes and hunches, and they try hard to construct the world in their light. Hence, great thinkers also make great errors.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 23 (p. 236)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

...honorable errors do not count as failures in science, but as seeds for progress in the quintessential activity of correction.

*Leonardo's Mountain of Clams and the Diet of Worms*

Part III, Chapter 8 (p. 163)

Harmon Brown. New York, New York, USA. 1998

**Heinlein, Robert A.** 1907–88

American science fiction writer

I shot an error into the air. It's still going...everywhere.

*Expanded Universe*

The Happy Days Ahead (p. 514)

Penguin Putnam, Inc. New York, New York, USA. 1980

**Hippocrates** 460 BCE–377 BCE

Greek physician

I know that the common herd of physicians, like the vulgar, if there happen to have been any innovation made about that day, such as the bath being used, a walk taken, or any unusual food eaten, all which were better done than otherwise, attribute notwithstanding the cause of these disorders, to some of these things, being ignorant of the true cause, but proscribing what may have been very proper.

In *Great Books of the Western World* (Volume 10)

*Hippocratic Writings*

On Ancient Medicine, 21 (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

Nature itself cannot err.

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 4 (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huxley, Thomas Henry** 1825–95

English biologist

Next to being right in this world, the best of all things is to be clearly and definitely wrong. If you go buzzing about between right and wrong, vibrating and fluctuating, you come out nowhere; but if you are absolutely and thoroughly and persistently wrong, you must, some of these days, have the extreme good fortune of knocking your head against a fact, and that sets you all straight again.

*Collected Essays* (Volume 3)

*Science and Education*

On Science and Art in Relation to Education (p. 174)

Macmillan & Company Ltd. London, England. 1904

It sounds paradoxical to say the attainment of scientific truth has been effected, to a great extent, by the help of scientific errors.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 63)

Macmillan & Company Ltd. London, England. 1904

...there is no greater mistake than the hasty conclusion that opinions are worthless because they are badly argued.

*Collected Essays* (Volume 1)

*Method and Result*

Natural and Political Rights (p. 369)

Macmillan & Company Ltd. London, England. 1904

...irrationally held truths may be more harmful than reasoned errors.

*Collected Essays* (Volume 2)

*Darwiniana*

The Coming of Age of (p. 229)

Macmillan & Company Ltd. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

Believe truth! Shun error! — these, we see, are two materially different laws; and by choosing between them we may end by colouring differently our whole intellectual life. We may regard the chase for truth as paramount, and the avoidance of error as secondary; or we may, on the other hand, treat the avoidance of error as more imperative, and let truth take its chance.... Our errors are surely not such awful solemn things. In a world where we are so certain to incur them in spite of all our caution, a certain lightness of heart seems healthier than this excessive nervousness on their behalf. At any rate, it seems the fittest thing for the empiricist philosopher.

*The Will to Believe and Other Essays in Popular Philosophy*

The Will to Believe

Sections VII & VIII (p. 18)

Dover Publications, Inc. New York, New York, USA. 1956



**Jefferson, Thomas** 1743–1826  
3<sup>rd</sup> president of the United States

Error of opinion may be tolerated where reason is left free to combat it.

*The Inaugural Addresses of the Presidents of the United States*  
First Inaugural Address at Washington DC, March 4, 1801

**Jevons, William Stanley** 1835–82  
English economist and logician

...quantities which are called errors in one case, may really be most important and interesting phenomena in another investigation. When we speak of eliminating error we really mean disentangling the complicated phenomena of nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book III, Chapter XV (p. 339)  
Macmillan & Company Ltd. London, England. 1887

**Koyré, Alexandre** 1892–1964  
Russian-born French philosopher

What good is it then to spend time on error? Isn't the important thing the final success, the discovery, and not the tortuous paths that one followed and on which one could have gotten lost?...What is important for posterity is in fact the discovery or invention. Nonetheless (at least for the historian-philosopher) it is the dead end, the error...which are sometimes as important as the successes. They can, maybe, be even more important. They are...instructive by permitting us, sometimes, to grasp and to comprehend the secret paths of thought.

Translated by J. Mepham  
*Galilean Studies* (p. 77)  
The Harvester Press. Hassocks, England. 1978

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

In spite of the errors into which I may have been led, the work may possibly contain ideas and arguments that will have a certain value for the advancement of knowledge, until such time as the great subjects, with which I have ventured to deal, are treated anew by men capable of shedding further light upon them.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter VIII (p. 405)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

The only method of preventing such errors from taking place, and of correcting them when formed, is to restrain and simplify our reasoning as much as possible. This

depends entirely upon ourselves, and the neglect of it is the only source of our mistakes.

*Elements of Chemistry in a New Systematic Order*  
Preface of the Author (p. xviii)  
Printed for William Creech. Edinburgh, Scotland. 1790

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

We err when we expect more enlightenment from an hypothesis than from the facts themselves.

*The Science of Mechanics* (5<sup>th</sup> edition)  
Chapter V, Part I (p. 600)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Maimonides, Moses** 1135–1204  
Spanish-born philosopher, jurist, and physician

Today he can discover his errors of yesterday and tomorrow he may obtain light on what he thinks himself sure of today.

In H.P. Charles and B.C. Knight (eds.)  
*Organization and Control in Prokaryotic Cells. Twentieth Symposium of the Society For General Microbiology*  
Editor's Preface (p. xi)  
Cambridge University Press. Cambridge, England. 1970

**Mayr, Ernst** 1904–2005  
German-born American biologist

It is curious how often erroneous theories have had a beneficial effect for particular branches of science.

*The Growth of Biological Thought: Diversity, Evolution and Inheritance*  
Chapter 20 (p. 847)  
Harvard University Press. Cambridge, Massachusetts, USA. 1982

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

...the errors are not the art, but in the artificers.

*Mathematical Principles of Natural Philosophy*  
Preface to the First Edition  
E.P. Dutton & Company. New York, New York, USA. 1922

**Neyman, Jerzy** 1894–1981  
Russian-born American statistician

Whenever we attempt to test a hypothesis we naturally try to avoid errors in judging it. This seems to indicate the right way of proceeding: when choosing a test we should try to minimize the frequency of errors that may be committed in applying it.

*Lectures and Conferences on Mathematical Statistics*  
Chapter I, Part 3 (p. 55)  
U.S. Department of agriculture. Washington, D.C. 1952

**Nicolle, Charles** 1866–1936  
French Bacteriologist

Error is all around us and creeps in at the least opportunity. Every method is imperfect.

In W.I.B. Beveridge  
*The Art of Scientific Investigation*

Chapter Nine (p. 102)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

...errors in judgment must occur in the practice of an Art which consists largely in balancing probabilities...

*Aequanimitas: With Other Addresses to Medical Students, Nurses and Practitioners of Medicine*  
Teacher and Student (p. 19)  
Publisher undetermined

**Parrot, Max**  
No biographical data available

If it is useful to make discoveries in natural science, it is not less so, to correct as many as possible of the errors which arise in this domain of human knowledge, and which are sustained by the authority or the assent of respectable savants.

Translated by J. Griscom  
Considerations Upon the Temperature of the Terrestrial Globe  
*American Journal of Science and Arts*, Volume 26, I, Article II, July 1834

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

In those sciences of measurement which are the least subject to error — meteorology, geodesy, and metrical astronomy — no man of self-respect ever now states his results, without affixing to it its probable error; and if this practice is not followed in other sciences it is because in those the probable errors are too vast to be estimated.

In Justus Buchler (ed.)  
*Philosophical Writings of Peirce* (p. 3)  
Dover Publications. New York, New York, USA. 1955

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

A final word about the theory of errors. Here it is that the causes are complex and multitude. To how many snares is not the observer exposed, even with the best instruments.

*The Foundations of Science*  
Science and Method, Book I  
Chapter IV, Section IV (p. 402)  
The Science Press. New York, New York, USA. 1913

**Pomfret, John**

The best may slip, and the most cautious fall;  
He's more than mortal that ne'er err'd at all.

*The Poetical Works of John Pomfret*  
Love Triumphant over Reason, I. 145  
At The Apollo Press. Edinburgh, Scotland. 1779

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

But science is one of the very few human activities — perhaps the only one — in which errors are systematically criticized and fairly often, in time, corrected. This is why we can say that, in science, we often learn from our mistakes, and why we can speak clearly and sensibly about making progress there.

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 10, Section I (p. 216)  
Harper & Row, Publishers. New York, New York, USA. 1963

**Reagan, Ronald W.** 1911–2004  
40<sup>th</sup> president of the United States

I will stand on, and continue to use, the figures I have used, because I believe they are correct. Now, I'm not going to deny that you don't now and then slip up on something; no one bats a thousand.

On Bandwagon, Reagan Seeks to Stiffen Credibility Grip  
*Washington Post*, 20 April 1980 (A8)

**Russell, Cheryl**  
No biographical data available

Always expect to find at least one error when you proof-read your own statistics. If you don't, you are probably making the same mistake twice.

In Tom Parker  
*Rules of Thumb* (p. 124)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1983

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

The error of our eye directs our mind. What error leads must err.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Troilus and Cressida  
Act V, Scene ii, l. 110–111  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Siegel, Eli** 1902–78  
American philosopher, poet, critic, and founder of Aesthetic Realism

When truth is divided, errors multiply.

*Damned Welcome*  
Aesthetic Realism, Maxims, Part Two, #360 (p. 147)  
Definition Press. New York, New York, USA. 1972

**Sterne, Laurence** 1713–68  
English novelist and humorist

The laws of nature will defend themselves; — but error — (he would add, looking earnestly at my mother) — error, Sir, creeps in thro' the minute holes and small crevices which human nature leaves unguarded.

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 1)  
Book II, Chapter XIX (p. 131)  
Macmillan & Company Ltd. London, England. 1900

In a word, he would say, error was error, — no matter where it fell, — whether in a fraction, — or a pound, — ‘twas alike fatal to truth, and she was kept down at the bottom of her well, as inevitably by mistake in the dust of a butterfly’s win, — as in the disk of the sun, the moon, and all the stars of heaven put together.

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 1)  
Book II, Chapter XIX (p. 131)  
Macmillan & Company Ltd. London, England. 1900

### Stetson, Harlan T.

Astronomer

The more closely emotional response is entwined with error, the more difficult does it become to change one’s thinking.

In Joseph Jastrow (ed.)  
*The Story of Human Error*  
Error in Astronomy (p. 45)  
D. Appleton-Century Company, Incorporated. New York, New York, USA. 1936

### Thomas, Lewis 1913–93

American physician and biologist

Biology needs a better word than “error” for the driving force in evolution. Or maybe “error” will do after all, when you remember that it came from an old root meaning to wander about, looking for something.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
The Wonderful Mistake (p. 30)  
The Viking Press. New York, New York, USA. 1979

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

One cannot too soon forget his errors...

*The Writings of Henry David Thoreau* (Volume 8)  
Winter  
9 Jan 1842 (p. 144)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Tukey, John W. 1915–2000

American statistician

For the Bureau has worked hard to learn the accuracy of its measurements and it supplies with each weight a certificate indicating how much the weight may differ from exactly one pound. The calibration of the weight is valuable just because its possible error is known. When the Bureau of the Census makes an enumeration, there are errors, which they acknowledge. They know the extent of the errors from many sources and they try to learn more about those from others.... It is far easier to put out a figure, than to accompany the figure with a wise and reasoned account of its liability to systematic and fluctuating errors. Yet if the figure is...to serve as the basis of an important decision, the accompanying amount may be more important than the figures themselves.

Memorandum on Statistics in the Federal Government  
*The American Statistician*, Volume 3, Number 5, February 1949 (p. 9)

### Tupper, Martin Farquhar 1810–80

English writer and poet

Error is a hardy plant; it flourishes in every soil.

*Proverbial Philosophy: A Book of Thoughts and Arguments Of Truth in Things False* (p. 5)  
J. Hatchard & Son. London, England. 1842

### van de Kamp, Peter

No biographical data available

...should we not come to the rescue of a cosmic phenomenon trying to reveal itself in a sea of errors?

*Dark Companions of Stars: Astrometric Commentary on the Lower End of the Main Sequence*  
Chapter 15 (p. 322)  
D. Reidel Publishing Company. Dordrecht, Netherlands. 1986

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

Error is to truth as sleep is to waking. As though refreshed, one returns from error to the path of truth.

*Wisdom and Experience*  
Science and Philosophy (p. 126)  
Routledge & Kegan Paul Ltd. London, England. 1949

I could have never have known so well how paltry men are, and how little they care for really high aims, if I had not tested them by my scientific researches. Thus I saw that most men only care for science so far as they get a living by it, and that they worship even error when it affords them a substance.

In Johann Peter Eckermann  
*Conversations with Goethe*  
Wednesday, October 12, 1825 (p. 119)  
J.M. Dent & Sons Ltd. London, England. 1970

### von Helmholtz, Hermann 1821–94

German scientist and philosopher

But any pride I might have felt in my conclusions was perceptibly lessened by the fact that I knew that the solution of these problems had almost always come to me as the gradual generalisation of favourable examples, by a series of fortunate conjectures, after many errors. I am fain to compare myself with a wanderer on the mountains who, not knowing the path, climbs slowly and painfully upwards and often has to retrace his steps because he can go no further — then, whether by taking thought or from luck, discovers a new track that leads him on a little till at length when he reaches the summit he finds to his shame that there is a royal road, by which he might have ascended, had he only had the wits to find the right approach to it. In my works, I naturally said nothing about my mistake to the reader, but only described the made track by which he may now reach the same heights without difficulty.

In L. Koenigsberger  
*Hermann von Helmholtz* (pp. 180–181)  
 At the Clarendon Press. Oxford, England. 1906

**Wallace, Alfred Russel** 1823–1913  
 English humanist, naturalist, and geographer

It is true that man is still, as he always has been, subject to error; his judgments are often incorrect, his beliefs false, his opinions changeable from age to age. But experience of error is his best guide to truth, often dearly bought, and, therefore, the more to be relied upon. And what is it but the accumulated experience of past ages that serves us as a beacon light to warn us from error, to guide us in the way of truth.

*My Life*  
 Chapter XIV (pp. 203–204)  
 Chapman & Hall. London, England. 1905

**Ward, Lester Frank** 1898–1970  
 American sociologist

...it is the misfortune of all truly great minds to be wedded to errors as well as to truths.

*Dynamic Sociology* (Volume 1)  
 Chapter I (p. 83)  
 D. Appleton & Company. New York, New York, USA. 1910

**Watson, Alfred N.**  
 No biographical data available

A standard error is just as bad as any other error.  
 Statement made at a meeting of the American Statistical Association, Chicago, 1942

**Whewell, William** 1794–1866  
 English philosopher and historian

...we may see how theories may be highly estimable, though they contain false representations of the real state of things, and may be extremely useful, though they involve unnecessary complexity. In the advance of knowledge, the value of the true part of the theory may much outweigh the accompanying error, and the use of a rule may be little impaired by its want of simplicity.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 1)  
 Book III, Chapter III, Section 2 (p. 181)  
 John W. Parker. London, England. 1837

**Whitehead, Alfred North** 1861–1947  
 English mathematician and philosopher

There is great room for error here.  
*Science and the Modern World*  
 Chapter II (p. 35)  
 The Macmillan Company. New York, New York, USA. 1929

The results of science are never quite true. By a healthy independence of thought perhaps we sometimes avoid adding other people's errors to our own.

*The Aims of Education and Other Essays*

Chapter X (p. 233)  
 The Macmillan Company. New York, New York, USA. 1959

**Wright, Wilbur** 1867–1912  
 American aeronautical engineer

If a man is in too big a hurry to give up an error he is liable to give up some truth with it, and in accepting the arguments of the other man he is sure to get some error with it.

In Fred C. Kelly (ed.)  
*Miracle at Kitty Hawk*  
 Chapter III, Letter from Wilbur Wright to George A. Spratt, April 27, 1903 (p. 89)  
 Farrar, Straus & Young. New York, New York, USA. 1951

## ERUPTION

**Virgil** 70 BCE–19 BCE  
 Roman epic, didactic, and idyllic poet

...but Aetna hard at hand  
 With hideous ruin thunders, and anon  
 Shoots a dark cloud to heaven or whirling smoke  
 Pitch-black, with glowing ashes, and aloft  
 Heaves balls of fire, and licks the stars, anon  
 Rocks and the uptorn entrails of the hill  
 Spews forth, and heaps the molten stones in air

Booming, and from his lowest depth upboils.  
 In *Great Books of the Western World* (Volume 13)  
*The Aeneid*  
 Book III, l. 571–577 (p. 162)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## ESCHATOLOGY

**Dyson, Freeman J.** 1923–  
 American physicist and educator

I hope...to hasten the arrival of the day when eschatology, the study of the end of the universe, will be a respectable scientific discipline and not merely a branch of theology.

Time Without End: Physics and Biology in an Open Universe  
*Review of Modern Physics*, Volume 51, Number 3

## ESOTERIC

**Taylor, Angus E.**  
 American mathematician

One of the difficulties which a mathematician has in describing his work to non-mathematicians is that the present day language of mathematics has become so esoteric that a well educated layman, or even a group of scientists, can comprehend essentially nothing of the discourse which mathematicians hold with each other, or of the accounts of their latest researches which are published in their professional journals.

Some Aspects of Mathematical Research  
*American Scientist*, Volume 35, Number 2, April 1947 (p. 211)

## ESTIMATE

### King, W. J.

No biographical data available

Ideally another man's promises should be negotiable instruments, like his personal check, in compiling estimates.

The Unwritten Laws of Engineering  
*Mechanical Engineering*, June 1944 (p. 4)

## ETERNITY

### Aurelius Antoninus, Marcus 121–180

Roman emperor

Whatever may happen to thee, it was prepared for thee from all eternity; and the implication of causes was from eternity spinning the thread of thy being, and of that which is incident to it.

In *Great Books of the Western World* (Volume 12)  
*The Meditations of Marcus Aurelius*  
 Book X, #5 (p. 296)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Geikie, Sir Archibald 1835–1924

English geologist

It is not a pleasant experience to discover that a fortune which one has unconcernedly believed to be ample has somehow taken to itself wings and disappeared. When the geologist was suddenly awakened by the energetic warning of the physicist, who assured him that he had enormously overdrawn his account with past time, it was but natural under the circumstances that he should think the accountant to be mistaken, who thus returned to him dishonored the large drafts he had made on eternity.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1895

Geological Change and Time (p. 125)  
 Government Printing Office. Washington, D.C. 1896

### Harrison, Edward Robert 1919–2007

English-born American cosmologist

If eternity is silliness, then infinity of space is sheer madness.

*Masks of the Universe*  
 Chapter 12 (p. 202)  
 The Macmillan Company. New York, New York, USA. 1985

### Paine, Thomas 1737–1809

Anglo-American political theorist and writer

It is difficult beyond description to conceive that space can have no end; but it is more difficult to conceive an end. It is difficult beyond the power of man to conceive

an eternal duration of what we call time; but it is more impossible to conceive a time when there shall be no time.

*The Age of Reason*  
 Part First, Chapter X (p. 25)  
 W. B. Cooke & W. M. Scott. Toronto, Ontario, Canada. 1887

### Stoppard, Tom 1937–

Czech-born English playwright

ROS: Eternity is a terrible thought. I mean, where's it going to end?

*Rosencrantz and Guildenstern Are Dead*  
 Act Two (p. 71)  
 Grove Press, Inc. New York, New York, USA. 1967

### Vaughan, Henry 1621–95

English metaphysical poet

I saw eternity the other night,  
 Like a great ring of pure and endless light,  
 All calm, as it was bright: —  
 And round beneath it,  
 Time, in hours, days, years,  
 Driven by the spheres,  
 Like a vast shadow moved; in which the World  
 And all her train were hurl'd.

*Poetry and Selected Prose*  
 A Vision  
 Oxford University Press, Inc. London, England. 1963

### Young, Edward 1683–1765

English poet and dramatist

Eternity is written in the skies.

*Night Thoughts*  
 Night IX  
 Printed by R. Nobels for R. Edwards. London, England. 1797

## ETHER

### Lodge, Sir Oliver 1851–1940

English physicist

For well nigh a century we have had a wave theory of light; and a wave theory of light is almost certainly true. It is directly demonstrable that light consists of waves of some kind or other, and that these waves travel at a certain well-known velocity — achieving a distance equal to seven times the circumference of the Earth every second; from New York to London and back in the thirtieth part of a second; and taking only eight minutes on the journey from the Sun to the Earth. This propagation in time of an undulatory disturbance necessarily involves a medium. If waves setting out from the Sun exist in space eight minutes before striking our eyes, there must necessarily be in space some medium which conveys them. Waves we cannot have, unless they be waves in something.

*The Ether of Space*  
 Harper & Brothers. London, England. 1909

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

It matters little whether the ether really exists; that is the affair of metaphysicians. The essential thing for us is that everything happens as if it existed...

...some day, no doubt, the ether will be thrown aside as useless.

*The Foundations of Science*  
Science and Hypothesis, Chapter XII (p. 174)  
The Science Press. New York, New York, USA. 1913

**Thomson, Sir Joseph John** 1856–1940  
English physicist

At first sight the idea that we are immersed in a medium almost infinitely denser than lead might seem inconceivable; it is not so if we remember that in all probability matter is composed mainly of holes. We may, in fact, regard matter as possessing a bird-cage kind of structure, in which the volume of the ether disturbed by the wires when the structure is moved is infinitesimal in comparison with the volume enclosed by them.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*  
Progress in Physics  
Government Printing Office. Washington, D.C. 1910

## ETHER SPACE

**Anaxagoras** ca. 500 BCE–428 BCE  
Greek philosopher of nature

The formation of the world began with a vortex, formed out of chaos by Energy. This vortex started at the center and gradually spread. It separated matter into two regions, the rare, hot, dry and light material, the aether, in the outer regions, and the heavier, cooler, moist material, the air, in the inner regions. The air condensed in the center of the vortex, and out of the air, the clouds, water and earth separated. But after the formation of earth, because of the growing violence of the rotary motion, the surrounding fiery aether tore stones away from the earth and kindled them to stars, just as stones in a whirlpool rush outward more than water. The sun, moon and all the stars are stones on fire, ...are moved round by the revolution of the aether.

In Walter R. Fuchs  
*Mathematics for the Modern Mind*  
Chapter 2, Section 2.1 (p. 60)  
Macmillan. New York, New York, USA. 1967

**Bruncken, Herbert Gerhardt**  
No biographical data  
Eddington, Einstein, and Jeans one night  
Sailed off on an ether wave,  
Sailed on a curve of celestial light  
Into the cosmic cave.

A Space-Time Lullaby  
*The Physics Teacher*, Volume 1, Number 1, April 1963 (p. 47)

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

As far as and beyond the remotest stars the world is filled with aether. It permeates the interstices of the atoms. Aether is everywhere.... There is no space without aether, and no aether which does not occupy space.

*New Pathways in Science*  
Chapter II, Section IV (pp. 38–39)  
The Macmillan Company. New York, New York, USA. 1935

**Einstein, Albert** 1879–1955  
German-born physicist

We may sum up as follows: According to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, an ether exists. Space without an ether is inconceivable.

*The World as I See It* (p. 204)  
Philosophical Library. New York, New York, USA. 1949

**Hoffmann, Banesh** 1906–86  
Mathematician and educator

First we had the luminiferous ether.  
Then we had the electromagnetic ether.  
And now we haven't e(i)ther.

*The Strange Story of the Quantum*  
Chapter III (p. 33)  
Dover Publications, Inc. New York, New York, USA. 1959

**Lodge, Sir Oliver** 1851–1940  
English physicist

The first thing to realize about the ether is its absolute continuity. A deep-sea fish has probably no means of apprehending the existence of water; it is too uniformly immersed in it: and that is our condition in regard to ether.

*Ether and Reality*  
Hodder & Stoughton. London, England. 1930

All pieces of matter and all particles are connected together by the ether and by nothing else. In it they move freely and of it they may be composed. We must study the kind of connection between matter and ether. The particles embedded in the ether are not independent of it, they are closely connected with it, it is probable that they are formed out of it: they are not like grains of sand suspended in water, they seem more like minute crystals formed in a mother liquor.

*Ether and Reality*  
Hodder & Stoughton. London, England. 1930

**Maxwell, James Clerk** 1831–79  
Scottish physicist

Ethers were invented for the planets to swim in, to constitute electric atmospheres and magnetic effluvia, to

convey sensations from one part of our body to another, till all space was filled several times over with ether.

In Sir James Jeans

*The Mysterious Universe*

Chapter IV (p. 97)

The Macmillan Company. New York, New York, USA. 1932

**Planck, Max** 1858–1947

German physicist

The ether, this child of sorrow of classical mechanics...

In Jean-Pierre Luminet

*Black Holes* (p. 18)

Cambridge University Press. New York, New York, USA. 1992

**Thomson, Sir Joseph John** 1856–1940

English physicist

In fact, all mass is mass of the ether; all momentum, momentum of the ether; and all kinetic energy, energy of the ether. This view, it should be said, requires the density of the ether to be immensely greater than that of any known substance.

In Sir Oliver Lodge

*Ether and Reality*

Hodder & Stoughton. London, England. 1930

## ETHICS

### Accreditation Board for Engineering and Technology

Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by:

- I. using their knowledge and skill for the enhancement of human welfare;
- II. being honest and impartial, and serving with fidelity the public, their employer;
- III. striving to increase the competence and prestige of the engineering profession;
- and
- IV. supporting the professional and technical societies of their disciplines.

*Code of Ethics for Engineers*

October 1977

**Baruch, Bernard M.** 1870–1965

American presidential advisor

Science has taught us how to put the atom to work. But to make it work for good instead of for evil lies in the domain dealing with the principles of human duty. We are now facing a problem more of ethics than physics.

Address to United Nations Atomic Energy Commission

UN Headquarters, New York City, June 14, 1946

**Cabot, Richard Clarke** 1868–1939

American physician

Ethics and Science need to shake hands.

*The Meaning of Right and Wrong*

Introduction (p. 10)

The Macmillan Company. New York, New York, USA. 1933

**Caplan, Arthur**

No biographical data available

The use of fetuses as organ and tissue donors is a ticking time bomb of bioethics.

In Joe Levine

Help from the Unborn

*Time*, Volume 129, Number 2, January 12, 1987 (p. 62)

**Einstein, Albert** 1879–1955

German-born physicist

Scientific statements of facts and relations, indeed, cannot produce ethical derivatives. However, ethical derivatives can be made rational and coherent by logical thinking and empirical knowledge. If we can agree on some fundamental ethical propositions, then other ethical propositions can be derived from them, provided that the original premises are stated with sufficient precision. Such ethical premises play a similar role in ethics to that played by axioms in mathematics.

In Philipp Frank

*Relativity — A Richer Truth*

The Laws of Science and the Laws of Ethics (p. 9)

Jonathan Cape. London, England. 1951

A man's ethical behavior should be based effectually on sympathy, education, and social ties and needs; no religious basis is necessary. Man would indeed be in a poor way if he had to be restrained by fear of punishment and hope of reward after death.

Religion and Science

*New York Times Magazine*, November 9, 1930

**Florman, Samuel C.** 1925–

Author and professional engineer

As a professional, I abide by established standards... As a human being I hope that I deal adequately with each day's portion of moral dilemmas. But between legality on the one hand and individual predilection on the other, there is hardly any room for the abstraction called "engineering ethics."

*Blaming Technology*

Moral Blueprints (p. 172)

St. Martin's Press. New York, New York, USA. 1981

**Graham, Loren R.**

No biographical data available

Science should submit to ethics, not ethics to science.

*Between Science and Values*

Introduction (p. 26)

Columbia University Press. New York, New York, USA. 1981

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

We do not know whether we shall succeed in once more expressing the spiritual form of our future communities in the old religious language. A rationalistic play with words and concepts is of very little assistance here; the most important preconditions are honesty and directness. But since ethics is the basis for the communal life of men, and ethics can only be derived from that fundamental human attitude which I have called the spiritual pattern of the community, we must bend all our efforts to reuniting ourselves, along with the younger generation, in a common human outlook. I am convinced that we can succeed in this if again, we can find the right balance between the two kinds of truth.

In Ken Wilbur (ed.)

*Quantum Questions*

Chapter 3 (p. 45)

Shambhala Publications, Inc. Boston, Massachusetts, USA. 2001

**Hess, Elmer**

No biographical data available

If a man is good in his heart, then he is an ethical member of any group in society. If he is bad in his heart, he is an unethical member. To me the ethics of medical practice is as simple as that.

Do Doctors Charge Too Much?

*American Weekly*, April 24, 1955**Hill, Archibald V.**

No biographical data available

If ethical principles deny our right to do evil in order that good may come, are we justified in doing good when the foreseeable consequences are evil?

Quoted in Crispin Tickell

*Climatic Change*

Chapter 2 (p. 37)

Center for International Affairs, Harvard University, USA. 1977

**Lynd, Robert Wilson** 1879–1949

English writer

It is an engaging problem in ethics whether, if you have been lent a cottage, you have the right to feed the mice.

*The Peal of Bells*

Chapter II (p. 9)

Methuen &amp; Company Ltd. London, England. 1924

**Marshall, T. H.**

No biographical data available

Ethical codes are based on the belief that between professional and client there is a relationship of trust, and between buyer and seller there is not.

The Recent History of Professionalism in Relation to Social Structure and Social Philosophy

*Canadian Journal of Economics and Political Science*, V (p. 327)**Pascal, Blaise** 1623–62

French mathematician and physicist

Physical science will not console me for the ignorance of morality in the times of affliction But the science of ethics will always console me for the ignorance of the physical sciences.

In *Great Books of the Western World* (Volume 33)*Pensées*

Section II, 67

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Ethics and science have their own domain which touch but do not interpenetrate. The one shows us to what goal we should aspire, the other, given the goal, teaches us how to attain it. So they can never conflict since they can never meet. There can no more be immoral science than there can be scientific morals.

*The Foundations of Science*

The Value of Science, Introduction (p. 206)

The Science Press. New York, New York, USA. 1913

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The hope of getting some argument or theory to share our responsibilities is, I believe, one of the basic motives of “scientific” ethics.

*The Open Society and Its Enemies* (Volume 1)

Chapter 5

Chapter 5, # 18 (p. 511)

Princeton University Press. Princeton, New Jersey, USA. 1950

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Science can discuss the causes of desires, and the means for realizing them, but it cannot contain any genuinely ethical sentences, because it is concerned with what is true or false.

*Religion and Science*

Science and Ethics (p. 237)

Henry Holt &amp; Company. New York, New York, USA. 1935

Science, by itself, cannot supply us with an ethic. It can show us how to achieve a given end, and it may show us that some ends cannot be achieved.

The Science to Save Us from Science

*The New York Times Magazine*, March 19, 1950**Sigma Xi**

Whether or not you agree that trimming and cooking are likely to lead on to downright forgery, there is little to support the argument that trimming and cooking are less reprehensible and more forgivable. Whatever the rationalization is, in the last analysis one can no more be a little bit dishonest than one can be a little bit pregnant. Commit any of these three sins and your scientific research career is in jeopardy and deserves to be.



*Honor in Science*

Chapter 3 (p. 14)

New Haven, Connecticut, USA. 1986

**Stackman, Elvin** 1885–1979  
American plant pathologist

Science cannot stop while ethics catches up...and nobody should expect scientists to do all the thinking for the country.

U.S. Science Holds Its Biggest Powwow  
*Life*, January 9, 1950 (p. 17)

**Strutt, John William (Lord Rayleigh)** 1842–1919  
English physicist

...the application of fundamental discoveries in science is altogether too remote for it to be possible to control such discoveries at the source.

*British Association Report*  
1938 (p. 20)

**Wiener, Norbert** 1894–1964  
American mathematician

Those of us who have contributed to the new science of cybernetics thus stand in a moral position which is, to say the least, not very comfortable. We have contributed to the initiation of a new science which...embraces technical developments with great possibilities for good and for evil.

*Cybernetics; Or, Control and Communication in the Animal and the Machine*

Introduction (p. 28)

The MIT Press. Cambridge, Massachusetts, USA. 1961

**Wilson, Edward O.** 1929–  
American biologist and author

Scientists and humanists should consider together the possibility that the time has come for ethics to be removed temporarily from the hands of philosophers and biologized.

*Sociobiology: The New Synthesis*

Part III, Chapter 27 (p. 562)

Harvard University Press. Cambridge, Massachusetts, USA. 1975

An enduring environmental ethic will aim to preserve not only the health and freedom of our species, but access to the world in which the human spirit was born.

*The Diversity of Life*

Chapter Fifteen (p. 381)

W.W. Norton & Company, Inc. New York, New York, USA. 1992

## EUCLID

**Dostoevsky, Fyodor Mikhailovich** 1821–81  
Russian novelist

...if God exists and if He really did create the world, then, as we all know, He created it according to the geometry of Euclid and the human mind with the conception of

only three dimensions in space. Yet there have been and still are geometricians and philosophers, and even some of the most distinguished, who doubt whether the whole universe, or to speak more widely, the whole of being, was only created in Euclid's geometry; they even dare to dream that two parallel lines, which according to Euclid can never meet on earth, may meet somewhere in infinity. I have come to the conclusion that, since I can't understand even that, I can't expect to understand about God.

*The Brothers Karamazov*

Book V, Chapter 3

The Modern Library. New York, New York, USA. 1950

**Einstein, Albert** 1879–1955  
German-born physicist

In your schooldays most of you who read this book made acquaintance with the noble building of Euclid's geometry, and you remember — perhaps with more respect than love — the magnificent structure, on the lofty staircase of which you were chased about for uncounted hours by conscientious teachers.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Part I, Chapter 1 (p. 5)

Pi Press. New York, New York, USA. 2005

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

The Elements of Euclid is as small a part of mathematics as the Iliad is of literature; or as the sculpture of Phidias is of the world's total art.

In Columbia University

*Lectures on Science, Philosophy and Art 1907–1908* (p. 8)

New York, New York, USA. 1908

**Lindsay, Vachel** 1879–1931  
American poet

Old Euclid drew a circle  
On a sand-beach long ago,  
He bound it and enclosed it  
With angles thus and so.

*The Congo and Other Poems*

Euclid

The Macmillan Company. New York, New York, USA. 1914

**Sylvester, James Joseph** 1814–97  
English mathematician

The early study of Euclid made me a hater of geometry...

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to the British Association (p. 660)

University Press. Cambridge, England. 1904–1912

**Turner, H. H.**  
No biographical data available

When Euclid framed his definitions  
He did not miss "the point";  
Space was prescribed by his conditions

For angles twain conjoint.

*The Mathematical Gazette*, Volume VI, Number 100, October 1912  
(p. 403)

## EUGENICS

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer, and statistician

[Eugenics] must be introduced into the national conscience, like a new religion. It has, indeed, strong claim to become an orthodox religious tenet for the future, for Eugenics co-operates with the workings of Nature by securing that humanity shall be represented by the fittest races. What Nature does blindly, slowly and ruthlessly, man must do providently, quickly and kindly.

*Essays in Eugenics*

Eugenics: Its Definition, Scope and Aims (p. 42)  
The Eugenics Education Society. London, England. 1909

Eugenics is the study of the agencies under social control that may improve or impair the racial qualities of future generations either physically or mentally. The feeble nations of the world are necessarily giving way before the nobler varieties of mankind.

Hereditary Character and Talent  
*Macmillan's Magazine*, November, 1864

The chief result of these Inquiries has been to elicit the religious significance of the doctrine of evolution. It suggests an alteration in our mental attitude, and imposes a new moral duty. The new mental attitude is one of a greater sense of moral freedom, responsibility, and opportunity; the new duty which is supposed to be exercised concurrently with, and not in opposition to the old ones upon which the social fabric depends, is an endeavor to further evolution, especially that of the human race.

*Inquiries into Human Faculty and Its Development*

Conclusion (p. 220)  
AMS Press. New York, New York, USA. 1973

The creed of eugenics is founded upon the idea of evolution...

*Essays in Eugenics*

Eugenics as a Factor in Religion (p. 68)  
The Eugenics Education Society. London, England. 1909

The publication in 1859 of *The Origin of Species* by Charles Darwin made a marked epoch in my own mental development, as it did in that of human thought generally. Its effect was to demolish a multitude of dogmatic barriers by a single stroke, and to arouse a spirit of rebellion against all ancient authorities whose positive and unauthenticated statements were contradicted by modern science.

*Memories of My Life*

Chapter 20 (p. 287)  
Methuen & Company Ltd. London, England. 1908

## EUREKA

**Archimedes of Syracuse** 287 BCE–212 BCE  
Sicilian mathematician

I have found it!

In Marcus Vitruvius Pollio  
Translated by J. Gwilt  
*The Architecture of Marcus Vitruvius Pollio*  
Book IX, Section 10 (p. 205)  
Lockwood & Company. London, England. 1874

**Hawking, Stephen William** 1942–  
English theoretical physicist

There's nothing like the Eureka moment, of discovering something that no one knew before.

Lecture

The Future of Theoretical Physics and Cosmology: Stephen Hawking  
60<sup>th</sup> Birthday Symposium  
Stephen Hawking's 60 Years in a Nutshell  
January 11, 2002

## EVAPORATION

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Evaporation is an unseen heavenward waterfall.

*The Note-Books of Samuel Butler* (Volume 1)  
1874–1883 (p. 81)  
University Press of America, Inc. Lanham, Maryland, USA. 1984

**Warren, Henry White** 1831–1912  
Teacher, lecturer, and author

The sunshine says to the sea, held in the grasp of gravitation, "Rise from your bed! Let millions of tons of water fly on the wings of the viewless air, hundreds of miles to the distant mountains, and pour there those millions of tons that shall refresh a whole continent, and shall gather in rivers fitted to bear the commerce and the navies of nations." Gravitation says, "I will hold every particle of this ocean as near the centre of the earth as I can." Sunshine speaks with its word of power, and says, "Up and away!" And in the wreathing mists of morning these myriads of tons rise in the air, flyaway hundreds of miles, and supply all the Niagaras, Mississippis and Amazons of earth. The sun says to the earth, wrapped in the mantle of winter, "Bloom again;" and the snows melt, the ice retires, and vegetation breaks forth, birds sing, and spring is about us.

*Recreations in Astronomy*

Chapter II (p. 36)  
Chautauqua Press. New York, New York, USA. 1886

## EVENT

**Charlie Chan**  
Fictional character

Strange events permit themselves the luxury of occurring in strange places.

*The Chinese Ring*  
Film (1944)

**Ferguson, Kitty** Science writer

Events in the heavens happen in their own good time and not before, and they are often not repeatable. Astronomers have learned to take what's an offer and make the best of it.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*  
Prologue (p. 4)  
Walker & Company. New York, New York, USA. 1999

**Milne, Edward Arthur** 1896–1950

English astrophysicist and cosmologist

Not only the laws of nature, but also the events occurring in nature, the world itself, must appear the same to all observers, wherever they may be.

*Zeitschrift für Betriebswirtschaft*  
Volume 6, 1933 (p. 1)

## EVIDENCE

**Jung, Carl G.** 1875–1961

Swiss psychologist and psychiatrist

I see no sense in publishing a condensation of papers in which I went to so much trouble to discuss the subject in detail. I should have to omit all my evidence and rely on a type of categorical statement which would not make my results any easier to understand. The characteristic ruminant activity of ungulate animals, which consists in the regurgitation of what has already been chewed over, is anything but stimulating to my appetite...

*Memories, Dreams, Reflections*

Introduction (pp. xiii)

Vintage Books. New York, New York, USA. 1963

**Mackin, J. Hoover** 1905–68

American geologist

...evidence is hard to come by, it is largely circumstantial, and there is never enough of it.

In Claude C. Albritton

*The Fabric of Geology*

Rational and Empirical Methods of Investigation in Geology (pp. 159–160)

Addison-Wesley Publishing Company, Inc. Reading, Massachusetts, USA. 1963

**Pasteur, Louis** 1822–95

French chemist

...I am the most hesitating of men, the most fearful of committing myself when I lack evidence. But on the contrary, no consideration can keep me from defending what I hold as true when I can rely on solid scientific evidence.

In Rene Dubos

*Louis Pasteur: Free Lance of Science*

Chapter III (p. 76)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Sagan, Carl** 1934–96

American astronomer and author

I believe that the extraordinary should certainly be pursued. But extraordinary claims require extraordinary evidence.

*Broca's Brain: Reflections on the Romance of Science*

Part II, Chapter 5 (p. 62)

Random House, Inc. New York, New York, USA. 1979

**Shapiro, Robert** 1935–

DNA researcher

The mere statement that something is true need not be considered evidence in its favor no matter how many voices join in the chorus.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*

Chapter One (p. 34)

Summit Books. New York, New York, USA. 1986

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

It was not my opinion; I think there is no sense in forming an opinion when there is no evidence to form it on. If you build a person without any bones in him he may look fair enough to the eye, but he will be limber and cannot stand up; and I consider that evidence is the bones of an opinion.

*Personal Recollections of Joan of Arc*

Chapter II (pp. 8–9)

Oxford University Press, Inc. New York, New York, USA. 1996

## EVOLUTION

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Has joy any survival value in the operations of evolution? I suspect that it does; I suspect that the morose and fearful are doomed to quick extinction.

*Desert Solitaire*

Water (p. 143)

Ballantine Books. New York, New York, USA. 1968

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born U.S. naturalist, geologist, and teacher

It is not true that a slight variation among the successive offspring of the same stock goes on increasing until the difference amounts to a specific distinction. On the contrary, it is a matter of fact that extreme variations finally degenerate or become sterile; like monstrosities they die out, or return to their type.

Evolution and Permanence of Type

*The Atlantic Monthly*, January 1874

**Allen, Grant** 1848–99

Naturalist

In the mud of the Cambrian main  
Did our earliest ancestors dive;  
From a shapeless, albuminous grain  
We mortals are being derived.

*The Evolutionist at Large*

A Ballade of Evolution

Chatto &amp; Windus. London, England. 1881

**Aquinas, St. Thomas** 1227?–74

Dominican philosopher and theologian

We see that things which lack intelligence, such as natural bodies, act for an end, and this is evident from their acting always, or nearly always, in the same way, so as to obtain the best result. Hence it is plain that not fortuitously, but designedly, do they achieve their end. Now whatever lacks intelligence cannot move towards an end, unless it be directed by some being endowed with knowledge and intelligence; as the arrow is shot to its mark by the archer. Therefore some intelligent being exists by whom all natural things are directed to their end; and this being we call God.

*Summa Theologia*

eq. 2, art. 3

H. Regnery Company. Chicago, Illinois, USA. 1966

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Nature which governs the whole will soon change all things which thou seest, and out of their substance will make other things, and again other things from the substance of them, in order that the world may be ever new.

In *Great Books of the Western World* (Volume 12)*The Meditations of Marcus Aurelius*

Book VII, #25 (p. 281)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Observe constantly that all things take place by change, and accustom thyself to consider that the nature of the Universe loves nothing so much as to change the things which are, and to make new things like them.

In *Great Books of the Western World* (Volume 12)*The Meditations of Marcus Aurelius*

Book IV, #36 (p. 266)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Let us begin from God, and show that our pursuit from its exceeding goodness clearly proceeds from him, the Author of good and Father of light.

In *Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 93 (p. 125)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But any one who properly considers the subject, will find natural philosophy to be, after the word of God, the surest remedy against superstition, and the most approved support of faith. She is therefore rightly bestowed upon religion as a most faithful attendant, for the one exhibits the will and the other the power of God. Nor was he wrong who observed, “Ye err, not knowing the Scriptures and the power of God;” thus uniting in one bond the revelation of his will, and the contemplation of his power.

In *Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 89 (p. 124)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bak, Per** 1947–2003

Physicist

History, including that of evolution, is just “one damned thing after another.” We can explain in hindsight what has happened, but we cannot predict what will happen in the future. The Danish philosopher Soren Kierkegaard expressed the same view in his famous phrase “Life is understood backwards, but must be lived forwards.

*How Nature Works: The Science of Self-Organized Criticality*

Chapter 1 (pp. 7–8)

Springer-Verlag. New York, New York, USA. 1996

**Barbellion, Wilhelm Nero Pilate** 1889–1919

English author

How I hate the man who talks about the “brute creation,” with an ugly emphasis on brute.... As for me, I am proud of my close kinship with other animals. I take a jealous pride in my Simian ancestry. I like to think that I was once a magnificent hairy fellow living in the trees, and that my frame has come down through geological time via sea jelly and worms and Amphioxus, Fish, Dinosaurs, and Apes. Who would exchange these for the pallid couple in the Garden of Eden?

In Clarence Day, Jr.

*This Simian World*

Frontispiece

Alfred A. Knopf. New York, New York, USA. 1941

**Bates, Henry Walter** 1825–92

English naturalist and explorer

...on these expanded membranes [*i.e.*, butterfly wings] Nature writes, as on a tablet, the story of the modifications of species.... As the laws of nature must be the same for all beings, the conclusions furnished by this group of insects must be applicable to the whole organic world...

*The Naturalist on the River Amazons* (Volume 2)

Chapter V (p. 346)

John Murray. London, England. 1863

**Bateson, William** 1861–1926

English biologist and geneticist

Modern research lends not the smallest encouragement or sanction to the view that gradual evolution occurs by the transformation of masses of individuals, though that fancy has fixed itself on popular imagination.

Address of the President of the British Association for the Advancement of Science, August 14, 1914

[T]hough we must hold to our faith in the evolution of species, there is little evidence as to how it has come about, and no clear proof that the process is continuing in any considerable degree at the present time.

Address of the President of the British Association for the Advancement of Science, August 20, 1914

It is easy to imagine how Man was evolved from an Amoeba, but we cannot form a plausible guess as to how *Veronica agrestis* and *Veronica polita* were evolved, either one from the other, or both from a common form. We have not even an inkling of the steps by which a Silver Wyandotte fowl descended from *Gallus bankiva*, and we can scarcely even believe that it did.

In J. Arthur Thomsom

*Concerning Evolution*

Chapter II, Section 11 (p. 99)

Yale University Press. New Haven, Connecticut, USA. 1925

### **Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

If single acts [of creation] would evince design, how much more a vast universe, that by inherent laws gradually builded itself, and then created its own plants and animals, a universe so adjusted that it left by the way the poorest things, and steadily wrought toward more complex, ingenious, and beautiful results! Who designed this mighty machine, created matter, gave to it its laws, and impressed upon it that tendency which has brought forth the almost infinite results on the globe, and wrought them into a perfect system? Design by wholesale is grander than design by retail.

*Evolution and Religion*

Part I

Divine Providence and Design (p. 115)

Fords, Howard & Hulbert. New York, New York, USA. 1885

### **Behe, Michael** 1952–

American biochemist, author, and proponent of “intelligent design”

In the abstract, it might be tempting to imagine that irreducible complexity simply requires multiple simultaneous mutations — that evolution might be far chancier than we thought, but still possible. Such an appeal to brute luck can never be refuted.... Luck is metaphysical speculation; scientific explanations invoke causes.

*Darwin's Black Box*

Chapter 2 (p. 40)

The Free Press. New York, New York, USA. 1996

By irreducibly complex I mean a single system composed of several well-matched, interacting parts that contribute

to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning. An irreducibly complex system cannot be produced directly (that is, by continuously improving the initial function, which continues to work by the same mechanism) by slight, successive modification of a precursor system, because any precursors to an irreducibly complex system that is missing a part is by definition non-functional.

*Darwin's Black Box*

Chapter 2 (p. 39)

The Free Press. New York, New York, USA. 1996

In the face of the enormous complexity that modern biochemistry has uncovered in the cell, the scientific community is paralyzed. No one at Harvard University, no one at the National Institutes of Health, no member of the National Academy of Sciences, no Nobel prize winner — no one at all can give a detailed account of how the cilium, or vision, or blood clotting, or any complex biochemical process might have developed in a Darwinian fashion.

*Darwin's Black Box*

Chapter 9 (p. 187)

The Free Press. New York, New York, USA. 1996

...some proponents [of artificial life] see great significance in the fact that they can write short computer programs which display images on the screen that resemble biological objects such as a clam shell. The implication is that it doesn't take much to make a clam. But a biologist or biochemist would want to know, if you opened the computer clam, would you see a pearl inside? If you enlarged the image sufficiently, would you see cilia and ribosomes and mitochondria and intracellular transport systems and all the other systems that real, live organisms need?

*Darwin's Black Box*

Chapter 9 (p. 191)

The Free Press. New York, New York, USA. 1996

### **Bergson, Henri** 1859–1941

French philosopher

...evolution does not mark out a solitary route...it takes directions without aiming at ends, and...it remains inventive even in its adaptations.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter II (p. 108)

The Modern Library. New York, New York, USA. 1944

### **Borland, Hal** 1900–78

American writer

Evolution is not a straight-line process, like industrial manufacturing. If it were, the old models would be discontinued entirely and only the very newest ones would be made. If that were true in nature, creatures with-

out backbones would have vanished when vertebrates evolved, fish would have vanished when amphibians evolved, amphibians would have vanished when reptiles came along, and reptiles would have vanished when the birds and mammals came along.

*The Enduring Pattern*

Life — Flesh and Blood: Reptiles (p. 189)

Simon & Schuster. New York, New York, USA. 1959

### **Bounoure, Louis**

No biographical data available

Evolutionism is a fairy tale for grown-ups. This theory has helped nothing in the progress of science. It is useless.

*The Advocate*, March 8, 1984 (p. 17)

### **Bradley, Jr., John Hodgdon** 1898–1962

American geologist

It is clear that for his own welfare man must first alter his thinking about nature and himself. He must realize that the gods are not unanimous in the desire to elevate any creature to Olympus.

*Parade of the Living*

Part III, Chapter XX (p. 278)

Coward-McCann, Inc. New York, New York, USA. 1930

### **Brenner, Sydney** 1927–

South African-born English molecular biologist

Anything that is produced by evolution is bound to be a bit of a mess.

In Roger Lewin

Why Is Development So Illogical?

*Science*, Volume 224, Number 4655, 22 June, 1984 (p. 1328)

### **Brown, Relis B.**

No biographical data available

The piecing together of the evolution story is comparable to the reconstruction of an atom-bombed metropolitan telephone exchange by a child who has only seen a few telephone receivers.

*Biology* (p. 531)

D.C. Heath & Company. Boston, Massachusetts, USA. 1961

### **Bryan, William Jennings** 1860–1925

American lawyer, orator, and politician

All the ills from which America suffers can be traced back to the teaching of evolution. It would be better to destroy every other book ever written, and save just the first three verses of Genesis.

In Richard Hofstadter

*Anti-Intellectualism in American Life*

Chapter V (p. 125)

Alfred A. Knopf. New York, New York, USA. 1963

### **Bulgakov, Mikhail** 1891–1940

Russian novelist and playwright

Oh, what a marvelous affirmation of evolutionary theory!  
Oh, what a great chain extends from a dog to Mendeleev the chemist!

In Michael D. Gordin

*A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the Periodic Table*

Chapter 1 (p. 3)

Basic Books. New York, New York, USA. 2004

### **Burroughs, John** 1837–1921

American naturalist and writer

Invisible, impalpable forces streaming around us and through us; perpetual change and transformation on every hand; every day a day of creation, every night a revelation of unspeakable grandeur; suns and systems forming in the cyclones of stardust; the whole starry host of heavens flowing like a meadow brook.

In Frances Mason

*Creation by Evolution*

Why Must We Be Evolutionists? (p. 23)

The Macmillan Company. New York, New York, USA. 1928

### **Butler, Samuel** 1612–80

English novelist, essayist, and critic

[An] organism must act in one or other of these two ways: It must either change slowly and continuously with the surroundings, paying cash for everything, meeting the smallest change with a corresponding modification so far as is found convenient; or it must put off change as long as possible, and then make larger and more sweeping changes.

*God the Known and God the Unknown*

Introduction (p. 14)

Yale University Press. New Haven, Connecticut, USA. 1917

### **Calvino, Italo** 1923–1985

Italian writer and novelist

When you're young, all evolution lies before you, every road is open to you, and at the same time you can enjoy the fact of being there on the rock, flat mollusk-pulp, damp and happy. If you compare yourself with the limitations that come afterwards, if you think of how having one form excludes other forms, of the monotonous routine where you finally feel trapped, well, I don't mind saying life was beautiful in those days.

Translated by William Weaver

*Cosmicomics*

The Spiral (p. 142)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

### **Campbell, J. H.**

No biographical data available

In fact, nearly every scientist who has written on the general subject of evolution has felt compelled to show how deftly he can skate toward the abyss of teleology without falling in.

In D.J. Depew and B.H. Weaver (eds.)  
*Evolution at a Crossroads: The New Biology and the New Philosophy of Science*  
 An Organizational Interpretation of Evolution (p. 163)  
 MIT Press. Cambridge, Massachusetts, USA. 1985

**Carruth, William Herbert** 1859–1924  
 American poet

A fire-mist and a planet,  
 A crystal and a cell,  
 A jelly-fish and a saurian,  
 And caves where the  
 cave-men dwell;  
 Then a sense of law  
 and beauty  
 And a face turned from the clod —  
 Some call it Evolution,  
 And others call it  
 God.

*Each in His Own Tongue*  
 Wise-Parslow Company. New York, New York, USA. 1925

**Carson, Rachel** 1907–64  
 American marine biologist and author

It is true that I accept the theory of evolution as the most logical one that has ever been put forward to explain the development of living creatures on this earth. As far as I am concerned, however, there is absolutely no conflict between a belief in evolution and a belief in God as the creator. Believing as I do in evolution, I merely believe that is the method by which God created, and is still creating, life on earth. And it is a method so marvelously conceived that to study it in detail is to increase — and certainly never to diminish — one's reverence and awe both for the Creator and the process.

In Paul Brooks  
*The House of Life: Rachel Carson at Work*  
 The Writer and His Subject (p. 9)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1972

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
 English writer

There may be a broken trail of stones and bones faintly suggesting the development of the human body. There is nothing even faintly suggesting such a development of this human mind.

*The Everlasting Man*  
 Chapter I (p. 22)  
 Dodd, Mead & Company. New York, New York, USA. 1925

Man is not merely an evolution but rather a revolution. That he has a backbone or other parts upon a similar pattern to birds and fishes is an obvious fact, whatever be the meaning of the fact. But if we attempt to regard him, as it were, as a quadruped standing on his hind legs, we shall find what follows far more fantastic and subversive than if he were standing on his head.

*The Everlasting Man*  
 Chapter I (p. 6)  
 Dodd, Mead & Company. New York, New York, USA. 1925

...the dogmatism of Darwinians has been too strong for the agnosticism of Darwin; and men have insensibly fallen into turning this entirely negative term [the “Missing Link”] into a positive image. They talk of searching for the habits and habitat of the Missing Link; as if one were to talk of being on friendly terms with the gap in a narrative or the hole in an argument, of taking a walk with a *non-sequitur* or dining with an undistributed middle.

*The Everlasting Man*  
 Chapter II (p. 27)  
 Dodd, Mead & Company. New York, New York, USA. 1925

**Collins, Mortimer** 1827–76  
 English writer and novelist

There was an Ape in the days that were earlier;  
 Centuries passed and his hair became curlier;  
 Centuries more gave a thumb to his wrist, —  
 Then he was Man, — and a Positivist.

*Selections from the Poetical Works of Mortimer Collins*  
 The Posit  
 Stanza 5  
 Richard Bentley & Son. London, England. 1886

**Cousteau, Jacques-Yves** 1910–77  
 French naval officer and ocean explorer

The story of evolution is probably the most fascinating of all we have to tell because it reaches into our very fiber. It ties all forms of life together and provides us with a common bond to plants and animals. Basically, we are composed of the same substances and possess the same basic drives, making us all brothers in a cosmic experiment. Astronomers tell us that the earth should continue to exist another five billion years. Since life has only been around for three billion years, we are still in our youth. The insights gained through the study of evolution will assure us a future and allow us to determine our destiny.

*The Ocean World of Jacques Cousteau: The Adventure of Life*  
 Introduction (p. 9)  
 The World Publishing Company. New York, New York, USA. 1973

**Crick, Francis Harry Compton** 1916–2004  
 English molecular biologist, physicist, and neuroscientist

The age of the earth is now established beyond any reasonable doubt as very great, yet in the United States millions of Fundamentalists still stoutly defend the naive view that it is relatively short, an opinion deduced from reading the Christian Bible too literally. They also usually deny that animals and plants have evolved and changed radically over such long periods, although this is equally well established. This gives one little confidence that what they have to say about the process of natural selection is likely to be unbiased, since their views are pre-determined by a slavish adherence to religious dogmas.

*The Astonishing Hypothesis: The Scientific Search for the Soul*  
Chapter 18 (pp. 261–262)  
Charles Scribner's Sons. New York, New York, USA. 1994

Every time I write a paper on the origin of life, I determine I will never write another one, because there is too much speculation running after too few facts.

*Life Itself: Its Origin and Nature* (p. 153)  
Simon & Schuster. New York, New York, USA. 1981

Biologists must constantly keep in mind that what they see was not designed, but rather evolved. It might be thought, therefore, that evolutionary arguments would play a large part in guiding biological research, but this is far from the case. It is difficult enough to study what is happening now. To figure out exactly what happened in evolution is even more difficult. Thus evolutionary achievements can be used as hints to suggest possible lines of research, but it is highly dangerous to trust them too much.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 13 (pp. 138–139)  
Basic Books, Inc. New York, New York, USA. 1988

I have no doubt, as will emerge later, that this loss of faith in Christian religion and my growing attachment to science plays a dominant part in my scientific career, not so much on a day-to-day basis but in the choice of what I have considered interesting and important.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 1 (p. 11)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Crothers, Samuel McChord** 1857–1927  
American clergyman and writer

Evolution is a cosmic game of Pussy wants a corner. Each creature has its eye on some snug corner where it would rest in peace. Each corner is occupied by some creature that is not altogether satisfied and that is on the lookout for a larger sphere. There is much beckoning between those who are desirous of making a change. Now and then some bold spirit gives up his assured position and scrambles for something better. The chances are that the adventurer finds it harder to attain the coveted place than he thought.

*The Gentle Reader*  
The Mission of Humor (pp. 68–69)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Darwin, Charles Robert** 1809–82  
English naturalist

There is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*  
Chapter XV (p. 243)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

When I view all beings not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Cambrian system was deposited, they seem to me to become ennobled.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter XV (p. 243)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

On the same principle, if a man were to make a machine for some special purpose but were to use old wheels, springs and pulleys, only slightly altered, the whole machine, with all its parts, might be said to be specially contrived for its present purpose. Thus throughout nature almost every part of each living being has probably served, in a slightly modified condition, for diverse purposes, and has acted in the living machinery of many ancient and distinct specific forms.

*The Works of Charles Darwin*  
Volume 17, The Various Contrivances by Which Orchids Are Fertilized by Insects, Chapter IX (p. 283)  
New York University Press. New York, New York, USA. 1987-

For my own part I would as soon be descended from that heroic little monkey, who braved his dreaded enemy in order to save the life of his keeper, or from that old baboon, who descending from the mountains, carried away in triumph his young comrade from a crowd of astonished dogs — as from a savage who delights to torture his enemies, offers up bloody sacrifices, practises infanticide without remorse, treats his wives like slaves, knows no decency, and is haunted by the grossest superstitions.

In *Great Books of the Western World* (Volume 49)  
*The Descent of Man*  
Part III, Chapter XXI (pp. 596–597)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I am actually weary of telling people that I do not pretend to adduce direct evidence of one species changing into another, but I believe that this view is in the main correct, because so many phenomena can thus be grouped and explained.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
Letter 124, Darwin to F.W. Hutton, April 20, 1861 (p. 184)  
D. Appleton & Company. New York, New York, USA. 1903

Man may be excused for feeling some pride at having risen, though not through his own exertions, to the very summit of the organic scale; and the fact of his having thus risen, instead of having been aboriginally placed there, may give him hope for a still higher destiny in the distant future. But we are not here concerned with hopes or fears, only with the truth as far as our reason permits us to discover it; and I have given the evidence to the best of my ability.



In *Great Books of the Western World* (Volume 49)  
*The Descent of Man*  
 Part III, Chapter XXI (p. 597)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the expression often used by Mr. Herbert Spencer of the Survival of the Fittest is more accurate, and is sometimes equally convenient.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter III (p. 32)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Darwin, Erasmus** 1731–1802

English physician and poet

“The world has been evolved, not created: it has arisen little by little from a small beginning, and has increased through the activity of the elemental forces embodied in itself, and so has rather grown than come into being at an almighty word. What a sublime idea of the infinite might of the great Architect, the Cause of all causes, the Father of all fathers, the Ens Entium! For if we would compare the Infinite, it would surely require a greater Infinite to cause the causes of effects than to produce the effects themselves.

In George Bernard Shaw  
*Back to Methuselah*  
 Preface (p. xx)  
 Constable & Company Ltd. London, England. 1921

All animals undergo perpetual transformations; which are in part produced by their own exertions...and many of these acquired forms or propensities are transmitted to their posterity.

*Zoonomia* (Volume 1)  
 Section XXXIX.4 (p. 502)  
 Printed for J. Johnson. London, England. 1794

... would it be too bold to imagine, that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine, that all warm-blooded animals have arisen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end!

*Zoonomia* (Volume 1)  
 Section XXXIX.4 (p. 505)  
 Printed for J. Johnson. London, England. 1794

### **Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

The account of the origin of life that I shall give is necessarily speculative; by definition, nobody was around to

see what happened.

*The Selfish Gene*  
 Chapter 2 (p. 15)  
 Oxford University Press, Inc. Oxford, England. 1976

Evolution is very possibly not, in actual fact, always gradual. But it must be gradual when it is being used to explain the coming into existence of complicated, apparently designed objects, like eyes. For if it is not gradual in these cases, it ceases to have any explanatory power at all. Without gradualness in these cases, we are back to miracle, which is simply a synonym for the total absence of explanation.

*River Out of Eden: A Darwinian View of Life*  
 Chapter 3 (p. 83)  
 Basic Books. New York, New York, USA. 1995

For Darwin, any evolution that had to be helped over the jumps by God was no evolution at all. It made a nonsense of the central point of evolution.

*The Blind Watchmaker*  
 Chapter 9 (p. 249)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1986

The more statistically improbable a thing is, the less can we believe that it just happened by blind chance. Superficially the obvious alternative to chance is an intelligent Designer. But Charles Darwin showed how it is possible for blind physical forces to mimic the effects of conscious design, and, by operating as a cumulative filter of chance variations, to lead eventual to organized and adaptive complexity, to mosquitoes and mammoths, to humans and therefore, indirectly, to books and computers. Darwin's theory is now supported by all the available relevant evidence, and its truth is not doubted by any serious modern biologist.

*The Necessity of Darwinism*  
*New Scientist*, Volume 94, 15 April 1982 (p. 130)

My argument will be that Darwinism is the only known theory that is in principle capable of explaining certain aspects of life. If I am right it means that, even if there were no actual evidence in favor of Darwinian theory (there is, of course) we should still be justified in preferring it over all rival theories.

One way to dramatize this point is to make a prediction. I predict that, if a form of life is ever discovered in another part of the universe, however outlandish and weirdly alien that form of life may be in detail, it will be found to resemble life on earth in one key respect: it will have evolved by some kind of Darwinian natural selection.

*The Blind Watchmaker*  
 Chapter 11 (pp. 287–288)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1986

Biology is the study of complicated things that give the appearance of having been designed for a purpose.

*The Blind Watchmaker*  
 Chapter 1 (p. 1)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1986

I want to return now to the charge that science is just a faith. The more extreme version of that charge — and one that I often encounter as both a scientist and a rationalist — is an accusation of zealotry and bigotry in scientists themselves as great as that found in religious people. Sometimes there may be a little bit of justice in this accusation.

The Humanist

*Is Science a Religion?*, January 1997

In the Cambrian strata of rocks, vintage about 600 million years, are the oldest ones in which we find most of the major invertebrate groups. And we find many of them already in an advanced state of evolution, the very first time they appear. It is as though they were just planted there, without any evolutionary history. Needless to say, this appearance of sudden planting has delighted creationists.

*The Blind Watchmaker*

Chapter 9 (p. 229)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

... Darwin made it possible to be an intellectually fulfilled atheist.

*The Blind Watchmaker*

Chapter 1 (p. 6)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

### **Day, Clarence** 1874–1935

American writer

As to modesty and decency, if we are simians we have done well, considering: but if we are something else — fallen angels — we have indeed fallen far.

*This Simian World*

Chapter Thirteen (p. 75)

Alfred A. Knopf. New York, New York, USA. 1941

### **Denton, Michael J.** 1943–

British-Australian molecular biobiologist

When a number of enzymes are necessary for the assembly of a particular compound, they are arranged adjacent to each other so that, after each step in the operation, the partially completed compound can be conveniently passed to the next enzyme which performs the next chemical operation and so on until the compound is finally assembled. The process is so efficient that some compounds can be assembled in less than a second, while in many cases the same synthetic operations carried out by chemists, even in a well-equipped lab, would take several hours or days or even weeks.

*Evolution: A Theory in Crisis*

Chapter 14 (p. 334)

Adler & Adler. Bethesda, Maryland, USA. 1986

The impossibility of gradual functional transformation is virtually self-evident in the case of proteins: mere causal observation reveals that a protein is an interacting whole,

the function of every amino acid being more or less (like letters in a sentence or cogwheels in a watch) essential to the function of the entire system. To change, for example, the shape and function of the active site (like changing the verb in a sentence or an important cogwheel in a watch) in isolation throughout the molecule, destabilizing the whole system and rendering it useless.

*Evolution: A Theory in Crisis*

Chapter 13 (p. 321)

Adler & Adler. Bethesda, Maryland, USA. 1986

The complexity of the simplest known type of cell is so great that it is impossible to accept that such an object could have been thrown together suddenly by some kind of freakish, vastly improbable, event. Such an occurrence would be indistinguishable from a miracle.

*Evolution: A Theory in Crisis*

Chapter 11 (p. 264)

Adler & Adler. Bethesda, Maryland, USA. 1986

Protein molecules are the ultimate stuff of life. If we think of the cell as being analogous to a factory, then the proteins can be thought of as analogous to the machines on the factory floor which carry out individually or in groups of all the essential activities on which the life of the cell depends. Each protein is a sort of micro-miniaturized machine, so small that it must be magnified a million times before it is visible to the human eye. The structure and functioning of these fascinating work horses of the cell was a complete mystery until the 1950s.

*Evolution: A Theory in Crisis*

Chapter 10 (p. 234)

Adler & Adler. Bethesda, Maryland, USA. 1986

No living system can be thought of as being primitive or ancestral with respect to any other system, nor is there the slightest empirical hint of an evolutionary sequence among all the incredibly diverse cells on earth.

*Evolution: A Theory in Crisis*

Chapter 11 (p. 250)

Adler & Adler. Bethesda, Maryland, USA. 1986

Considering the way the prebiotic soup is referred to in so many discussions of the origin of life as an already established reality, it comes as something of a shock to realize that there is absolutely no positive evidence for its existence.

*Evolution: A Theory in Crisis*

Chapter 11 (p. 261)

Adler & Adler. Bethesda, Maryland, USA. 1986

Molecular biology has shown that even the simplest of all living systems on the earth today, bacterial cells, are exceedingly complex objects. Although the tiniest bacterial cells are incredibly small, weighing less than  $10^{-12}$  gms, each is in effect a veritable micro-miniaturized factory containing thousands of exquisitely designed pieces of intricate molecular machinery, made up altogether of one hundred thousand million atoms, far more complicated

than any machine built by man and absolutely without parallel in the nonliving world.

*Evolution: A Theory in Crisis*

Chapter 11 (p. 250)

Adler & Adler. Bethesda, Maryland, USA. 1986

At the heart of the problem lay a seeming paradox — proteins can do many things, but they cannot perform the function of storing and transmitting information for their own construction. On the other hand, DNA can store information, but cannot manufacture anything nor duplicate itself. So DNA needs proteins and proteins need DNA. A seemingly unbreakable cycle — the ultimate chicken-and-egg problem.

*Nature's Destiny: How the Laws of Biology Reveal Purpose In the Universe*

Part 2, Chapter 12 (p. 293)

The Free Press, New York, New York, USA; 1998

### **DeVore, Irven** 1934–

American anthropologist

I personally cannot discern a shred of evidence for “[intelligent] design.” If 97% of all creatures have gone extinct, some plan isn’t working very well!

Presentation

Cosmic Questions, Conference, Smithsonian Institute, April 1999

### **Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

The faster death goes, the faster evolution goes.

*Pilgrim at Tinker Creek*

Chapter 10, II (p. 175)

Harper’s Magazine Press. New York, New York, USA. 1974

### **Disraeli, Benjamin, 1<sup>st</sup> Earl of**

**Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

What is the question now placed before society with the glib assurance which to me is most astonishing? That question is this: Is man an ape or an angel? I, my lord, I am on the side of the angels. I repudiate with indignation and abhorrence those new fangled theories.

Speech

Oxford Diocesan Conference, 25 November 1864

You know, all is development. The principle is perpetually going on. First, there was nothing, then there was something; then — I forget the next — I think there were shells, then fishes; the we came — let me see — did we come next? Never mind that; we came at last. And at the next change there will be something very superior to us — something with wings. Ah! That’s it: we were fishes, and I believe we shall be crows.

*Tancred*

Book I, Chapter IX

H. Colburn. London, England. 1847

### **Dobzhansky, Theodosius** 1900–75

Russian-American scientist

The long pageant of evolution extending over one billion years appears to have been brought about by fundamental causes which are still in operation and which can be experimented with today.

*Genetics and The Origin of Species*

Preface to the Third Edition (p. ix)

Columbia University Press. New York, New York, USA. 1951

### **Nothing in Biology Makes Sense Except in the Light of Evolution**

Title of article

*The American Biology Teacher*, Volume 35, March 1973 (p. 125)

Seen in the light of evolution, biology is, perhaps, intellectually the most satisfying and inspiring science. Without that light it becomes a pile of sundry facts — some of them interesting or curious but making no meaningful picture as a whole.

*The American Biology Teacher*

Title of article, Volume 35, March 1973 (p. 129)

Evolution comprises all the stages of the development of the universe: the cosmic, biological, and the human or cultural developments. Attempts to restrict the concept of evolution to biology are gratuitous. Life is a product of the evolution of inorganic nature, and man is a product of the evolution of life.

Changing Man

*Science*, Volume 155, Number 3761, 27 January 1967 (p. 409)

Evolution is a creative process, in precisely the same sense in which composing a poem or a symphony, carving a statue, or painting a picture are creative acts.... It renders possible formations of living systems that would otherwise be infinitely improbable. Nothing can be simpler and more ingenious than its mode of operation: gene constellations that fit the environment survive better and reproduce more often than those that fit less well.

*Genetics of the Evolutionary Process*

Chapter 12, Evolution as a Creative Process (pp. 430, 431)

Columbia University Press. New York, New York, USA. 1970

I venture another, and perhaps equally reckless generalization — nothing makes sense in biology except in the light of evolution, *sub specie evolutionism*. If the living world has not arisen from common ancestors by means of an evolutionary process, then the fundamental unity of living things is a hoax and their diversity, a joke.

Biology, Molecular and Organismic

*American Zoologist*, Volume 4, 1964 (p. 449)

...any evolution theory which disregard the established genetic principles is faulty at its source.

*Genetics and The Origin of Species*

Chapter I (p. 12)

Columbia University Press. New York, New York, USA. 1951

**Dowdeswell, Wilfrid Hogarth** 1914–96

No biographical data available

Studies centered exclusively on the past tend inevitably to obscure the present and future, thus fostering the idea that evolution has come to a comparative standstill at the present time or is proceeding too slowly to be detected.

*The Mechanism of Evolution* (p. 1)

Heinemann. London, England. 1955

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Most enlightened persons now accept as a fact that everything in the cosmos — from heavenly bodies to human beings — has developed and continues to develop through evolutionary processes.

Humanistic Biology

*American Scientist*, Volume 53, Number 1, March 1965 (p. 6)

**Dyson, Freeman J.** 1923–

American physicist and educator

In five billion years or less, we've evolved from some sort of primordial slime into human beings. What will happen in another ten billion years? It's just utterly impossible to conceive of ourselves changing as drastically as that over and over again, for I think all you can say is that the material form that life would take on in that kind of time scale is completely open.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Imagine... (p. 351)

Ticknor & Fields. New York, New York, USA. 1984

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The stately drama of stellar evolution turns out to be more like the hair-breadth escapades of the films. The music of the spheres has almost a suggestion of — jazz.

*Stars and Atoms*

Lecture I (p. 27)

Yale University Press. London, England. 1927

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Life, even cellular life, may exist out yonder in the dark. But high or low in nature, it will not wear the shape of man. That shape is the evolutionary product of a strange, long wandering through the attics of the forest roof, and so great are the chances of failure, that nothing precisely and identically human is likely to ever come that way again.

*The Immense Journey*

Little Men and Flying Saucers (pp. 160–161)

Vintage Books. New York, New York, USA. 1957

It was the failures who had always won, but by the time they won they had come to be called successes. This is

the final paradox, which men call evolution.

*The Star Thrower*

The Inner Galaxy, III (p. 311)

Times Books. New York, New York, USA. 1978

**Eldredge, Niles** 1943–

American paleontologist

CHARLES ROBERT DARWIN stands among the giants of Western thought because he convinced a majority of his peers that all of life shares a single, if complex, history. He taught us that we can understand life's history in purely naturalistic terms, without recourse to the supernatural or divine.

*Time Frames: The Rethinking of Darwinian Evolution and The Theory of Punctuated Equilibria*

PREFACE (p. 13)

Simon & Schuster. New York, New York, USA. 1985

I needed to explain why evolution leaves and entirely different sort of pattern in the rock record than Darwin — and his long string of successors, including many paleontologists — had supposed.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 97)

John Wiley & Sons, Inc. New York, New York, USA. 1995

No wonder paleontologists shied away from evolution for so long. It seems never to happen. Assiduous collecting of cliff faces yields zigzags, minor oscillations, and the very occasional slight accumulation of change — over millions of years, at a rate too slow to really account for all the prodigious change that has occurred in evolutionary history. When we do see the introduction of evolutionary novelty, it usually shows up with a bang and often with no firm evidence that the organisms did not evolve elsewhere! Evolution cannot forever be going on someplace else. Yet that's how the fossil record has struck many a forlorn paleontologist looking to learn something about evolution.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 95)

John Wiley & Sons, Inc. New York, New York, USA. 1995

Scientists, being as a rule more or less human beings, passionately stick up for their ideas, their pet theories. It's up to someone else to show you are wrong.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 221)

John Wiley & Sons, Inc. New York, New York, USA. 1995

Simple extrapolation does not work. I found that out back in the 1960s as I tried in vain to document examples of the kind of slow, steady directional change we all thought ought to be there, ever since Darwin told us that natural selection should leave precisely such a telltale signal as we collect our fossils up cliff faces. I found instead, that once species appear in the fossil record, they tend not to change much at all. Species

remain imperturbably, implacably resistant to chance as a matter of course.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 3)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

Stasis is now abundantly well documented as the preeminent pale ontological pattern in the evolutionary history of species.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 77)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

The persistent pattern of no change within samples, coupled with the abrupt appearance of new species — organisms marked with anatomical innovations — had to be telling us something about the way the evolutionary process works.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 97)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

As a paleontologist, I readily concede that my long dead fossils, lacking any traces of their soft anatomies or behaviors, are totally mute on the subject of reproduction and transmission of genetic information. And this is, I acknowledge, a major limitation to our data.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 2)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

But we saw — as did several pale ontological contemporaries of Darwin — that if you do collect a series of fossils up through a sequence of sedimentary rock, and if you don't see much evidence of anatomical change through that series, that is indeed evidence that substantial gradual evolutionary change has not occurred within that species lineage, no matter how guppy the record may be. That's why the evidence for stasis now appears so overwhelming.

*Reinventing Darwin: The Great Debate at the High Table of Evolutionary Theory* (p. 96)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Each animal or vegetable form remembers the next inferior and predicts the next higher.

*Letters and Social Aims*  
Poetry and Imagination (p. 8)  
James R. Osgood & Company. Boston, Massachusetts, USA. 1876

How far off yet is the trilobite! how far the quadruped! how inconceivably remote is man! All duly arrive, and then race after race of men. It is a long way from granite to the oyster; farther yet to Plato and the preaching of the immortality of the soul.

*Ralph Waldo Emerson: Essays and Lectures*  
Essays: Second Series  
Nature (p. 546)

The Library of America. New York, New York, USA. 1983

A SUBTLE chain of countless rings

The next unto the farthest brings;

The eye reads omens where it goes,

And speaks all languages the rose;

And, striving to be man, the worm

Mounts through all the spires of form.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
Nature (p. 281)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Fana, C.**

No biographical data available

[Hypotheses] on the origin of species are an indication of our mental tendencies rather than the synthetic result of facts incontrovertibly ascertained. Let us admit without further preamble: the success attained by the theory of evolution is not due primarily to its self-evident character, for even the most generally admitted facts cannot always be reconciled with it, but rather to the sympathy of the scientific world for the dogma of continuity of natural phenomena.

*Brain and Heart* (p. 41)  
Oxford University Press, Inc. Oxford, England. 1926

### **Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Using stories we may of course also introduce “scientific” accounts, say, of the origin of the world and thus make the children acquainted with science as well. But science must not be given any special position except for pointing out that there are lots of people who believe in it. Later on the stories which have been told will be supplemented with “reasons,” where by reasons I mean further accounts of the kind found in the tradition to which the story belongs. And, of course, there will also be contrary reasons. Both reasons and contrary reasons will be told by the experts in the fields and so the young generation becomes acquainted with all kinds of sermons and all types of wayfarers.

*Knowledge Science and Relativism*  
Chapter 8 (p. 189)  
Cambridge University Press. Cambridge, England. 1999

Three cheers for the fundamentalists in California who succeeded in having a dogmatic formulation of the theory of evolution removed from the text books and an account of Genesis included. (But I know that they would become as chauvinistic and totalitarian as scientists are today when given the chance to run society all by themselves. Ideologies are marvelous when used in the companies of other ideologies. They become boring and doctrinaire as soon as their merits lead to the removal of their opponents.) The most important change, however, will have to occur in the field of education.

*Knowledge Science and Relativism*

Chapter 8 (pp. 187–188)  
Cambridge University Press. Cambridge, England. 1999

Will the laymen be able to come to a correct judgment? Most certainly, for the competence, the complications and the successes of science are vastly exaggerated. One of the most exhilarating experiences is to see how a lawyer, who is a layman, can find holes in the testimony, the technical testimony, of the most advanced expert and thus prepare the jury for its verdict. Science is not a closed book that is understood only after years of training. It is an intellectual discipline that can be examined and criticized by anyone who is interested and that looks difficult and profound only because of a systematic campaign of obfuscation carried out by many scientists (though, I am happy to say, not by all).

*Knowledge Science and Relativism*

Chapter 8 (p. 187)  
Cambridge University Press. Cambridge, England. 1999

Science, surely, was always in the forefront of the fight against authoritarianism and superstition. It is to science that we owe our increased intellectual freedom *vis-a-vis* religious beliefs; it is to science that we owe the liberation of mankind from ancient and rigid forms of thought. Today these forms of thought are nothing but bad dreams — and this we learned from science. Science and enlightenment are one and the same thing — even the most radical critics of society believe this.

*Knowledge Science and Relativism*

Chapter 8 (p. 181)  
Cambridge University Press. Cambridge, England. 1999

**Futuyma, Douglas J.** 1942–  
American biologist

Evolution, a fact rather than mere hypothesis, is the central unifying concept in biology. By extension it affects almost all other fields of knowledge and thought and must be considered one of the most influential concepts in Western thought.

*Evolutionary Biology*

Chapter One (p. 14)  
Sinauer Associates. Sunderland, Massachusetts, USA. 1979

**Gale, Barry**  
No biographical data available

Though often brilliantly and ingeniously composed, his argument was based, in many instances, on new and often unsubstantiated hypotheses, sometimes fuzzy analogies and metaphors, the repudiation of competing explanations, and a frequent plea to complexity and general ignorance, rather than compelling, clearly incontrovertible evidence in its own support; and it is clear that Darwin knew this.

*Evolution Without Evidence: Charles Darwin and the Origin of Species*  
(p. 101)

University of New Mexico Press. Albuquerque, New Mexico, USA. 1982

Yet even here, where Darwin's arguments are strongest, nagging questions remain. For example, a reader of the Origin might be justified in wondering what Creationist view Darwin is referring to. Perhaps this is a problem more for the present-day reader. Darwin's contemporaries may have known exactly what he meant, though I doubt it. Often the Creationist position seems merely a straw man — set up only to be knocked down. The constraints on space in the Origin, which led Darwin to abandon his original intention of arguing on both sides of the mutability issue, add to this feeling. The result is that the Creationist position is never clearly defined in the Origin.

*Evolution Without Evidence: Charles Darwin and the Origin of Species*  
(p. 139)

University of New Mexico Press. Albuquerque, New Mexico, USA. 1982

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer and statistician

The conditions that direct the order of the whole of the living world around us, are marked by their persistence in improving the birthright of successive generations. They determine, at much cost of individual comfort, that each plant and animal shall, on the general average, be endowed at its birth with more suitable natural faculties than those of its representative in the preceding generation.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (p. 194)  
AMS Press. New York, New York, USA. 1973

**Gamow, George** 1904–68  
Russian-born American physicist

Indeed, it took less than an hour to make the atoms, a few hundred million years to make the stars and planets, but five billion years to make man.

*The Creation of the Universe*

Conclusion (p. 139)  
The Viking Press. New York, New York, USA. 1952

**Geddes, Patrick** 1854–1932  
Scottish biologist and botanist

**Thomson, J. Arthur**  
No biographical data available

Yet ideas of unity amid diversity, of order amid change, have also long been growing, even finding expression, and this not merely, as sporadically in all ages, in impressions and speculations on decline or on better things; but in clearer and more comprehensive surveys of the processes of change, even inquiries into its method. These, in fact, have gone towards making up that general idea we now more or less share, of the universe as not only orderly, but in the process of change. Changing order, orderly change, and this everywhere — in nature inorganic and organic, in individual and in social life — for

this vast conception, now everywhere diffusing, often expressed, rarely as yet applied, we need some general term — and this is Evolution.

*Evolution*

Introduction (pp. viii–ix)

Henry Holt & Company. New York, New York, USA. 1911

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

I am, in point of fact, a particularly haughty and exclusive person, of pre-Adamite ancestral descent. You will understand this when I tell you that I can trace my ancestry back to a protoplasmal, primordial, atomic globule.

*The Complete Plays of Gilbert and Sullivan*

The Mikado

Operetta, Act I

W.W. Norton & Company, Inc. New York, New York, USA. 1976

... a Darwinian Man, though well-behaved,

At best is only a monkey shaved!

*The Complete Plays of Gilbert and Sullivan*

Princess Ida

Operetta, Act II

W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Gish, D. T.**

No biographical data available

Furthermore, the architects of the modern synthetic theory of evolution have so skillfully constructed their theory that it is not capable of falsification. The theory is so plastic that it is capable of explaining anything.

*Evolution? The Fossils Say No!*

Chapter I (p. 17)

Creation-Life Publishers. San Diego, California, USA. 1979

**Gould, Donald** 1919–2002

English medical writer and editor

The scientific establishment bears a grisly resemblance to the Spanish Inquisition. Either you accept the rules and attitudes and beliefs promulgated by the “papacy” (for which read, perhaps, the Royal Society or the Royal College of Physicians), or face a dreadful retribution. We will not actually burn you at the stake, because that sanction, unhappily, is now no longer available under our milksop laws. But we will make damned sure that you are a dead duck in our trade.

Letting Poetry Loose in the Laboratory

*New Scientist*, August 29, 1992 (p. 51)

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Well evolution is a theory. It is also a fact. And facts and theories are different things, not rungs in a hierarchy of increasing certainty. Facts are the world’s data. Theories are structures of ideas that explain and interpret facts.

Facts do not go away when scientists debate rival theories to explain them. Einstein’s theory of gravitation replaced Newton’s, but apples did not suspend themselves in mid-air, pending the outcome. And humans evolved from ape-like ancestors whether they did so by Darwin’s proposed mechanism or by some other yet to be discovered.

*Hen’s Teeth and Horses Toes*

Evolution as Fact and Theory (p. 254)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

These shortest-term studies are elegant and important, but they cannot represent the general mode for building patterns in the history of life. The reason strikes most people as deeply paradoxical, even funny — but the argument truly cannot be gainsaid. Evolutionary rates of a moment, as measured for guppies and lizards, are vastly too rapid to represent the general modes of change that build life’s history through geological ages.... These measured changes over years and decades are too fast by several orders of magnitude to build the history of life by simple cumulation. Reznick’s guppy rates range from 3,700 to 45,000 darwins (a standard metric for evolution, expressed as change in units of standard deviation — a measure of variation around the mean value of a trait in a population — per million years). By contrast, rates for major trends in the fossil record generally range from 0.1 to 1.0 darwin. Reznick himself states that “the estimated rates [for guppies] are...four to seven orders of magnitude greater than those observed in the fossil record” (that is, ten thousand to ten million times faster!).

This View of Life, the Paradox of the Visibly Irrelevant

*Natural History*, Volume 106, Number 11, December 1997 (p. 62, 64)

Two organisms may maintain the same feature because both inherited it from a common ancestor. These are homologous similarities, and they indicate “propinquity of dissent,” to use Darwin’s words. Forelimbs of people, porpoises, bats and horses provide the classic example of homology in most textbooks. They look different, and do different things, but are built of the same bones. No engineer, starting from scratch each time, would have built such disparate structures from the same parts. Therefore, the parts existed before the particular set of structures now housing them: they were, in short, inherited from a common ancestor.

*The Panda’s Thumb: More Reflections In Natural History*

Chapter 24 (p. 248)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

We talk about the “march from monad to man” (old-style language again) as though evolution followed continuous pathways to progress along unbroken lineages. Nothing could be further from reality. I do not deny that, through time, the most “advanced” organism has tended to increase in complexity. But the sequence [allocated in most texts] from jellyfish to trilobite to nautiloid to armored fish to dinosaur to monkey to human is no lineage at all,

but a chronological set of termini on unrelated evolutionary trunks. Moreover life shows no trend to complexity in the usual sense — only an asymmetrical expansion of diversity around a starting point constrained to be simple.

*Eight Little Piggies: Reflections in Natural History*

Tires to Sandals (p. 322)

W.W. Norton & Company, Inc. New York, New York, USA.1993

There is no progress in evolution. The fact of evolutionary change through time doesn't represent progress as we know it. Progress is not inevitable. Much of evolution is downward in terms of morphological complexity, rather than upward. We're not marching toward some greater thing. The actual history of life is awfully damn curious in the light of our usual expectation that there's some predictable drive toward a generally increasing complexity in time. If that's so, life certainly took its time about it: five-sixths of the history of life is the story of single-celled creatures only.

*The Third Culture*

The Pattern of Life's History (p. 52)

Simon & Shuster. New York, New York, USA. 1995

We cannot understand much of the history of late nineteenth- and early twentieth-century anthropology, with its plethora of taxonomic names proposed for nearly every scrap of fossil bone, unless we appreciate its obsession with the identification and ranking of races. For many schemes of classification sought to tag the various fossils as ancestors of modern races and to use their relative age and apishness as a criterion for racial superiority.

*Human Equality Is a Contingent Fact of History*

*Natural History*, Volume 93, Number 11, November, 1984 (p. 28)

We are here because one odd group of fishes had a peculiar fin anatomy that could transform into legs for terrestrial creatures; because the earth never froze entirely during an ice age; because a small and tenuous species, arising in Africa a quarter of a million years ago, has managed, so far, to survive by hook and by crook. We may yearn for a "higher" answer — but none exists.

*Life magazine*, December 1988

The absence of fossil evidence for intermediary stages between major transitions in organic design, indeed our inability, even in our imagination, to construct functional intermediates in many cases, has been a persistent and nagging problem for gradualistic accounts of evolution.

*Is a New and General Theory of Evolution Emerging?*

*Paleobiology*, January 1980 (p. 127)

The history of most fossil species includes two features particularly inconsistent with gradualism: 1. Stasis. Most species exhibit no directional change during their tenure on earth. They appear in the fossil record looking much the same as when they disappear; morphological change is usually limited and directionless. 2. Sudden appearance. In any local area, a species does not arise gradually

by the steady transformation of its ancestors; it appears all at once and "fully formed."

*Evolution's Erratic Pace*

*Natural History*, Volume 86, Number 5, May 1977 (p. 14)

The extreme rarity of transitional forms in the fossil record persists as the trade secret of paleontology. The evolutionary trees that adorn our textbooks have data only at the tips and nodes of their branches; the rest is inference, however reasonable, not the evidence of fossils...

*Evolution's Erratic Pace*

*Natural History*, Volume 86, Number 5, May 1977 (p. 14)

All paleontologists know that the fossil record contains precious little in the way of intermediate forms; transitions between major groups are characteristically abrupt. Gradualists usually extract themselves from this dilemma by invoking the extreme imperfection of the fossil record — if only one step in a thousand survives as a fossil, geology will not record continuous change. Although I reject this argument...let us grant the traditional escape and ask a different question. Even though we have no direct evidence for smooth transitions, can we invent a reasonable sequence of intermediate forms — that is, viable, functioning organisms — between ancestors and descendants in major structural transitions? Of what possible use are the imperfect incipient stages of useful structures? What good is half a jaw or half a wing? The concept of preadaptation provides the conventional answer by permitting us to argue that incipient stages performed different functions. The half jaw worked perfectly well as a series of gill-supporting bones; the half wing may have trapped prey or controlled body temperature. I regard preadaptation as an important, even an indispensable, concept. But a plausible story is not necessarily true. I do not doubt that preadaptation can save gradualism in some cases, but does it permit us to invent a tale of continuity in most or all cases? I submit, although it may only reflect my lack of imagination, that the answer is no...

*This View of Life. The Return of Hopeful Monsters*

*Natural History*, Volume 86, Number 6, June 1977 (pp. 24–25)

Since we proposed punctuated equilibria to explain trends, it is infuriating to be quoted again and again by creationists — whether through design or stupidity, I do not know — as admitting that the fossil record includes no transitional forms. Transitional forms are generally lacking at the species level, but they are abundant between larger groups.

*Hen's Teeth and Horses Toes*

*Evolution as Fact and Theory* (p. 260)

W.W. Norton & Company, Inc. New York, New York, USA.1983

Orchids manufacture their intricate devices from the common components of ordinary flowers, parts usually fitted for very different functions. If God had designed a beautiful machine to reflect his wisdom and power,



surely he would not have used a collection of parts generally fashioned for other purposes. Orchids were not made by an ideal engineer; they are jury-rigged from a limited set of available components. Thus, they must have evolved from ordinary flowers.

*The Panda's Thumb: More Reflections in Natural History*  
Chapter 1 (p. 20)

W.W. Norton & Company, Inc. New York, New York, USA.1980

Odd arrangements and funny solutions are the proof of evolution — paths that a sensible God would never tread but that a natural process, constrained by history, follows performe.

*The Panda's Thumb: More Reflections in Natural History*  
Chapter 1 (pp. 20–21)

W.W. Norton & Company, Inc. New York, New York, USA.1980

Scientific claims must be testable; we must, in principal, be able to envision a set of observations that would render them false. Miracles cannot be judged by this criterion, as Whitcomb and Morris have admitted. But is all creationists' writing merely about untestable singularities? Are arguments never made in proper scientific form? Creationists do offer some testable statements, and these are amenable to scientific analysis. Why, then, do I continue to claim that creationism isn't science? Simply because these relatively few statements have been tested and conclusively refuted.

In Ashley Montagu (ed.)

*Science and Creationism*

Genesis vs. Geology (pp. 130–131)

Oxford University Press, Inc. New York, New York, USA. 1984

Sediments between 4 and 10 million years in age are potential guardians of the Holy Grail of human evolution — the period when our lineage began its separate end run to later domination, and a time for which no fossil evidence exists at all.

Empire of the Apes

*Natural History*, Volume 96, Number 5, May 1987 (p. 24)

Gradualism, the idea that all change must be smooth, slow, and steady, was never read from the rocks. It was primarily a prejudice of nineteenth-century liberalism facing a world in revolution. But it continues to color our supposedly objective reading of life's history.

This View of Life, An Early Start

*Natural History*, Volume 87, Number 2, February 1978 (p. 24)

Darwin has been vindicated by a rich Precambrian record, all discovered in the past thirty years. Yet the peculiar character of this evidence has not matched Darwin's prediction of a continuous rise in complexity toward Cambrian life, and the problem of the Cambrian explosion has remained as stubborn as ever — if not more so, since our confusion now rests on knowledge, rather than ignorance about the nature of Precambrian life.

*Wonderful Life: The Burgess Shale and The Nature of History*

Chapter II (p. 57)

W.W. Norton & Company, Inc. New York, New York, USA.1989

But our ways of learning about the world are strongly influenced by the social preconceptions and biased modes of thinking that each scientist must apply to any problem. The stereotype of a fully rational and objective "scientific method," with individual scientists as logical (and interchangeable) robots, is self-serving mythology.

This View of Life. In the Mind of the Beholder

*Natural History*, Volume 103, Number 2, February 1994 (p. 14)

If justification required eyewitness testimony, we would have no sciences of deep time — no geology, no ancient human history either. (Should I believe Julius Caesar ever existed? The hard bony evidence for human evolution... surely exceeds our reliable documentation of Caesar's life.)

Dorothy, It's Really Oz

*Time Magazine*, August 23, 1999 (p. 59)

I emphatically do not assert the general "truth" of this philosophy of punctuational change. Any attempt to support the exclusive validity of such a grandiose notion would border on the nonsensical... Nonetheless, I will confess to a personal belief that a punctuational view may prove to map tempos of biological and geographic change more accurately and more often than any of its competitors — if only because complex systems in steady state are both common and highly resistant to change. As my colleague British geologist Derek V. Ager writes in supporting a punctuational view of geologic change: "The history of any one part of the earth, like the life of a soldier, consists of long periods of boredom and short terror."

*The Panda's Thumb: Reflections in Natural History*

Chapter 17 (p. 185)

W.W. Norton & Company, Inc. New York, New York, USA.1980

It seems the height of antiquated hubris to claim that the universe carried on as it did for billions of years in order to form a comfortable abode for us. Chance and historical contingency give the world of life most of its glory and fascination. I sit here happy to be alive and sure that some reason must exist for "why me?" Or the earth might have been totally covered with water, and an octopus might now be telling its children why the eight-legged God of all things had made such a perfect world for cephalopods. Sure we fit. We wouldn't be here if we didn't. But the world wasn't made for us and it will endure without us.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 14 (p. 206)

W.W. Norton & Company, Inc. New York, New York, USA.1987

In the bad old days, before men rose from their armchairs to look at rocks in the field, biblical limitations of the Mosaic chronology precluded any understanding of our earth's history.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 5)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

[Darwin's notebooks] include many statements showing that he espoused but feared to expose something he perceived as far more heretical than evolution itself: philosophical materialism — the postulate that matter is the stuff of all existence and that all mental and spiritual phenomena are its by-products.

*Ever Since Darwin: Reflections in Natural History*  
Chapter 1 Darwin's Delay (p. 24)  
W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Grassé, Pierre P.** 1895–1985  
French zoologist

Through use and abuse of hidden postulates, of bold, often ill-founded extrapolations, a pseudoscience has been created. It is taking root in the very heart of biology and is leading astray many biochemists and biologists, who sincerely believe that the accuracy of fundamental concepts has been demonstrated, which is not the case.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
An Introduction to the Study of Evolution (p. 6)  
Academic Press. New York, New York, USA. 1977

Today, our duty is to destroy the myth of evolution, considered as a simple, understood, and explained phenomenon which keeps rapidly unfolding before us. Biologists must be encouraged to think about the weaknesses of the interpretations and extrapolations that theoreticians put forward or lay down as established truths. The deceit is sometimes unconscious, but not always, since some people, owing to their sectarianism, purposely overlook reality and refuse to acknowledge the inadequacies and the falsity of their beliefs.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
An Introduction to the Study of Evolution (p. 8)  
Academic Press. New York, New York, USA. 1977

Some contemporary biologists, as soon as they observe a mutation, talk about evolution. They are implicitly supporting the following syllogism: mutations are the only evolutionary variations, all living beings undergo mutations, therefore all living beings evolve. This logical scheme is, however, unacceptable: first, because its major premise is neither obvious nor general; second, because its conclusion does not agree with the facts. No matter how numerous they may be, mutations do not produce any kind of evolution.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 88)  
Academic Press. New York, New York, USA. 1977

What is the use of their unceasing mutations, if they do not change? In sum, the mutations of bacteria and viruses

are merely hereditary fluctuations around a median position; a swing to the right, a swing to the left, but no final evolutionary effect.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 87)  
Academic Press. New York, New York, USA. 1977

The opportune appearance of mutations permitting animals and plants to meet their needs seems hard to believe. Yet the Darwinian theory is even more demanding: a single plant, a single animal would require thousands and thousands of lucky, appropriate events. Thus, miracles would become the rule: events with an infinitesimal probability could not fail to occur.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter IV (p. 103)  
Academic Press. New York, New York, USA. 1977

Once one has noticed microvariations (on the one hand) and specific stability (on the other), it seems very difficult to conclude that the former (microvariation) comes into play in the evolutionary process.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter III (p. 88)  
Academic Press. New York, New York, USA. 1977

It follows that any explanation of the mechanism in creative evolution of the fundamental structural plans is heavily burdened with hypotheses. This should appear as an epigraph to every book on evolution. The lack of direct evidence leads to the formation of pure conjectures as to the genesis of the phyla; we do not even have a basis to determine the extent to which these opinions are correct.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter II (p. 31)  
Academic Press. New York, New York, USA. 1977

**Greene, Graham** 1904–1991  
English novelist, playwright, and critic

God...created a number of possibilities in case some of his prototypes failed — that is the meaning of evolution.

*Travels with My Aunt*  
Part 2, Chapter 7 (p. 227)  
Penguin Books. Harmondsworth, England. 1977

**Guiterman, Arthur** 1871–1943  
Poet

Recall from Time's abysmal chasm  
That piece of primal protoplasm  
The First Amoeba, strangely splendid,  
From whom we're all of us descended.

*Gaily the Troubadour*  
Ode to the Amoeba  
E.P. Dutton & Company, Inc. New York, New York, USA. 1936

**Haeckel, Ernst** 1834–1919  
German biologist and philosopher

Our concern is rather with the unparalleled influence that Darwinism, and its application to man, have had during the last forty years on the whole province of science; and at the same time, with its irreconcilable opposition to the dogmas of the Churches.

*Last Words on Evolution: A Popular Retrospect and Summary* (p. 36)  
P. Eckler Publishing Company, New York, New York, USA. 1920

It was obvious that both the general theory of evolution and its extension to man in particular must meet from the first with the most determined resistance on the part of the Churches. Both were in flagrant contradiction to the Mosaic story of creation, and other Biblical dogmas that were involved in it, and are still taught in our elementary schools. It is creditable to the shrewdness of the theologians and their associates, the metaphysicians, that they at once rejected Darwinism, and made a particularly energetic resistance in their writings to its chief consequence, the descent of man from ape. This resistance seemed the more justified and hopeful as, for seven or eight years after Darwin's appearance, few biologists accepted his theory, and the general attitude amongst them was one of cold skepticism.

*Last Words on Evolution: A Popular Retrospect and Summary* (pp. 38–39)  
P. Eckler Publishing Company, New York, New York, USA. 1920

Our science of evolution won its greatest triumph when, at the beginning of the twentieth century, its most powerful opponents, the Churches, became reconciled to it, and endeavored to bring their dogmas into line with it.

*Last Words on Evolution: A Popular Retrospect and Summary* (p. 55)  
P. Eckler Publishing Company, New York, New York, USA. 1920

**Hawkins, Gerald S.** 1928–2003  
English archaeoastronomer

We should expect to find stars and galaxies in all stages of evolution as they form from existing material and then decay. For stars this is certainly the case.... There may be a similar evolutionary process for galaxies, but at the moment we do not have enough experimental evidence to give us the clues to the evolutionary pattern.

*A New Theory of the Universe*  
*Science Digest*, Volume 52, November, 1962 (p. 45)

**Herford, Oliver** 1863–1935  
American writer and illustrator

Child-ren, behold the Chim-pan-zee;  
He sits on the an-ces-tral tree  
From which we sprang in ag-es gone.  
I'm glad we sprang: had we held on,  
We might, for aught that I can say,  
Be horrid Chim-pan-zees to-day.

*A Child's Primer of Natural History*  
The Chimpanzee

Charles Scribner's Sons, New York, New York, USA. 1899

**Holmes, Jr., Oliver Wendell** 1841–1935  
American jurist

When one thinks coldly I see no reason for attributing to man a significance different in kind from that which belongs to a baboon or to a grain of sand.

*Holmes-Pollock Letters*  
August 30, 1907

**Hooper, Judith**  
American biology writer

They conceived the evidence that would carry the vital intellectual argument, but at its core lay flawed science, dubious methodology and wishful thinking. Clustered around the peppered moth is a swarm of human ambition, and self-delusions shared among some of the most renowned evolutionary biologists of our era.

*Of Moths and Men: The Untold Story of Science and the Peppered Moth*  
Prologue: The Moths of Oxford (pp. xix–xx)  
W.W. Norton & Company, Inc. New York, New York, USA. 2002

**Hoyle, Sir Fred** 1915–2001  
English mathematician, astronomer, and writer

The chance that higher life forms might have emerged in this way is comparable with the chance that “a tornado sweeping through a junk yard might assemble a Boeing 747 from the materials therein.”

Hoyle on Evolution  
*Nature*, Volume 294, Number 5837, November 12, 1981 (p. 105)

At all events, anyone with even a nodding acquaintance with the Rubik cube will concede the near-impossibility of a solution being obtained by a blind person moving the cube faces at random. Now imagine 1050 blind persons each with a scrambled Rubik cube, and try to conceive of the chance of them all simultaneously arriving at the solved form. You then have the chance of arriving by random shuffling of just one of the many biopolymers on which life depends. The notion that not only the biopolymers but the operating programme of a living cell could be arrived at by chance in a primordial organic soup here on the Earth is evidently nonsense of a high order.

The Big Bang in Astronomy  
*New Scientist*, November 19, 1981 (pp. 521–527)

**Huxley, Aldous** 1894–1963  
English writer and critic

I had motives for not wanting the world to have a meaning; consequently assumed that it had none, and was able without any difficulty to find satisfying reasons for this assumption. The philosopher who finds no meaning in the world is not concerned exclusively with a problem in pure metaphysics, he is also concerned to prove that there is no valid reason why he personally should not do as he wants to do, or why his friends should not seize political power and govern in the way that they find most

advantageous to themselves.... For myself, the philosophy of meaninglessness was essentially an instrument of liberation, sexual and political.

*Ends and Means*

Chapter XIV (p. 270)

Chatto & Windus. London, England. 1938

A poor degenerate from the ape,  
Whose hands are four, whose tail's a limb,  
I contemplate my flaccid shape  
And know I may not rival him.

*Leda*

First Philosopher's Song

George H. Doran Company. New York, New York, USA. 1920

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

There is no more need to postulate an *élan vital* or a guiding purpose to account for evolutionary progress than to account for adaptation, for degeneration or any other form of specialization.... The purpose manifested in evolution, whether in adaptation, specialization, or biological progress, is only an apparent purpose. It is just as much a product of blind forces as is the falling of a stone to earth or the ebb and flow of the tides. It is we who have read purpose into evolution, as earlier men projected will and emotion into inorganic phenomena like storm or earthquake.

*Evolution: The Modern Synthesis*

Chapter 10 (pp. 568, 576)

George Allen & Unwin Ltd. London, England. 1942

The concept of evolution was soon extended into other than biological fields. Inorganic subjects such as the life-histories of stars and the formation of the chemical elements on the one hand, and on the other hand subjects like linguistics, social anthropology, and comparative law and religion, began to be studied for an evolutionary angle, until today we are enabled to see evolution as a universal and all pervading process.

In James R. Newman (ed.)

*What Is Science? Twelve Eminent Scientists and Philosophers Explain Their Various Fields to the Layman*

Biology (p. 272)

Simon & Schuster. New York, New York, USA. 1955

Evolutionary science is a discipline or subject in its own right. But it is [also] the joint product of a number of separate branches of study and learning. Biology provides its central and largest component, but it has also received indispensable contributions from pure physics and chemistry, cosmogony and geology among the natural sciences, and among human studies from history and social science, archaeology and prehistory, psychology and anthropology. As a result, the present is the first period in which we have been able to grasp that the universe is a process in time and to get a first glimpse of our true relation with it. We can see ourselves as history, and can

see that history in its proper relation with the history of the universe as a whole.

*Evolution in Action*

Chapter I (pp. 1–2)

Harper & Brothers. New York, New York, USA. 1953

Evolution may lay claim to be considered the most central and the most important of the problems of biology. For an attack upon it we need facts and methods from every branch of the science — ecology, genetics, paleontology, geographical distribution, embryology, systematics, comparative anatomy — not to mention reinforcements from other disciplines such as geology, geography, and mathematics.

*Evolution: The Modern Synthesis*

Chapter I (p. 13)

George Allen & Unwin Ltd. London, England. 1942

Evolution in the extended sense can be defined as a directional and essentially irreversible process occurring in time, which in its course gives rise to an increase of variety and an increasingly high level of organization in its products. Our present knowledge indeed forces us to the view that the whole of reality is evolution — a single process of self-transformation.

In James R. Newman (ed.)

*What Is Science? Twelve Eminent Scientists and Philosophers Explain Their Various Fields to the Layman*

Evolution and Genetics (p. 278)

Simon & Schuster. New York, New York, USA. 1955

Furthermore, with the adoption of the evolutionary approach in non-biological fields, from cosmology to human affairs, we are beginning to realize that biological evolution is only one aspect of evolution in general. Evolution in the extended sense can be defined as a directional and essentially irreversible process occurring in time, which in its course gives rise to an increase of variety and an increasingly high level of organization, in its products. Our present knowledge indeed forces us to the view that the whole of reality is evolution — a single process of self-transformation.

In James R. Newman (ed.)

*What Is Science? Twelve Eminent Scientists and Philosophers Explain Their Various Fields to the Layman*

Biology (p. 278)

Simon & Schuster. New York, New York, USA. 1955

As a result of a thousand million years of evolution, the universe is becoming conscious of itself, able to understand something of its past history and possible future.... It is as if man had been suddenly appointed managing director of the biggest business of all, the business of evolution — appointed without being asked if he wanted it, and without proper warning and preparation. What is more, he can't refuse the job. Whether he wants to or not, whether he is conscious of what he is doing or not, he is in point of fact determining the future direction of evolution on this earth. That is his inescapable destiny, and the

sooner he realizes it and starts believing in it, the better for all concerned.

*New Bottles for Old Wine*

Transhumanism (p. 13)

Harper & Brothers Publishers. New York, New York, USA. 1957

**Huxley, Thomas Henry** 1825–95

English biologist

Unity of plan everywhere lies hidden under the mask of diversity of structure — the complex is everywhere evolved out of the simple.

*Collected Essays* (Volume 8)

A Lobster; or, The Study of Zoology (pp. 205–206)

Macmillan & Company Ltd. London, England. 1904

The hypothesis of special creation is not only a mere specious mask for our ignorance; its existence in Biology marks the youth and imperfection of the science. For what is the history of every science but the history of the elimination of the notion of creative, or other interferences, with the natural order of the phenomena? Harmonious order governing eternally continuous progress — the web and woof of matter and force interweaving by slow degrees, without a broken thread, that veil which lies between us and the Infinite — that universe which alone we know or can know; such is the picture which science draws of the world.

The Origin of Species

*Westminster Review*, New Series, Volume 17, 1860 (pp. 541–570)

It is very desirable to remember that evolution is not an explanation of the cosmic process, but merely a generalized statement of the method and results of that process.

*Evolution and Ethics*

Prolegomena (p. 6)

Harper & Brothers Publishers. New York, New York, USA. 1942

Natural knowledge tends more and more to the conclusion that “all the choir of heaven and furniture of the earth” are the transitory forms of parcels of cosmic substance wending along the road of evolution, from nebulous potentiality, through endless growths of sun and planet and satellite; through all varieties of matter; through infinite diversities of life and thought; possibly, through modes of being of which we neither have a conception, nor are competent to form any, back to the indefinable latency from which they arose.

*Collected Essays* (Volume 9)

Evolution and Ethics (p. 50)

Macmillan & Company Ltd. London, England. 1904

If it [theory of evolution] had not existed, the palæontologist would have had to invent it.

*Collected Essays* (Volume 4)

The Rise and Progress of Palæontology (p. 44)

Macmillan & Company Ltd. London, England. 1904

I would rather be the offspring of two apes than be a man and afraid to face the truth.

In Cyril Bibby

*T.H. Huxley: Scientist, Humanist, and Educator*

Chapter XIII (p. 259)

Horizon Press. New York, New York, USA. 1960

I have endeavored to show that no absolute structural line of demarcation... can be drawn between the animal world and ourselves; and I may add the expression of my belief that the attempts to draw a psychical distinction is equally futile, and even the highest faculties of feeling and of intellect begin to germinate in lower forms of life. At the same time, no one is more strongly convinced than I am of the vastness of the gulf between civilized man and the brutes; or is more certain that whether from them or not, he is assuredly not of them.

*Collected Essays* (Volume 7)

On the Relations of Man to the Lower Animals (p. 152)

Macmillan & Company Ltd. London, England. 1904

If the fundamental proposition of evolution is true, that the entire world, living and non-living, is the result of the mutual interaction, according to definite laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed, it is no less certain that the existing world lay, potentially, in the cosmic vapor, and that a sufficient intellect could, from a knowledge of the properties of the molecules of that vapor, have predicted, say the state of the Fauna of Great Britain in 1869, with as much certainty as one can say what will happen to the vapor of the breath in a cold winter's day.

In Henri Bergson

*Creative Evolution*

Chapter I (p. 38)

The Modern Library. New York, New York, USA. 1944

...the whole world, living and not living, is the result of the mutual interaction, according to laws, of the forces... possessed by the molecules of which the primitive nebulosity of the universe was composed.

*The Reception of the Origin of Species* (p. 18)

Kessinger Publishing. Whitefish, Montana, USA. 2004

**Jacob, François** 1920–

French biologist

Evolution is a tinkerer.

In Francis Crick

*What Mad Pursuit: A Personal View of Scientific Discovery*

Introduction (p. 5)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Jastrow, Robert** 1925–

American space scientist

At present, science has no satisfactory answer to the question of the origin of life on the earth. Perhaps the appearance of life on the earth is a miracle. Scientists are reluctant to accept that view, but their choices are limited; either life was created on the earth by the will of a

being outside the grasp of scientific understanding, or it evolved on our planet spontaneously, through chemical reactions occurring in nonliving matter lying on the surface of the planet. The first theory places the question of the origin of life beyond the reach of scientific inquiry. It is a statement of faith in the power of a Supreme Being not subject to the laws of science. The second theory is also an act of faith. The act of faith consists in assuming that the scientific view of the origin of life is correct, without having concrete evidence to support that belief.

*Until the Sun Dies*

Chapter 7 (p. 62)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

### **Jeffers, Robinson** 1887–1962

American poet

You [Pacific Ocean] were much younger when we crawled out of the womb and lay in the sun's eye on the tideline.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

Continent's End (p. 16)

Stanford University Press. Stanford, California. USA. 1988

And the earth is a particle of dust by a sand-grain sun, lost in a nameless cove of the shores of a continent.

Galaxy on galaxy, innumerable swirls of innumerable stars, endured as it were forever and humanity

Came into being, its two or three million years are a moment, in a moment it will certainly cease out from being

And galaxy on galaxy endure after that as it were forever...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 2)

Margrave (p. 160)

Stanford University Press. Stanford, California. USA. 1988

### **Johnson, Philip**

Law professor

Persons who want naturalistic evolution to be accepted as unquestioned fact must therefore use their cultural authority to enact rules of discourse that protect the purported fact from the attacks of unbelievers. First, they can identify science with naturalism, which means that they insist as a matter of first principle that no consideration whatever be given to the possibility that mind or spirit preceded matter. Second, they can impose a rule of procedure that disqualifies purely negative argument, so that a theory which obtains some very modest degree of empirical support can become immune to disproof until and unless it is supplanted by a better naturalistic theory.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October 1990

For the scientific materialist the materialism comes first; the science comes thereafter. We might therefore more accurately term them "materialists employing science."

And if materialism is true, then some materialistic theory of evolution has to be true simply as a matter of logical deduction, regardless of the evidence.

The Unraveling of Scientific Materialism

*First Things*, November 1997

Darwinists believe that the mutation-selection mechanism accomplishes wonders of creativity not because the wonders can be demonstrated, but because they cannot think of a more plausible explanation for the existence of wonders that does not involve an unacceptable creator, *i.e.*, a being or force outside the world of nature.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October 1990

Creationists are disqualified from making a positive case, because science by definition is based upon naturalism.

The rules of science also disqualify any purely negative argumentation designed to dilute the persuasiveness of the theory of evolution. Creationism is thus out of court and out of the classroom — before any consideration of evidence. Put yourself in the place of a creationist who has been silenced by that logic, and you may feel like a criminal defendant who has just been told that the law does not recognize so absurd a concept as "innocence."

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October 1990

The problem with scientific naturalism as a worldview is that it takes a sound methodological premise of natural science and transforms it into a dogmatic statement about the nature of the universe. Science is committed by definition to empiricism, by which I mean that scientists seek to find truth by observation, experiment, and calculation rather than by studying sacred books or achieving mystical states of mind. It may well be, however, that there are certain questions — important questions, ones to which we desperately want to know the answers — that cannot be answered by the methods available to our science. These may include not only broad philosophical issues such as whether the universe has a purpose, but also questions we have become accustomed to think of as empirical, such as how life first began or how complex biological systems were put together.

Evolution as Dogma: The Establishment of Naturalism

*First Things*, October 1990

### **Keith, Arthur** 1866–1955

English anatomist

The fossil remains found at Piltdown by Mr. Dawson set students of man's evolution the most difficult task that has confronted them hitherto. In his characterization, Piltdown man was quite unlike any fossil type known to us. Sir Arthur Smith Woodward was impressed by his simian similarities; I, on the other hand, was impressed by those features which, as I thought then, were eminently human

and modern. Hence arose those discrepancies between us — discrepancies of a quarter of a century ago. Since then, much has happened. Discoveries are being made which help to throw Piltdown man into his proper place in the crowded throng of evolving human forms. We now know that when the Piltdown type was being evolved in England — or at the western end of the Old World — a totally different type had come into being in the Eastern lands of the Old World... So long as man is interested in his long past history, in the vicissitudes which our early forerunners passed through, and the varying fate which overtook them, the name of Charles Dawson is certain of remembrance.

The Piltdown Man Discovery  
*Nature*, Volume 142, Number 3587, July 30, 1938 (p. 197)

The German Fuhrer, as I have consistently maintained, is an evolutionist; he has consciously sought to make the practice of Germany conform to the theory of evolution.

*Evolution and Ethics*  
Chapter 40 (p. 230)  
G.P. Putnam's Sons. New York, New York, USA. 1947

Christianity makes no distinction of race or of color; it seeks to break down all racial barriers. In this respect the hand of Christianity is against that of Nature, for are not the races of mankind the evolutionary harvest which Nature has toiled through long ages to produce? May we not say, then, that Christianity is anti-evolutionary in its aim?

*Evolution and Ethics*  
Chapter 17 (p. 72)  
G.P. Putnam's Sons. New York, New York, USA. 1947

Meantime let me say that the conclusion I have come to is this: the law of Christ is incompatible with the law of evolution as far as the law of evolution has worked hitherto. Nay, the two laws are at war with each other; the law of Christ can never prevail until the law of evolution is destroyed.

*Evolution and Ethics*  
Chapter 4 (p. 15)  
G.P. Putnam's Sons. New York, New York, USA. 1947

**King, Ben** 1857–94  
Poet

We seem to exist in a hazardous time,  
Driftn' along here through space;  
Nobody knows just when we begun,  
Or how fur we've gone in the race.

*Ben King's Verse*  
Evolution, Stanza 1  
Forbes & Company. Chicago, Illinois, USA. 1903

**Kipling, Rudyard** 1865–1936  
British writer and poet

We are very slightly changed  
From the semi-apes who ranged

India's prehistoric clay;  
He that drew the longest bow  
Ran his brother down, you know,  
As we run men down to-day.  
*Rudyard Kipling's Verse*  
A General Summary  
Hodder & Stroughton. London, England. 1919

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

Evolution has made countless mistakes; for every existing species hundreds must have perished in the past; the fossil record is a waste-basket of the Chief Designer's discarded hypotheses. It is by no means unlikely that *Homo sapiens*, too, is the victim of some minute error in construction — perhaps in the circuitry of his nervous system — which makes him prone to delusions, and urges him toward self-destruction.

In Arne Tiselius and Sam Nilsson (eds.)  
*The Place of Value in a World of Fact*  
The Urge to Self Destruction (p. 298)  
John Wiley & Sons, Inc. New York, New York, USA. 1970

**Leopold, Aldo** 1886–1948  
American naturalist

We know now what was unknown to all the preceding caravan of generations: that men are only fellow-voyagers with other creatures in the odyssey of evolution.

*A Sand County Almanac, with Essays on Conservation from Round River*  
Part II, Wisconsin (p. 117)  
Sierra Club. San Francisco, California, USA. 1970

**Lewin, Roger Amos**  
Anthropologist

The central question of the Chicago conference was whether the mechanisms underlying microevolution can be extrapolated to explain the phenomena of macroevolution. At the risk of doing violence to the positions of some of the people at the meeting, the answer can be given as a clear, No...

*Evolution Theory Under Fire*  
*Science*, Volume 210, Number 4472, November 21, 1980 (p. 883)

The key issue is the ability correctly to infer a genetic relationship between two species on the basis of a similarity in appearance, at gross and detailed levels of anatomy. Sometimes this approach...can be deceptive, partly because similarity does not necessarily imply an identical genetic heritage: a shark (which is a fish) and a porpoise (which is a mammal) look similar.

*Bones of Contention*  
Chapter 6, Rama's Ape Destroyed (p. 123)  
Simon & Schuster Inc. New York, New York, USA. 1987

Racism, as we would characterize it today, was explicit in the writings of virtually all the major anthropologists

of the first decades of this century, simply because it was the generally accepted world view. The language of the epic tale so often employed by Arthur Keith, Grafton Elliot Smith, Henry Fairfield Osborn, and their contemporaries fitted perfectly an imperialistic view of the world, in which Caucasians were the most revered product of a grand evolutionary march to nobility.

*Bones of Contention*

Chapter 13, Man's Place in Nature (p. 307)  
Simon & Schuster Inc. New York, New York, USA. 1987

It is, in fact, a common fantasy, promulgated mostly by the scientific profession itself, that in the search for objective truth, data dictate conclusions. If this were the case, then each scientist faced with the same data would necessarily reach the same conclusion. But as we've seen earlier and will see again and again, frequently this does not happen. Data are just as often molded to fit preferred conclusions.

*Bones of Contention*

Chapter 4, The Taung Child: Accepted (p. 68)  
Simon & Schuster Inc. New York, New York, USA. 1987

How is it that trained men, the greatest experts of their day, could look at a set of modern human bones, the cranial fragments, and "see" a clear simian signature in them; and see in an apes jaw the unmistakable signs of humanity? The answers, inevitably, have to do with the scientist's expectations and their effects on the interpretation of the data.

*Bones of Contention*

Chapter 3, The Taung Child: Rejection (p. 61)  
Simon & Schuster Inc. New York, New York, USA. 1987

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Lead us, Evolution, lead us,  
Up the future's endless stair;  
Chop us, change us, prod us, weed us.  
For stagnation is despair:  
Groping, guessing, yet progressing,  
Lead us nobody knows where.

*Poems*

Evolutionary Hymn  
G. Bles. London, England. 1964

**Lewontin, Richard C.** 1929–

American evolutionary geneticist and philosopher of science

We take the side of science in spite of the patent absurdity of some of its constructs, in spite of its failure to fulfill many of its extravagant promises of health and life, in spite of the tolerance of the scientific community for unsubstantiated just-so stories, because we have a prior commitment, a commitment to materialism. It is not that the methods and institutions of science somehow compel us to accept a material explanation of the phenomenal world, but, on the contrary, that we are forced by our a

priori adherence to material causes to create an apparatus of investigation and a set of concepts that produce material explanations, no matter how counter-intuitive, no matter how mystifying to the uninitiated. Moreover, that materialism is an absolute, for we cannot allow a Divine Foot in the door.

*Billions and Billions of Demons*

*New York Review of Books*, January 9, 1997

Creationists have capitalized on scientific disputes among biologists on the details of the evolutionary process by pretending that serious students of the subject are themselves in doubt about evolution. Evolutionary study is a living science; as such it is rich with controversy about particular issues of detail and mechanism. Creationists have extracted published statements in those controversies and used them dishonestly to suggest that biologists are in doubt about the fact of organic evolution. Local school boards and students must clearly be impressed that scientists in universities seem themselves to be denying evolution.

*BioScience*, September 1981 (p. 559)

Given the immense extent, inherent complexity, and counterintuitive nature of scientific knowledge, it is impossible for anyone, including non-specialist scientists, to retrace the intellectual paths that lead to scientific conclusions about nature. In the end we must trust the experts and they, in turn, exploit their authority as experts and their rhetorical skills to secure our attention and our belief in things that we do not really understand.

*Billions and Billions of Demons*

*New York Review of Books*, January 9, 1997

The only alternative is to say that they did arise from muck because God's finger went out and touched that muck. That is to say, there was a non-natural process. And that's really where the action is. Either you think that complex organisms arose by non-natural phenomena, or you think that they arose by natural phenomena. If they arose by natural phenomena, they had to evolve. And that's all there is to it.

*The Electric Windmill: An Inadvertent Autobiography*

Agnostic Evolutionists (p. 205)  
Regnery Gateway. Washington, D.C. 1988

The problem is to get [the creationists] to reject irrational and supernatural explanations of the world, the demons that exist only in their imaginations, and to accept a social and intellectual apparatus, Science, as the only begetter of truth. The reason that people do not have a correct view of nature is not that they are ignorant of this or that fact about the material world, but that they look to the wrong sources in their attempt to understand.

*Billions and Billions of Demons*

*New York Review of Books*, January 9, 1997



As to assertions without adequate evidence, the literature of science is filled with them, especially the literature of popular science writing. Carl Sagan's list of the "best contemporary science-popularizers" includes E.O. Wilson, Lewis Thomas, and Richard Dawkins, each of whom has put unsubstantiated assertions or counterfactual claims at the very center of the stories they have retailed in the market.

Billions and Billions of Demons  
*New York Review of Books*, January 9, 1997

[S]cience, like other productive activities, like the state, the family, sport, is a social institution completely integrated into and influenced by the structure of all our other social institutions. The problems that science deals with, the ideas that it uses in investigating those problems, even the so-called scientific results that come out of scientific investigation, are all deeply influenced by predispositions that derive from the society in which we live. Scientists do not begin life as scientists after all, but as social beings immersed in a family, a state, a productive structure, and they view nature through a lens that has been molded by their social experience.

*Biology as Ideology*  
A Reasonable Skepticism (p. 3)  
HarperCollins. New York, New York, USA. 1993

It is said that there is no place for an argument from authority in science. The community of science is constantly self-critical.... It is certainly true that within each narrowly defined scientific field there is constant challenge to new technical claims and to old wisdom.... But when scientists transgress the bounds of their own specialty they have no choice but to accept the claims of authority, even though they do not know how solid the grounds of those claims may be. Who am I to believe... quantum physics if not Steven Weinberg, or about the solar system if not Carl Sagan? What worries me is that they may believe what Dawkins and Wilson tell them about evolution.

Billions and Billions of Demons  
*New York Review of Books*, January 9, 1997

It is the great irony of modern evolutionary genetics that the spirit of explanation has moved more and more towards optimal adaptation, while the technical developments of population genetics of the past 30 years have been increasingly to show the efficacy of non adaptive forces in evolution.

A Natural Selection  
*Nature*, Volume 339, Number 6220, 11 May, 1989 (p. 107)

**Lull, Richard Swann** 1867–1957  
American paleontologist

The great heart of nature beats, its throbbing stimulates the pulse of life, and not until that heart is stilled forever will the rhythmic tide of evolution cease to flow.

*Organic Evolution*  
Epilogue (p. 698)  
The Macmillan Company. New York, New York, USA. 1961

Since Darwin's day, Evolution has been more and more generally accepted, until now in the minds of informed, thinking men there is no doubt that it is the only logical way whereby the creation can be interpreted and understood. We are not so sure, however, as to the *modus operandi*, but we may rest assured that the process has been in accordance with great natural laws, some of which are as yet unknown, perhaps unknowable.

*Organic Evolution*  
Part I, Chapter I (p. 15)  
The Macmillan Company. New York, New York, USA. 1961

**Lunn, Arnold** 1888–1974  
English writer

Whatever may befall this theory in the future, whether it is to be superseded by some other theory or not, Darwin's everlasting title to glory will be that he explained the seemingly marvelous adaptation of living things by the mere action of natural factors without looking to a divine intervention, without resorting to any finalist or metaphysical hypothesis.

*The Flight from Reason: A Study of the Victorian Hersay* (p. 68)  
Eyre & Spottiswoode Ltd. London, England. 1932

**Lyell, Sir Charles** 1797–1875  
English geologist

...at successive periods of the past, the same area of land and water has been inhabited by species of animals and plants even more distinct than those which now people the antipodes, or which now co-exist in the arctic, temperate, and tropical zones.

*The Student's Elements of Geology* (3<sup>rd</sup> edition)  
Chapter VIII (p. 125)  
Harper & Brothers Publishers. New York, New York, USA. 1878

**Macartney, Frederick T.** 1887–1980  
Australian poet

Man's evolution from the brute  
Affords him, with so many gains,  
Life, liberty and the pursuit  
Of peak-time buses, trams and trains.

*Gaily the Troubadour*  
Pantoum: Aspects of Evolution  
E.P. Dutton & Company, Inc. New York, New York, USA. 1936

**Maeterlinck, Maurice** 1862–1949  
Belgian playwright and poet

The bees have existed for many thousands of years; we have watched them for ten or twelve lustres. And if it could even be proved that no change has occurred in the hive since we first opened it, should we have the right to conclude that nothing had changed before our

first questioning glance? Do we not know that in the evolution of species a century is but as a drop of rain that is caught in the whirl of the river, and that millenaries glide as swiftly over the life of universal matter as single years over the history of a people?

*The Life of the Bee*

Chapter VIII (p. 369)

Dodd, Mead & Company. New York, New York, USA. 1929

**Margulis, Lynn** 1938–

American cell biologist and evolutionist

**Sagan, Dorion** 1959–

American science writer

Our bodies, like those of all life, preserve the environment of an earlier Earth. We coexist with present-day microbes and harbor remnants of others, symbiotically subsumed within our cells. In this way, the microcosm lives on in us and we in it.

*Microcosmos*

Introduction (p. 20)

Summit Books. New York, New York, USA. 1986

Far from leaving microorganisms behind on an evolutionary “ladder,” we are both surrounded by them and composed of them.

*Microcosmos*

Introduction (p. 14)

Summit Books. New York, New York, USA. 1986

As we examine ourselves as products of symbiosis over billions of years, the supporting evidence for our multimicrobe ancestry becomes overwhelming. Our bodies contain a veritable history of life on Earth. Our cells maintain an environment that is carbon- and hydrogen-rich, like that of the Earth when life began. They live in a medium of water and salts like the composition of the early seas. We became who we are by the coming together of bacterial partners in a watery environment. Although the evolutionary dynamics of DNA, genetic transfer, and symbiosis were not discovered until almost a century after Charles Darwin’s death in 1882, he had the shrewdness to write, “We cannot fathom the marvelous complexity of an organic being; but on the hypothesis here advanced this complexity is much increased. Each living creature must be looked at as a microcosm — a little universe, formed of a host of self-propagating organisms, inconceivably minute and as numerous as the stars in heaven.”

*Microcosmos*

Introduction (p. 18)

Summit Books. New York, New York, USA. 1986

...a hydrogen-rich environment exposed to energy in the presence of carbon — conditions that certainly existed throughout our solar system, if not the universe — will, by the rules of chemistry, produce the building blocks of life.

*Microcosmos*

Chapter 2 (p. 52)

Summit Books. New York, New York, USA. 1986

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

From what flat wastes of cosmic slime,  
And stung by what quick fire,  
Sunward the restless races climb! —  
Men risen out of mire!

*Unrest*

**Maynard Smith, John** 1920–2004

English evolutionary biologist

Thus, horses have very stiff backbones, and a consequence of this is that people can ride them. However, we would not say that the function of a horse’s backbone is to enable people to ride horses, because we do not think that horse’s backbones evolved as they did so as to enable people, in the future, to ride.

In G.A. Dover and R.B. Flavell (eds.)

*Genome Evolution*

Special Volume

No. 20

Overview — Unsolved Evolutionary Problems (p. 378)

**Mayr, Ernst** 1904–2005

German-born American biologist

There is indeed one belief that all true original Darwinians held in common, and that was their rejection of creationism, their rejection of special creation. This was the flag around which they assembled and under which they marched. When Hull claimed that “the Darwinians did not totally agree with each other, even over essentials”, he overlooked one essential on which all these Darwinians agreed. Nothing was more essential for them than to decide whether evolution is a natural phenomenon or something controlled by God. The conviction that the diversity of the natural world was the result of natural processes and not the work of God was the idea that brought all the so-called Darwinians together in spite of their disagreements on other of Darwin’s theories.

*One Long Argument: Charles Darwin and the Genesis of Modern*

*Evolutionary Thought*

Chapter Seven (p. 99)

Harvard University Press. Cambridge, Massachusetts, USA. 1991

Why did it take so long for evolution to be seriously proposed? And why did Darwinism face such an uphill battle after it was proposed? The reason is that Darwin challenged some of the basic beliefs of his age. Four of them were pillars of Christina dogma.

*One Long Argument: Charles Darwin and the Genesis of Modern*

*Evolutionary Thought*

Chapter Four (p. 38)

Harvard University Press. Cambridge, Massachusetts, USA. 1991

We live in an age that places great value on molecular biology. Let me emphasize the equal importance of evolutionary biology. The very survival of man on this globe may depend on a correct understanding of the evolutionary forces and their application to man. The meaning of race, of the impact of mutation, whether spontaneous or radiation-induced, of hybridization, of competition — all these evolutionary phenomena are of the utmost importance for the human species. Fortunately the large number of biologists who continue to cultivate the evolutionary vineyard is an indication of how many biologists realize this: we must acquire an understanding of the operation of the various factors of evolution not only for the sake of understanding our universe, but indeed very directly for the sake of the future of man.

*Cold Spring Harbor Symposia on Quantitative Biology*  
Genetics and Twentieth Century Darwinism, Where Are We?  
Volume XXIV, 1959 (p. 13)  
Cold Spring Harbor Laboratory, Cold Spring Harbor, New York, USA.

The demarcation between science and theology is perhaps easiest, because scientists do not invoke the supernatural to explain how the natural world works, and they do not rely on divine revelation to understand it. When early humans tried to give explanations for natural phenomena, particularly for disasters, invariably they invoked supernatural beings and forces, and even today divine revelation is as legitimate a source of truth for many pious Christians as is science. Virtually all scientists known to me personally have religion in the best sense of this word, but scientists do not invoke supernatural or divine revelation.

*This Is Biology: The Science of the Living World*  
Chapter 2 (p. 33)  
Harvard University Press, Cambridge, Massachusetts, USA. 1997

The basic framework of the theory is that evolution is a two-stage phenomenon: the production of variation and the sorting of the variants by natural selection. Yet agreement on this basic thesis does not mean that the work of the evolutionist is completed. The basic theory is in many instances hardly more than a postulate and its application raises numerous questions in almost every concrete case.

*Populations, Species, and Evolution*  
Chapter 1 (p. 6)  
Harvard University Press, Cambridge, Massachusetts, USA. 1970

The finding of a suitable mate for the “hopeless monster” and the establishment of reproductive isolation from the normal members of the parental population seem to me insurmountable difficulties [of survival].

*Populations, Species, and Evolution*  
Chapter 15 (p. 253)  
Harvard University Press, Cambridge, Massachusetts, USA. 1970

Every anti-evolutionist prior to 1859 allowed for the intermittent, if not constant, interference by the Creator.

The natural causes postulated by the evolutionists completely separated God from his creation, for all practical purposes. The new explanatory model replaced planned teleology by the haphazard process of natural selection. This required a new concept of God and a new basis for religion.

*The Nature of the Darwinian Revolution*  
*Science*, Volume 176, Number 4038, June 2, 1972 (p. 988)

Evolutionary biology, in contrast with physics and chemistry, is a historical science — the evolutionist attempts to explain events and processes that have already taken place. Laws and experiments are inappropriate techniques for the explication of such events and processes. Instead one constructs a historical narrative, consisting of a tentative reconstruction of the particular scenario that led to the events one is trying to explain.

*Darwin’s Influence on Modern Thought*  
*Scientific American*, Volume 283, Number 1, July 2000 (p. 80)

The occurrence of genetic monstrosities by mutation, for instance the homeotic mutant in *Drosophila*, is well substantiated, but they are such evident freaks that these monsters can be designated only as “hopeless.” They are so utterly unbalanced that they would not have the slightest chance of escaping elimination through stabilizing selection. Giving a thrush the wings of a falcon does not make it a better flier. Indeed, having all the other equipment of a thrush, it would probably hardly be able to fly at all. It is a general rule, of which every geneticist and breeder can give numerous examples, that the more drastically a mutation affects the phenotype, the more likely it is to reduce fitness. To believe that such a drastic mutation would produce a viable new type, capable of occupying a new adaptive zone, is equivalent to believing in miracles.

*Populations, Species, and Evolution*  
Chapter 15 (p. 253)  
Harvard University Press, Cambridge, Massachusetts, USA. 1970

The theory of evolution is quite rightly called the greatest unifying theory in biology.

*Populations, Species, and Evolution*  
Chapter 1 (p. 1)  
Harvard University Press, Cambridge, Massachusetts, USA. 1970

Anything truly novel always seemed to appear quite abruptly in the fossil record.

*Toward a New Philosophy of Biology: Observations of an Evolutionist*  
On the Evolutionary Synthesis and After (p. 530)  
Harvard University Press, Cambridge, Massachusetts, USA. 1988

I am taking a new look at the Darwinian revolution of 1859, perhaps the most fundamental of all intellectual revolutions in the history of mankind. It not only eliminated man’s anthropocentrism, but affected every metaphysical and ethical concept, if consistently applied.

*The Nature of the Darwinian Revolution*  
*Science*, Volume 176, Number 4038, June 2, 1972 (p. 981)

It is quite true, as several recent authors have indicated, that Darwin's book was misnamed, because it is a book on evolutionary changes in general and the factors that control them (selectivity, and so forth), but not a treatise on the origin of species.

*Systematics and The Origin of Species*

Chapter VII (p. 147)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

In high school I read Haeckel's *Weltratsel* naively and avidly, not as a guide to evolutionary studies but to have ammunition in arguments about the Bible and religion!

*The Evolutionary Synthesis*

Biographical Essay (p. 413)

Harvard University Press. Cambridge, Massachusetts, USA. 1980

### McCloud, James

No biographical data available

Progressive evolution is the universal plan. Everything which we meet in the world around us, matter and mind, every individual and all congregated masses, begin their course as germs and unfold in slow progression.... The faculties of all intelligent creation, all that you call mind, all that you call heart, are framed for an interminable series of evolutions.... It is not mainly the mould of this mighty frame of things which establishes it, it is the fact that creation is eternally unfolding new resources and presenting itself under successive and amazing combinations of which no creature in the universe had imagined it capable.

In Frances Mason

*Creation by Evolution*

Why Must We Be Evolutionists? (p. 23)

The Macmillan Company. New York, New York, USA. 1928

### Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

### Medawar, J. S.

No biographical data available

For a biologist the alternative to thinking in evolutionary terms is not to think at all.

*The Life Science: Current Ideas of Biology*

Chapter Two (p. 24)

Harper & Row Publishers. New York, New York, USA. 1977

...the testimony of Design is only for those who, secure in their beliefs already, are in no need of confirmation. This is just as well, for there is no theological comfort in the amplification of DNA and it is no use looking to evolution. The balance sheet of evolution has so closely written a debit column of all the blood and pain that goes with the natural process that not even the smoothest accountancy can make the transaction seem morally solvent to any standards of morals that human beings are accustomed to.

*The Life Science: Current Ideas of Biology*

Chapter Twenty-Three (p. 169)

Harper & Row Publishers. New York, New York, USA. 1977

### Miller, Kenneth R. 1948–

American biology professor and author

We know from astronomy that the universe had a beginning, from physics that the future is both open and unpredictable, from geology and paleontology that the whole of life has been a process of change and transformation. From biology we know that our tissues are not impenetrable reservoirs of vital magic, but a stunning matrix of complex wonders, ultimately explicable in terms of biochemistry and molecular biology. With such knowledge we can see, perhaps for the first time, why a Creator would have allowed our species to be fashioned by the process of evolution.

*Finding Darwin's God*

Chapter 9 (p. 290)

HarperCollins Publishers, Inc. New York, New York, USA. 1999

### Moody, Paul

No biographical data available

Does not science prove that there is no Creator? Emphatically, science does not prove that! Actually science proves nothing about first causes at all.

*Introduction to Evolution* (2<sup>nd</sup> edition) (p. 513)

Harper & Brothers Publishers. New York, New York, USA. 1953

The more I study science the more I am impressed with the thought that this world and universe have a definite design and a design suggests a designer. It may be possible to have a design without a designer, a picture without an artist, but my mind is unable to conceive of such a situation.

*Introduction to Evolution* (2<sup>nd</sup> edition) (p. 514)

Harper & Brothers Publishers. New York, New York, USA. 1953

### Morley, John 1<sup>st</sup> Viscount Morley of

**Blackburn** 1838–1923

British statesman and writer

Evolution is not a force, but a process; not a cause, but a law.

*On Compromise*

Chapter V (p. 210)

Macmillan & Company Ltd. London, England. 1886

### Morris, Desmond 1928–

Zoologist and ethnologist

There are one hundred and ninety-three living species of monkeys and apes. One hundred and ninety-two of them are covered with hair. The exception is a naked ape self-named *Homo sapiens*. This unusual and highly successful species spends a great deal of time examining his higher motives and an equal amount of time studiously ignoring his fundamental ones. He is proud that

he has the biggest brain of all the primates, but attempts to conceal the fact that he also has the biggest penis, preferring to accord this honour falsely to the mighty gorilla. He is an intensely vocal, acutely exploratory, over-crowded ape, and it is high time we examined his basic behavior.

*The Naked Ape*

Introduction (p. 9)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

**Morris, Henry** 1918–2006

American creationist

Evolution is the root of atheism, of communism, Nazism, behaviorism, racism, economic imperialism, militarism, libertinism, anarchism, and all manner of anti-Christian systems of belief and practice.

*The Remarkable Birth of Planet Earth*

Chapter VII (p. 75)

Creation-Life Publishers. San Diego, California, USA. 1972

**Muggeridge, Malcolm** 1903–90

English journalist and social critic

I myself am convinced that the theory of evolution, especially the extent to which it's been applied, will be one of the great jokes in the history books of the future. Posterity will marvel that so very flimsy and dubious an hypothesis could be accepted with the incredible credulity that it has.

*The Advocate*, March 8, 1984 (p. 17)

**Neaves, Lord Charles** 1800–76

English author

Pouter, tumbler and fantail are from the same source;  
The racer and hack may be traced to one horse;  
So men were developed from monkeys of course  
Which nobody can deny.

In John Burroughs (ed.)

*Songs of Nature*

The Origin of Species

Doubleday, Page & Company. Garden City, New York, USA. 1912

**Newman, H. H.**

No biographical data available

There are no rival hypotheses except the outworn and completely refuted idea of special creation, now retained only by the ignorant, the dogmatic, and the prejudiced.

*Evolution, Genetics, and Eugenics*

Chapter III (p. 51)

Greenwood Press Publishers. New York, New York, USA. 1969

**Newman, John Henry** 1907–66

Mathematician and mathematical historian

...I see nothing in the theory of evolution inconsistent with an Almighty Creator and Protector.

*Letters and Diaries*

Letter to David Brown, 4 April 1874 (p. 44)

**Oparin, Alexander Ivanovich** 1894–1980

Russian biochemist

From our point of view, therefore, the modern process of evolution of living organisms is fundamentally nothing more than the addition of some new links to an endless chain of transformations of matter, a chain the beginning of which extends to the very dawn of existence of our planet.

*The Origin of Life*

Chapter VIII (p. 245)

Dover Publications, Inc. New York, New York, USA. 1953

**Osborn, Henry Fairfield** 1857–1935

American paleontologist and geologist

In truth, from the period of the earliest stages of Greek thought man has been eager to discover some natural cause of evolution, and to abandon the idea of supernatural intervention in the order of nature.

*The Origin and Evolution of Life* (pp. ix–x)

Charles Scribner's Sons. New York, New York, USA. 1918

**Patterson, Colin** 1933–98

English paleontologist

Fossils may tell us many things, but one thing they can never disclose is whether they were ancestors of anything else.

*Evolution*

Chapter 11–2 (p. 133)

British Museum of Natural History. London, England. 1978

Just as pre-Darwinian biology was carried out by people whose faith was in the Creator and His plan, post-Darwinian biology is being carried out by people whose faith is in, almost, the deity of Darwin. They've seen their task as to elaborate his theory and to fill the gaps in it, to fill the trunk and twigs of the tree. But it seems to me that the theoretical framework has very little impact on the actual progress of the work in biological research. In a way some aspects of Darwinism and of neo-Darwinism seem to me to have held back the progress of science.

*The Listener*, October 8, 1981 (p. 392)

...we must ask first whether the theory of evolution by natural selection is scientific or pseudoscientific.... Taking the first part of the theory, that evolution has occurred, it says that the history of life is a single process of species-splitting and progression. This process must be unique and unrepeatable, like the history of England. This part of the theory is therefore a historical theory, about unique events, and unique events are, by definition, not part of science, for they are unrepeatable and so not subject to test.

*Evolution*

Chapter 12–2 (p. 145)

British Museum of Natural History. London, England. 1978

...it seemed obvious to [Darwin] that, if his theory of evolution [were] correct, fossils ought to provide incontrovertible proof of it, since each stratum should contain links between the species of earlier and later strata, and if sufficient fossils were collected, it would be possible to arrange them in ancestor descendent sequences and so build up a precise picture of the course of evolution. This was not so in Darwin's time, and today, after more than another hundred years of assiduous fossil collecting, the picture still has extensive gaps.

*Evolution*

Chapter 11–2 (p. 128)

British Museum of Natural History. London, England. 1978

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist and author

In short, evolution is not so much progress as it is simply change. It does not leave all its primitive forms behind. It carries them over from age to age, well knowing that they are the precious base of the pyramid on which the more fantastic and costly experiments must be carried.

*An Almanac for Moderns*

April Eighteenth (p. 31)

G.P. Putnam's Sons. New York, New York, USA. 1935

Evolution is not a mere product of life, like starch or blood; it is a part of life itself, just as flow is part of a river.

*An Almanac for Moderns*

July Twenty-Eighth (p. 141)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The evolution of life on earth, or of human society, is a unique historical process. [From such] a process, we may assume, for example, the laws of mechanics, of chemistry, of heredity and segregation, of natural selection, etc. Its description, however, is not a law but only a singular historical statement.

*The Poverty of Historicism*

Chapter IV (p. 108)

The Beacon Press. Boston, Massachusetts, USA. 1957

**Proudfit, David Law** 1842–97

American poet

A man sat on a rock and sought

Refreshment from his thumb;

A dinotherium wandered by

And scared him some.

His name was Smith.

The kind of rock

He sat upon was shale.

One feature quite distinguished him:

He had a tail.

In Frederic Lawrence Knowles

*A Treasury of Humorous Poetry*

Prehistoric Smith (p. 106)

Colonial Press. Boston, Massachusetts, USA. 1902

**Purcell, Rosamond** 1933–2004

American critic and writer

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Evolution is a quirky take of old structures pressed and altered to new functions.

*Illuminations: A Bestiary*

Angler Fish (p. 23)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Reade, Winwood** 1838–75

Philosopher and historian

There is a certain class of people who prefer to say that their fathers came down in the world through their own follies than to boast that they rose in the world through their own industry and talents. It is the same shabby-genteel sentiment, the same vanity of birth, which makes men prefer to believe that they are degenerated angels, rather than elevated apes.

*The Martyrdom of Man*

Chapter III, Amphibious Mankind (p. 351)

E.P. Dutton & Company. New York, New York, 1926

**Roberts, Catherine**

No biographical data available

Derived from the Latin *e* (out) and *volvare* (to roll), the basic meaning of evolve is to roll out, unfold, develop. Thus, despite the seemingly random and fortuitous nature of many of the hereditary variations that permanently alter evolving individuals and populations, the scientific age generally regards the evolution of life on earth as a continuous progression from the simple to the complex and more highly organized, which has culminated in a biosphere dominated by man.

*Science, Animals, and Evolution: Reflections on Some Unrealized Potentials of Biology and Medicine*

Introduction (p. 3)

Greenwood Press Publishers. Westport, Connecticut, USA. 1980

**Ruse, Michael** 1940–

English historian and philosopher of science

...one often sees it said that “evolution is not a fact, but a theory.” Is this the essence of my claim? Not really! Indeed, I suggest that this wise-sounding statement is confused to the point of falsity: it almost certainly is if, without regard for cause, one means no more by “evolution” than the claim that all organisms developed naturally from primitive beginnings. Evolution is a fact, fact, FACT!

*Darwinism Defended: A Guide to the Evolution Controversies*

Part I, Chapter 2 (p. 58)

Addison-Wesley, Advanced Book Program. Reading, Massachusetts, USA. 1982

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

It appears that during those ages when animals were torturing each other with ferocious horns and agonizing stings, Omnipotence was quietly waiting for the ultimate emergence of man, with his still more widely diffused cruelty. Why the Creator should have preferred to reach his goal by a process, instead of going straight to it, these modern theologians do not tell us.

*Religion and Science*

Evolution (p. 80)

Henry Holt & Company. New York, New York, USA. 1935

That Man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and beliefs, are but the outcome of accidental collocations of atoms...that all the labours of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins — all these things, if not quite beyond dispute, are yet so nearly certain that no philosophy which rejects them can hope to stand. Only within the scaffolding of unyielding despair, can the soul's habitation henceforth be safely built.

*Mysticism and Logic and Other Essays*

Chapter III (p. 47)

Longmans, Green & Company. London, England. 1925

**Sagan, Carl** 1934–96  
American astronomer and author

We are the product of 4.5 billion years of fortuitous, slow, biological evolution. There is no reason to think that the evolutionary process has stopped. Man is a transitional animal. He is not the climax of creation.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 1 (p. 5)

Dell Publishing, Inc. New York, New York, USA. 1975

Life forms developed that were finely attuned to their specific environments, exquisitely adapted to the conditions. But the conditions changed. The organisms were too specialized. They died. Other organisms were less well adapted, but they were more generalized. The conditions changed, the climate varied, but the organisms were able to continue. Many more species of organisms have died during the history of the Earth than are alive today. The secret of evolution is time and death.

*Cosmic Connection: An Extraterrestrial Perspective*

Chapter 1 (p. 5)

Anchor Press/Doubleday. Garden City, New York, USA. 1973

Occasionally someone remarks on what a lucky coincidence it is that the Earth is perfectly suitable for life — moderate enough temperatures, liquid water, oxygen atmosphere, and so on. But this is, at least in

part, a confusion of cause and effect. We earthlings are supremely well adapted to the environment of the Earth because we grew up here. Those earlier forms of life that were not well adapted died. We are descended from the organisms that did well. Organisms that evolve on a quite different world will doubtless sing its praises too.

*Cosmos*

Chapter II (p. 24)

Random House, Inc. New York, New York, USA. 1980

A being quite like us, but with a small physiological difference — a third eye, say or blue hair covering the nose and forehead — somehow evokes feelings of revulsion. Such feelings may have had adaptive value at one time in defending our small tribe against the beasts and neighbors. But in our time such feelings are obsolete and dangerous.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 1 (p. 7)

Dell Publishing, Inc. New York, New York, USA. 1975

**Savage, Jay Mathers** 1928–  
No biographical data available

No serious biologist today doubts the fact of evolution... the fact of evolution is amply clear... We do not need a listing of evidences to demonstrate the fact of evolution any more than we need to demonstrate the existence of mountain ranges.

*Evolution*

Preface (p. v, vi)

Holt, Rinehart & Winston. New York, New York, USA. 1963

**Schaffer, E. A.**

No biographical data available

...setting aside as devoid of scientific foundation the idea of immediate supernatural intervention in the first production of life, we are not only justified in believing, but compelled to believe, that living matter must have owed its origin to causes similar in character to those which have been instrumental in producing all other forms of matter in the universe, in other words, to a process of gradual evolution.

In J. Keosian

*The Origin of Life*

Chapter Two (p. 12)

Reinhold Book Corporation. New York, New York, USA. 1964

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Those whom we called brutes had their revenge when Darwin showed us that they were our cousins.

*The Revolutionist's Handbook & Pocket Companion*

Maxims for Revolutionists, Time's Revenges (p. 58)

USA. 1962

No doubt it is natural to a snail to think that any evolution which threatens to do away with shells will result in

general death from exposure.

In Dan H. Laurence (ed.)

*Shaw's Music: The Complete Music Criticism in Three Volumes* (Volume 3)

The Perfect Wagnerite, Not Love, But Life

M. Reinhardt. London, England. 1981

The pursuit of omnipotence and omniscience. Greater power and greater knowledge: these are what we are all pursuing even at the risk of our lives and the sacrifice of our pleasures. Evolution is that pursuit and nothing else. It is the path to godhead. A man differs from a microbe only in being further on the path.

*Back to Methuselah*

Part II, XXXIII (p. 76)

Constable & Company Ltd. London, England. 1921

**Sherrington, Sir Charles** 1857–1952

English physiologist

Nature, often as she hugs the old, seems seldom or never to revert to a past once abandoned.... Evolution can scrap but not revive.

*Man on His Nature*

Chapter V (p. 135)

Doubleday Anchor Books. Garden City, New York, USA. 1955

**Simpson, George Gaylord** 1902–84

American paleontologist

Until comparatively recently, many — probably most — biologists agreed with Darwin that the problem of the origin of life was not yet amenable to scientific study. Now, however, almost all biologists agree that the problem can be attacked scientifically. The consensus is that life did arise naturally from the nonliving and that even the first living things were not specially created.

*This View of Life: The World of an Evolutionist*

Chapter One (p. 11)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

The basic problems of evolution are so broad that they cannot hopefully be attacked from the point of view of a single scientific discipline.

*Tempo and Mode in Evolution*

Introduction (p. xv)

Columbia University Press. New York, New York, USA. 1944

The fact that theories are not subject to absolute and final proof has led to a serious vulgar misapprehension. Theory is contrasted with fact as if the two had no relationship or were antitheses: "Evolution is only a theory, not a fact." Of course, theories are not facts. They are generalizations about facts and explanations of facts, based on and tested by facts. As such they may be just as certain — merit just as much confidence — as what are popularly termed "facts." Belief that the sun will rise tomorrow is the confident application of a generalization. The theory that life has evolved is founded on much more evidence than supports the generalization that the sun rises every day. In the vernacular, we are justified in calling both "facts."

*Life: An Introduction to Biology* (2<sup>nd</sup> edition)

Chapter 1 (p. 16)

Harcourt, Brace & World, Inc. New York, New York, USA. 1965

Organic evolution is one of the basic facts and characteristics of the objective world. From one point of view it is the basic thing about that world, because it is the process by which the universe's greatest complexities arise and systematic organization culminates. Being the process by which we ourselves came to be, it is crucial for comprehension of our place in and relationship to the objective world.

*This View of Life: The World of an Evolutionist*

Preface (p. vii)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

Suppose that the most fundamental and general principle of a science had been known for over a century and had long since become a main basis for understanding and research by scientists in that field. You would surely assume that the principle would be taken as a matter of course by everyone with even a nodding acquaintance with the science. It would obviously be taught everywhere as basic to the science at any level of education. If you think that about biology, however, you are wrong. Evolution is such a principle in biology. Although almost everyone has heard of it, most Americans have only the scantest and most distorted idea of its real nature and significance.

*This View of Life: The World of an Evolutionist*

Chapter Two (p. 26)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

Evolution has no purpose; man must supply this for himself.

*The Meaning of Evolution*

Part III, Chapter XIX (p. 311)

Yale University Press. New Haven, Connecticut, USA. 1967

It has been said by some theorists that cases like that of the crocodile, virtually unchanged for 100 million years and more, represent a failure of the evolutionary force, a blind alley, a long senescence. As I gazed at my antagonist, it occurred to me how false this is. Here was no failure but an adaptation so successful that once developed it has never needed to change. Is it, perhaps, not the success but the failure of adaptation that has forced evolving life onward to what we, at least, consider higher levels?

*The Dechronization of Sam Magrude*

The Dechronization of Sam Magruder (p. 55)

St. Martin's Press. New York, New York, USA. 1996

...The fossil record shows very clearly that there is no central line leading steadily, in a goal-directed way, from a protozoan to man. Instead there has been continual and extremely intricate branching, and whatever course we follow through the branches there are repeated changes both in the rate and in the direction of evolution. Man is the end of one ultimate twig.... Even slight changes



in earlier parts of the history would have profound cumulative effects on all descendent organisms through the succeeding millions of generations.... The existing species would surely have been different if the start had been different, and if any stage of the histories of organisms and their environments had been different. Thus the existence of our present species depends on a very precise sequence of causative events through some two billion years or more. Man cannot be an exception to this rule. If the causal chain had been different, *Homo sapiens* would not exist.

The Nonprevalence of Humanoids  
*Science*, Volume 143, Number 3608, February 21, 1964 (p. 773)

**Skinner, Cornelia Otis** 1901–79

American actress and writer

It is disturbing to discover in oneself these curious revelations of the validity of the Darwinian theory. If it is true that we have sprung from the ape, there are occasions when my own spring appears not to have been very far.

*The Ape in Me*  
The Ape in Me (p. 3)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1959

**Smith, Langdon** 1858–1908

American poet

When you were a tadpole and I was a fish,  
In the Paleozoic time,  
And side by side on the ebbing tide,  
We sprawled through the ooze and slime...  
My heart was rife with the joy of life,  
For I loved you even then.

In E. Halderman-Julius  
*Poems of Evolution*  
Evolution  
Halderman-Julius. Girard, Kansas, USA. 1924

**Spencer, Herbert** 1820–1903

English social philosopher

If a single cell, under appropriate conditions, becomes a man in the space of a few years, there can surely be no difficulty in understanding how, under appropriate conditions, a cell may, in the course of untold millions of years give origin to the human race.

*The Principles of Biology* (Volume 1)  
Part III, Chapter III, Section 118 (p. 350)  
D. Appleton & Company. New York, New York, USA. 1897

Slowly, but surely, evolution brings about an increasing amount of happiness; all evils being but incidental.

*The Principles of Biology* (Volume 1)  
Part II, Chapter III, Section 120 (p. 354)  
D. Appleton & Company. New York, New York, USA. 1897

The survival of the fittest, which I have here sought to express in mechanical terms, is that which Mr. Darwin has called “natural selection, or the preservation of favoured races in the struggle for life.

*The Principles of Biology* (Volume 1)  
Part III, Chapter XII, Section 165 (pp. 444–445)  
D. Appleton & Company. New York, New York, USA. 1897

...universal evolution is in itself the negation of an absolute commencement of anything. Construed in terms of evolution, every kind of being is conceived as a product of modification wrought by insensible gradations upon a preexisting kind of being; and this holds as fully of the supposed “commencement of organic life” as of all subsequent developments of organic life.... That organic matter was not produced all at once, but was reached through steps, we are well warranted in believing by the experiences of chemists.

*The Principles of Biology* (Volume 1)  
On Alleged “Spontaneous Generation” and on the Hypothesis of Physiological Units (p. 482)  
D. Appleton & Company. New York, New York, USA. 1897

**Stanier, R. Y.**

No biographical data available

It might have happened thus; but we shall surely never know with certainty. Evolutionary speculation constitutes a kind of metascience, which has the same intellectual fascination for some biologists that metaphysical speculation possessed for some medieval scholastics. It can be considered a relatively harmless habit, like eating peanuts, unless it assumes the form of an obsession; then it becomes a vice.

In H.P. Charles and B.C. Knight (eds.)  
*Organization and Control in Prokaryotic Cells. Twentieth Symposium of the Society for General Microbiology*  
Some Aspects of the Biology of Cells and Their Possible Evolutionary Significance (p. 31)  
Cambridge University Press. Cambridge, England. 1970

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

Is evolution a theory, a system, or a hypothesis? It is much more — it is a general postulate to which all theories, all hypotheses, all systems must henceforward bow and which they must satisfy in order to be thinkable and true. Evolution is a light which illuminates all facts, a trajectory which all lines of thought must follow — this is what evolution is.

In Theodosius Dobzhansky  
Nothing in Biology Makes Sense Except in the Light of Evolution  
*The American Biology Teacher*, Volume 35, Number 3, March 1973 (p. 129)

**Tennyson, Alfred (Lord)** 1809–92

English poet

Evolution ever climbing after some ideal good  
And Reversion ever dragging Evolution in the mud.

*Alfred Tennyson's Poetical Works*  
Locksley Hall, Sixty Years After, Stanza 100  
Oxford University Press, Inc. London, England. 1953

As nine months go to the shaping an infant ripe for his birth,  
So many a million of ages have gone to the making of man.

*Alfred Tennyson's Poetical Works*

Maude, Part I, Section IV, Stanza VI

Oxford University Press, Inc. London, England. 1953

**Thomas, Lewis** 1913–93

American physician and biologist

In evolutionary terms, we have only just arrived.... We cannot trace ourselves back more than a few thousand years before losing sight of what we think of as the real human article.... And [we are] vulnerable, error-prone still, at risk of leaving only a thin layer of radioactive fossils.

In Lynn Margulis and Dorion Sagan

*Microcosmos*

Foreword (pp. 10, 11)

Summit Books. New York, New York, USA. 1986

**Thomson, J. Arthur** 1861–1933

Scottish biologist

The Evolution-idea is a master-key that opens many doors. It is a luminous interpretation of the world, throwing the light of the past upon the present.

*The Outline of Science* (Volume 1)

Chapter II (p. 55)

G.P. Putnam's Sons. New York, New York, USA. 1937

Organic evolution means that the present is the child of the past and the parent of the future.

*The Outline of Science* (Volume 1)

Chapter II (p. 56)

G.P. Putnam's Sons. New York, New York, USA. 1937

Evolution just means that the present is the child of the past and the parent of the future.

In Francis Mason (ed.)

*Creation by Evolution*

Why Must We Be Evolutionists? (p. 13)

The Macmillan Company. New York, New York, USA. 1928

...we must bear in mind the fact that millions of years are spent in the fashioning of minutiae of perfection in types which are certainly not near the highway of evolution that led to backboneed animals and eventually to man. Nothing is too remote, too minute, too trivial — everything must be finished and refined.

*The System of Animate Nature* (Volume 2)

Lecture XII (p. 394)

William & Norgate. London, England. 1920

**Torrey, Ray Ethan** 1887–1956

Botanist

All of us are human beings first and scientists afterwards, and the laws of evolution which we have seen written in the plant world are the laws of evolution of all life — of

your life and of mine. In studying these laws in their universal application you may, if you will, find some of the deepest satisfactions which life has to offer, and, as the years go by, you may slowly win to the concept of a living, organic universe whose highest values are not alien to those of human nature.

*General Botany for Colleges*

Summary (p. 431)

The Century Company. New York, New York, USA. 1932

**Trevelyan, George Macaulay** 1876–1962

English historian

Man's evolution is far more extraordinary than the first chapter of Genesis used to lead people to suppose. Man's history, pre-history, ancient, medieval and modern, is by far the most wonderful thing in the Universe [about] which any news has come through to us.

*History and the Reader* (pp. 24–25)

Cambridge University Press. London, England. 1945

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American writer and humorist

Evolution is the law of policies: Darwin said it, Socrates endorsed it, Cuvier proved it and established it for all time in his paper on "The Survival of the Fittest." These are illustrious names, this is a mighty doctrine: nothing can ever remove it from its firm base, nothing dissolve it, but evolution.

In John Tukey (ed.)

*Mark Twain's Which Was the Dream? And Other Symbolic Writings of the Later Years.*

Three Thousand Years Among the Microbes, Chapter 8 (pp. 467–468)

University of California Press. Berkeley, California, USA. 1968

Man has been here 32,000 years. That it took a hundred million years to prepare the world for him is proof that that is what it was done for. I suppose it is. I dunno. If the Eiffel tower were now representing the world's age, the skin of paint on the pinnacle-knob at its summit would represent man's share of that age; & anybody would perceive that that skin was what the tower was built for. I reckon they would. I dunno.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Was the World Made for Man? (p. 576)

The Library of America. New York, New York, USA. 1992

...you cannot make an oyster out of whole cloth, you must make the oyster's ancestor first. This is not done in a day. You must make a vast variety of invertebrates, to start with — belemnites, trilobites, jebustites, Amalekites, and that sort of fry, and put them to soak in a primary sea, and wait and see what will happen.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Was the World Made for Man? (p. 573)

The Library of America. New York, New York, USA. 1992

...it now seems plain to me that that theory ought to be vacated in favor of a new and truer one...the Descent of Man from the Higher Animals.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Man's Place in the Animal World (p. 207)

The Library of America. New York, New York, USA. 1992

**Wald, George** 1906–97

American biologist and biochemist

Evolution advances, not by a priori design, but by the selection of what works best out of whatever choices offer. We are the products of editing, rather than of authorship.

*Annals of the New York Academy of Science*

The Origin of Optical Activity, Volume 66, 1957 (p. 367)

**Wallace, David Rains**

No biographical data available

Evolution has no sense of history. It does not abandon past accomplishments to the fossil museum, but continues to play with them as though they'd happened yesterday.

*The Klamath Knot: Explorations of Myth and Evolution*

Primal Ooze (p. 45)

SierraClub Book. San Francisco, California, USA. 1983

**Wallin, Ivan E.** 1883–1969

American biologist

Organic evolution may be likened to a mammoth, creeping, kaleidoscopic procession which began to move when life first appeared upon earth. In the beginning the procession was small. With the passing eons of time, there has been an ever increasing multitude, slowly, but steadily, moving forward. New forms have constantly joined the procession, and old forms have dropped out. We have not been able to look back into the distant past and learn from when the procession started; we are not able to look forward into the future and predict where the procession means to go; we are only trying to analyze and determine the nature of the factors responsible for the kaleidoscopic nature of the procession as it appears today.

*Symbiontism and The Origin of Species*

Chapter X (p. 147)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

**Watson, James D.** 1928–

American geneticist and biophysicist

Today, evolution is an accepted fact for everyone but a fundamentalist minority, whose objections are not based on reasoning but on doctrinaire adherence to religious principles.

*Molecular Biology of the Gene* (5<sup>th</sup> edition)

Chapter I (p. 5)

Benjamin Cummings. San Francisco, California, USA. 2004

Evolution itself is accepted by zoologists not because it has been observed to occur or is supported by logi-

cally coherent arguments, but because it does fit all the facts of taxonomy, of palaeontology, and of geographical distribution, and because no alternative explanation is credible.

Adaptation

*Nature*, Volume 124, Number 3119, August 10, 1929 (p. 231)

**Watts, Alan Wilson** 1915–73

American philosopher

Things which are made, such as houses, furniture, and machines, are an assemblage of parts put together, or shaped, like sculpture, from the outside inwards. But things which grow shape themselves from within outwards.

*Nature, Man, and Woman*

Part I, Chapter 1 (p. 39)

Vintage Books. New York, New York, USA. 1970

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

It is possible to believe that all the past is but the beginning of a beginning, and that all that is and has been is but the twilight of the dawn. It is possible to believe that all that the human mind has ever accomplished is but the dream before the awakening. A day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool, and shall laugh and reach out their hands amidst the stars.

*The Discovery of the Future* (p. 61)

B.W. Huebsch. New York, New York, USA. 1913

...no rational mind can question the invincible nature of the evolutionary case.

*Mind at the End of Its Tether*

Chapter VIII (p. 29)

William Heinemann Ltd. London, England. 1945

**White, Timothy**

No biographical data available

You don't gradually go from being a quadruped to being a biped. What would the intermediate stage be — a triped? I've never seen one of those.

In Donald C. Johanson and Maitland A. Edey

*Lucy: The Beginnings of Humankind*

Chapter 16 (p. 309)

Simon & Schuster. New York, New York, USA. 1981

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The doctrine of evolution...interprets the vanishing of species and of sporadically variant individuals, as being due to maladjustment to the environment. This explanation has its measure of truth: it is one of the great generalizations of science. But enthusiasts have so strained its

interpretation as to make it explain nothing, by reason of the fact that it explains everything. We hardly ever know the definite character of the struggle which occasioned the disappearance. The phrase is like the liturgical refrain of a litany, chanted over the fossils of vanished species.

*The Function of Reason*

Chapter I (pp. 3–4)

Beacon Press. Boston, Massachusetts, USA. 1929

**Wilber, Ken** 1949–

American philosopher

...is there any conceivable reason that evolution, which has labored so mightily for fifteen billion years and produced so much wonderment, would just up and abruptly cease? Are there not higher spirals lying ahead? If we have discerned even the vaguest features of time's arrow, can we not stand on tiptoe and foresee dimly the arrow's arc into tomorrow?

*Sex, Ecology, Spirituality: The Spirit of Evolution*

Chapter 5 (p. 204)

Shambhala. Boston, Massachusetts, USA. 1995

**Willis, John Christopher** 1868–1958

No biographical data available

The process of evolution appears not to be a matter of natural selection of chance variations of adaptational value. Rather it is working upon some definite law that we do not yet comprehend. The law probably began its operations with the commencement of life, and it is carrying this on according to some definite plan.

*The Course of Evolution by Differentiation or Divergent Mutation*

*Rather Than by Selection* (p. 191)

The University Press. Cambridge, England. 1940

**Wilson, Edward O.** 1929–

American biologist and author

...theology made no provision for evolution. The biblical authors had missed the most important revelation of all! Could it be that they were not really privy to the thoughts of God?

*Consilience: The Unity of Knowledge*

Chapter 1 (p. 6)

Alfred A. Knopf. New York, New York, USA. 1998

...the evolutionary epic is probably the best myth we will ever have.

*On Human Nature*

Chapter 9 (p. 201)

Harvard University Press. Cambridge, Massachusetts, USA. 1978

## EXAMINATION

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

You will remember, of course, always to get the weather-gage of your patient. I mean, to place him so that the light

falls on his face and not on yours. It is a kind of ocular duel that is about to take place between you; you are going to look through his features into his pulmonary and hepatic and other internal machinery, and he is going to look into yours quite as sharply to see what you think about his probabilities for time or eternity.

*Medical Essays*

The Young Practitioner (p. 387)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Huxley, Thomas Henry** 1825–95

English biologist

Examination, like fire, is a good servant, but a bad master; and there seems to me to be some danger of its becoming our master. I by no means stand alone in this opinion. Experienced friends of mine do not hesitate to say that students whose career they watch appear to them to become deteriorated by the constant effort to pass this or that examination, just as we hear of men's brains becoming affected by the daily necessity of catching a train. They work to pass, not to know; and outraged Science takes her revenge. They do pass, and they don't know.

*Collected Essays* (Volume 3)

*Science and Education*

Universities: Actual and Ideal (p. 228)

Macmillan & Company Ltd. London, England. 1904

**Mayo, Charles Horace** 1865–1939

American physician

Examination must be within reason for the sick, or near-sick, and its extent will be based on the judgment and experience of the physician.

When Does Disease Begin? Can This Be Determined by Health Examination?

*Minnesota Medicine*, Volume 15, January 1932

**Mayo, William J.** 1861–1939

American physician

The examining physician often hesitates to make the necessary examination because it involves soiling the finger.

The Cancer Problem

*Lancet*, Volume 35, July 1, 1915

Sometimes I wonder whether today we take sufficient care to make a thorough physical examination before our patient starts off on the round of the laboratories, which have become so necessary that oftentimes we do not fully appreciate the value of our five senses in estimating the condition of the patient.

*Collected Papers of the Mayo Clinic & Mayo Foundation*

Discussion of Paper by T.E. Keys, Volume 30, 1938

## EXAMPLE

**Halmos, Paul R.** 1916–2006

Hungarian-born American mathematician

A good stock of examples, as large as possible, is indispensable for a thorough understanding of any concept, and when I want to learn something new, I make it my first job to build one.

In Joseph A. Gallian

*Contemporary Abstract Algebra*

Chapter 2 (p. 34)

D.C. Heath & Company. Lexington, Massachusetts, USA. 1994

## EXCAVATION

**Browne, Sir Thomas** 1605–82

English author and physician

The treasures of time lie high, in Urnes, Coynes, and Monuments, scarce below the roots of some vegetables.

*Hydriotophia*

Chapter 1 (p. 2)

Printed for Hen. Brome. London, England. 1658

**Marinatos, Spyridon** 1901–74

Greek archaeologist

To excavate is to open a book written in the language that the centuries have spoken into the earth.

*New York Times*, 11 January 1972

**Wheeler, Sir Mortimer** 1890–1976

English archaeologist

...the excavator without an intelligent policy may be described as an archaeological food-gatherer, master of a skill, perhaps, but not creative in the wider terms of constructive science.

*Archaeology from the Earth*

Chapter X (p. 129)

At The Clarendon Press. Oxford, England. 1954

## EXCEPTION

**Bateson, William** 1861–1926

English biologist and geneticist

Treasure your exceptions!... Keep them always uncovered and in sight. Exceptions are like the rough brickwork of a growing building which tells that there is more to come and shows where the next construction will be.

*The Method and Scope of Genetics*

An Inaugural Lecture, Delivered 23 October 1908 (p. 21)

**Hackett, L. W.**

No biographical data available

Investigators are always divided into those who are looking for rules and those who are looking for exceptions.

In Marston Bates

*The Natural History of Mosquitoes*

Chapter XI (p. 163)

The Macmillan Company. New York, New York, USA. 1949

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The young man knows the rules, but the old man knows the exceptions.

*The Young Practitioner*

Address

Bellevue Hospital College, March 2, 1871

## EXCLUDED MIDDLE

**Hilbert, David** 1862–1943

German mathematician

Existence proofs carried out with the help of the principle of excluded middle usually are especially attractive because of their surprising brevity and elegance. Taking the principle of excluded middle from the mathematician would be the same...[as] proscribing the telescope to the astronomer or to the boxer the use of his fists.

In Sahotra Sarkar

*The Emergence of Logical Empiricism*

The Foundations of Mathematics (p. 240)

## EXISTENCE

**Einstein, Albert** 1879–1955

German-born physicist

Of what is significant in one's own existence one is hardly aware, and it certainly should not bother the other fellow.

*Out of My Later Years* (p. 3)

Thames & Hudson. London, England. 1950

**Good, John Mason** 1764–1827

English physician and author

...it is natural history alone that can find us a clew to the labyrinth, that enables us to repose faith in the records of antiquity, and that establishes the important position, that the extravagance of a description is no argument against the truth of a description, and that it is somewhat too much to deny that a thing has existed formerly, for the mere reason that it does not exist now.

*The Book of Nature*

Series I, Lecture XV (p. 171)

Belknap & Hamersley. Hartford, Connecticut, USA. 1844

**Hoffmann, Banesh** 1906–86

Mathematician and educator

True, the universe is more than a collection of objective experimental data; more than the complexus of theories, abstractions, and special assumptions devised to hold the data together; more, indeed, than any construct modeled on this cold objectivity. For there is a deeper, more subjective world, a world of sensation and emotion, of aesthetic, moral, and religious values as yet beyond the

grasp of objective science. And towering majestically over all, inscrutable and inescapable, is the awful mystery of Existence itself, to confound the mind with an eternal enigma.

*The Strange Story of the Quantum*

Chapter XIV (pp. 189–190)

Dover Publications, Inc. New York, New York, USA. 1959

### Scott Cary

Fictional character

That [man's] existence begins and ends is man's conception, not nature's. And I felt my body dwindling, melting, becoming nothing. My fears melted away. And in their place came acceptance. All this vast majesty of creation, it had to mean something. And then I meant something, too. Yes, smaller than the smallest, I meant something, too. To God, there is no zero. I still exist!

*The Incredible Shrinking Man*

Film (1957)

Closing soliloquy narration

### Wheeler, John Archibald 1911–

American physicist and educator

Existence, the preposterous miracle of existence! To whom has the world of opening day never come as an unbelievable sight? And to whom have the stars overhead and the hand and voice nearby never appeared as unutterably wonderful, totally beyond understanding? I know no great thinker of any land or era who does not regard existence as the mystery of all mysteries.

Hermann Weyl and the Unity of Knowledge

*American Scientist*, Volume 74, July–August 1986 (p. 371)

## EXPAND

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

A spherical world, closed but continually expanding, is a new playground for thought.

*The Expanding Universe*

Chapter III, Section I (p. 66)

The University Press. Cambridge. 1933

## EXPERIENCE

### Adams, Henry Brooks 1838–1918

American man of letters

All experience is an arch to build upon.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter VI (p. 87)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

### Balfour, Arthur James 1848–1930

British prime minister

It is experience which has given us our first real knowledge of Nature and her laws. It is experience, in the shape of observation and experiment, which has given us the raw material out of which hypothesis and inference have slowly elaborated that richer conception of the material world which constitutes perhaps the chief, and certainly the most characteristic, glory of the modern mind.

*The Foundations of Belief*

Part II, Chapter I, Section III (p. 113)

Longmans, Green & Company. London, England. 1912

### Beveridge, William Ian Beardmore 1908–

Australian zoologist

The rare genius with a flair for research will not benefit from instruction in the methods of research, but most would-be research workers are not geniuses, and some guidance as to how to go about research should help them to become productive earlier than they would if left to find these things out for themselves by the wasteful method of personal experience.

*The Art of Scientific Investigation*

Preface (pp. x–xi)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### Bohn, H. G.

Experience is the mother of science.

*A Handbook of Proverbs* (p. 352)

George Bell & Sons. London, England. 1904

### Bohr, Niels Henrik David 1886–1962

Danish physicist

The great extension of our experience in recent years has brought to light the insufficiency of our simple mechanical conceptions and, as a consequence, has shaken the foundation on which the customary interpretation of observation was based...

*Atomic Theory and the Description of Nature*

Introductory Survey (p. 2)

Cambridge University Press. Cambridge, England. 1934

### Born, Max 1882–1970

German-born English physicist

My advice to those who wish to learn the art of scientific prophecy is not to rely on abstract reason, but to decipher the secret language of Nature from Nature's documents, the facts of experience.

*Experiment and Theory in Physics* (p. 44)

Cambridge University Press. Cambridge, England. 1944

### Bowen, Elizabeth 1899–1973

Anglo-Irish writer

Experience isn't interesting till it begins to repeat itself — in fact, till it does that, it hardly is experience.

*Death of the Heart*

The World (p. 8)

Alfred A. Knopf. New York, New York, USA. 1938

**Braithwaite, Richard B.** 1900–90  
Philosopher

The peaks of science may appear to be floating in the clouds, but their foundations are in the hard facts of experience.

*Scientific Explanation*

Chapter XI (p. 354)

At The University Press. Cambridge, England. 1959

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Science is nothing else than the search to discover unity in the wild variety of nature — or more exactly, in the variety of our experience.

*Science and Human Values*

The Creative Mind (p. 16)

Harper & Row Publishers. New York, New York, USA. 1965

There are two experiences on which our visual world is based: that gravity is vertical, and that the horizontal stands at right angles to it.

*The Ascent of Man*

Chapter 5 (p. 157)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

When ninety-nine hundredths of one set of phenomena are presented while the hundredth is withdrawn without apparent cause, so that we can no longer do something which according to our past experience we shall find no difficulty whatever in doing — then we may guess what a bee must feel as it goes flying up and down a window-pane. Then we have doubts thrown upon the fundamental axiom of life — *i.e.*, that like antecedents will be followed by like consequents. On this we go mad and die in a short time.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Bee in a Window Pane (p. 89)

Jonathan Cape. London, England. 1951

**Camus, Albert** 1913–60  
Algerian-French author and philosopher

You cannot acquire experience by making experiments. You cannot create experience. You must undergo it.

*Notebooks 1935–1951*

Notebook I, May 1935–September 1937 (p. 5)

Marlowe & Company. New York, New York, USA. 1998

**Cardozo, Benjamin N.** 1870–1938  
American jurist

Often a liberal antidote of experience supplies a sovereign cure for a paralyzing abstraction built upon a theory.

*The Paradoxes of Legal Science*

Chapter IV (p. 125)

Columbia University Press. New York, New York, USA. 1928

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

To most men, experience is like the stern lights of a ship, which illumine only the track it has passed.

*The Table Talk and Omniana of Samuel Taylor Coleridge*

Additional Table Talk

Experience (p. 319)

George Bell & Sons. London, England. 1884

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

The interpreter of the wonders of nature is experience. It never misleads us, only our grasp can do it with us. Until we can establish a general rule, we must accept the help of experience. Although nature begins with the cause, and with the experiment, we must do it inversely, we must discover the cause with experiments.

In Ferenc Szabadváry

*History of Analytical Chemistry*

Chapter III (pp. 21–22)

Gordon & Breach Science. Langhore, Pennsylvania, USA. 1992

Experience is never at fault; it is only your judgment that is in error in promising itself such results from experience as are not caused by our experiments. For having given a beginning, what follows from it must necessarily be a natural development of such a beginning, unless it has been subject to a contrary influence, while, if it is affected by any contrary influence, the result which ought to follow from the aforesaid beginning will be found to partake of this contrary influence in a greater or less degree in proportion to the said influence is more or less powerful than the aforesaid beginning.

*The Literary Works of Leonardo da Vinci* (Volume 2)

1153 (p. 240)

University of California Press. Berkeley, California, USA. 1977

Nature is full of infinite causes which were never set forth in experience.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Philosophy (p. 72)

George Braziller. New York, New York, USA. 1958

But first I shall test by experiment before I proceed further, because my intention is to consult experience first and then with reasoning show why such experience is bound to operate in such a way.

*The Literary Works of Leonardo da Vinci* (Volume 2)

1148 (p. 239)

University of California Press. Berkeley, California, USA. 1977

...good judgment is born of clear understanding, and a clear understanding comes of reasons derived from sound rules, and sound rules are the issue of sound experience — the common mother to all the sciences and arts.

*The Literary Works of Leonardo da Vinci* (Volume 1)

18 (p. 119)

University of California Press. Berkeley, California, USA. 1977

**de Cervantes, Miguel** 1547–1616

Spanish novelist, playwright, and poet

...experience itself, the mother of all the sciences.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part I, Chapter 21 (p. 63)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

Experience without theory teaches nothing.

*Out of the Crisis*

Chapter 11 (p. 317)

Massachusetts Institute of Technology Press. Cambridge,

Massachusetts, USA. 1986

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The cleavage between the scientific and the extra-scientific domain of experience is, I believe, not a cleavage between the concrete and the transcendental, but between the metrical and non-metrical.

*The Nature of the Physical World*

Chapter XIII (p. 275)

The Macmillan Company. New York, New York, USA. 1930

Science aims at constructing a world which shall be symbolic of the world of commonplace experience.

*The Nature of the Physical World*

Introduction (p. xiii)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

Our experience hitherto justifies us in believing that nature is the realization of the simplest conceivable mathematical ideas. I am convinced that we can discover by means of purely mathematical constructions the concepts and laws connecting them with each other, which furnish the key to the understanding of natural phenomena. Experience may suggest the appropriate mathematical concepts, but they most certainly cannot be deduced from it. Experience remains, of course, the sole criterion of the physical utility of a mathematical construction. But the creative principle resides in mathematics. In a certain sense, therefore, I hold it true that pure thought can grasp reality, as the ancients dreamed.

*Ideas and Opinions*

On the Method of Theoretical Physics (p. 267)

Crown Publishers, Inc. New York, New York, USA. 1954

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Experience has been declared, with equal truth and poetry, to adopt occasionally the tone, and attain to

something like the certainty, of Prophecy. In the contemplating mind the past and the future are linked by a bond as indissoluble as that which connects them in their actual sequence.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Quetelet on Probabilities (p. 365)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

**Hertz, Heinrich** 1857–94

German physicist

...that which is gained from experience can again be annulled by experience.

*The Principles of Mechanics Presented in a New Form*

Introduction (p. 9)

Dover Publications, Inc. New York, New York, USA. No date

**Hine, Reginald Leslie**

No biographical data available

That is the worst of learning from experience; it takes too long. Often it takes a lifetime. "Experience," said Sainte-Beuve, "is like the pole-star; it only guides a man in the evening, and rises when he is going to rest."

*Confessions of an Un-Common Attorney*

Part One, Reflections Upon the Married Estate (p. 91)

Macmillan. New York, New York, USA. 1945

**Hoffmann, Friedrich** 1660–1742

German physician

In medicine there are two supports — experience, which is the first parent of truth; and reason, which is the key to medical science. Experience comes first in order, and reason follows. Hence in medical affairs reasons which are not founded on experience have no value.

*Fundamenta Medicinæ*

Physiology, Chapter I, 7 (p. 5)

American Elsevier. New York, New York, USA. 1971

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

There is not, and never has been, a human being who was capable of thinking straight, except by checking his thoughts against objective experience.

*Of Men and Galaxies*

Motives and Aims of the Scientist (p. 16)

University of Washington Press. Seattle, Washington, USA. 1964

**James, William** 1842–1910

American philosopher and psychologist

...all the magnificent achievements of mathematical and physical science — our doctrines of evolution, of uniformity of law, and the rest — proceed from our indomitable desire to cast the world into a more rational shape in our minds than the shape into which it is thrown there by the crude order of our experience.

*The Will to Believe and Other Essays in Popular Philosophy*



The Dilemma of Determinism (p. 147)  
Dover Publications, Inc. New York, New York, USA. 1956

**Kant, Immanuel** 1724–1804

German philosopher

There can be no doubt that all our knowledge begins with experience. For how should our faculty of knowledge be awakened into action did not objects affecting our senses partly of themselves produce representations, partly arouse the activity of our understanding to compare these representations, and, by combining or separating them, work up the raw material of the sensible impressions into that knowledge of objects which is entitled experience?

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

Introduction, Part I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Latham, Peter Mere** 1789–1875

English physician

Wherefore then serveth experience, and of what use is it? Its first and best use is for the guidance of him that has it. Its next, and hardly less important use, is that it enables him to judge rightly the experience of others.

In William B. Bean

*Aphorisms from Latham* (p. 93)

Prairie Press. Iowa City, Iowa, USA. 1962

Nothing is so difficult to deal with as man's own Experience, how to value it according to amount, what to conclude from it, and how to use it and do good with it.

In William B. Bean

*Aphorisms From Latham* (p. 94)

Prairie Press. Iowa City, Iowa, USA. 1962

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

The Etruscans are not a theory or a thesis. If anything, they are an experience.

*Etruscan Places*

Chapter VI (p. 197)

Folio Society. London, England. 1972

**Lewis, Clarence Irving** 1883–1964

American philosopher

...knowing begins and ends in experience; but it does not end in the experience in which it begins.

Experience and Meaning

*The Philosophical Review*, Volume XLIII, 1934 (p. 134)

**Luciano, Giano**

No biographical data available

...nothing short of seeing a thing will help you know it. If you wish to know that pepper is hot and that vinegar is cooling, that colocynth and absinthe are bitter, that honey is sweet, and that aconite is poison; that

the magnet attracts steel, that arsenic whitens brass, and that tutia turns it of an orange color, you will, in every one of those cases, have to verify the assertion by experience.

*The New Pearl of Great Price*

Arguments in Favor of Our Most Glorious Art (pp. 86–87)

Arno Press. New York, New York, USA. 1974

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Mathematical and physiological researches have shown that the space of experience is simply an actual case of many conceivable cases, about whose peculiar properties experience alone can instruct us.

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 205)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**May, Donald C.**

No biographical data available

**Mead, George H.** 1863–1931

American philosopher, sociologist, and psychologist

...in the world of immediate experience, the world of things is there. Trees grow, day follows night, and death supervenes upon life. One may not say that relations here are external or even internal. They are not relations at all. They are lost in the indiscernibility of things and events, which are what they are. The world which is the test of all observations and all scientific hypothetical reconstruction has in itself no system that can be isolated as a structure of laws, or uniformities, though all laws and formulations of uniformities must be brought to its court for its imprimatur.

*The Philosophy of the Act*

Chapter II (p. 31)

The University of Chicago, Chicago, Illinois, USA; 1938

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

The experience of science — to stub your toe hard and then notice that it was really a rock on which you stubbed it — this experience is something that is hard to communicate by popularization, by education, or by talk. It is almost as hard to tell a man what it is like to find out something new about the world as it is to describe a mystical experience to a chap who has never had any hint of such an experience.

*The Open Mind*

Chapter VII (pp. 126–127)

Simon & Schuster. New York, New York, USA. 1955

**Paré, Ambroise** 1510–90

French surgeon

Science without experience does not bring much confidence.

*Attributed to be one of Paré's cannons*

**Planck, Max** 1858–1947  
German physicist

It is only when we have planted our feet on the firm ground which can be won only with the help of the experience of real life, that we have a right to feel secure in surrendering to our belief in a philosophy of the world based upon a faith in the rational ordering of this world.

Translated by W.H. Johnston

*The Philosophy of Physics*

Chapter IV (p. 125)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Even the careful and sober testing of our ideas by experience is in its turn inspired by ideas: experiment is planned action in which every step is guided by theory. We do not stumble upon our experiences, nor do we let them flow over us like a stream. Rather, we have to be active: we have to “make” our experiences. It is we who always formulate the questions to be put to nature; it is we who try again and again to put these questions so as to elicit a clear-cut “yes” or “no” (for nature does not give an answer unless pressed for it). And in the end, it is again we who give the answer; it is we ourselves who, after severe scrutiny, decide upon the answer to the question which we put to nature — after protracted and earnest attempts to elicit from her an unequivocal ‘no.’

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (p. 280)

Basic Books, Inc. New York, New York, USA. 1959

...it must be possible for an empirical scientific system to be refuted by experience.

*The Logic of Scientific Discovery*

Part I, Chapter I, Section 6 (p. 41)

Basic Books, Inc. New York, New York, USA. 1959

**Roberts, W. Milnor**

No biographical data available

From the laying out of a line of tunnel to its final completion, the work may be either a series of experiments (made at the expense of the proprietors of the project), or a series of judicious applications of the results of previous experience.

In Henry Drinker

*Tunneling, Explosive Compounds and Rock Drills* (p. 1005)

John Wiley & Sons, Inc. New York, New York, USA. 1878

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Mind you, that you have a sound scientific theory to correlate your observations at the bedside. Mere experience by itself is nothing. If I take my dog to the bedside with me, he sees what I see. But he learns nothing from it. Why? Because he’s not a scientific dog.

*The Doctor’s Dilemma*

Act I (p. 26)

Brentano’s. New York, New York, USA. 1920

**Thompson, Sir D’Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

...we have come to the edge of a world of which we have no experience, and where all our preconceptions must be recast.

*On Growth and Form* (Volume 1)

Chapter II (p. 77)

At The University Press. Cambridge, England. 1951

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

We should be careful to get out of an experience only the wisdom that is in it — and stop there; lest we be like the cat that sits down on a hot stove-lid. She will never sit down on a hot stove-lid again — and that is well; but she will also never sit down on a cold one any more.

*Following the Equator* (Volume 1)

Chapter XI (p. 125)

Harper & Brothers Publishers. New York, New York, USA. 1899

**von Baeyer, Adolf** 1835–1917

German-born physicist and author

Men who are capable of modifying their first beliefs are very rare. This ability was one of the reasons for the success of Claude Bernard and Pasteur. Out of a very vivid imagination they forged new hypotheses all the time but abandoned them with equal ease as soon as experience contradicted them.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 141)

W.A. Benjamin. New York, New York, USA. 1965

**Whewell, William** 1794–1866

English philosopher and historian

Experience can discover universal truths, though she cannot give them universality.

*History of Scientific Ideas* (Volume 1) (p. 270)

J. W. Parker & Son. London, England. 1858

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

DUMBY: Experience is the name everyone gives to their mistakes.

*The Works of Oscar Wilde* (Volume 5)

Lady Windermere’s Fan, Third Act (p. 60)

Lamb Publishing Company. New York, New York, USA. 1909

## EXPERIMENT

**Asimov, Isaac** 1920–92

American author and biochemist

There are fashions in science as in everything else. Conduct an experiment that brings about an unusual success and before you can say, "There are a dozen imitations!" there are a dozen imitations!

*Asimov on Chemistry*

Welcome, Stranger! (p. 55)

Anchor Press/Doubleday. Garden City, New York, USA. 1974

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...we must first, by every kind of experiment, elicit the discovery of causes and true axioms, and seek for experiments which may afford light rather than profit.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 70 (p. 116)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

All true and fruitful natural philosophy hath a double scale or ladder, ascendent and descendent, ascending from experiments to the invention of causes, and descending from causes to the invention of new experiments.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VII, Section 1 (p. 42)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bernard, Claude** 1813–78

French physiologist

There never are any unsuccessful experiments: they are all successful in their own definite conditions, so that negatives cannot nullify positive results.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section VI (p. 117)

Henry Schuman, Inc. New York, New York, USA. 1927

Experimentation is undeniably harder in medicine than in any other science; but for that very reason, it was never so necessary, and indeed so indispensable.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (pp. 2–3)

Henry Schuman, Inc. New York, New York, USA. 1927

Considered in itself, the experimental method is nothing but reasoning by whose help we methodically submit our ideas to experience — the experience of fact.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (p. 2)

Henry Schuman, Inc. New York, New York, USA. 1927

...an experiment is fundamentally just an observation induced with some object or another.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section v (p. 19)

Henry Schuman, Inc. New York, New York, USA. 1927

...we must not deceive ourselves, morals do not forbid making experiments on one's neighbor or on one's self; in everyday life men do nothing but experiment on one another. Christian morals forbid only one thing, doing ill to one's neighbor. So, among the experiments that may be tried on man, those that can only harm are forbidden, those that are innocent are permissible, and those that may do good are obligatory.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section III (p. 102)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bloch, Arthur** 1948–

American humorist

The experiment may be considered a success if no more than 50% of the observed measurements must be discarded to obtain a correspondence with the theory.

*Murphy's Law*

Maier's Law: Corollary (p. 47)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

If an experiment works, something has gone wrong.

*Murphy's Law*

Finagle's First Law (p. 15)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

In every experiment on living organisms, there must remain an uncertainty as regards the physical conditions to which they are subjected, and the idea suggests itself that the minimal freedom we must allow the organism in this respect is just large enough to permit it, so to say, to hide its ultimate secrets from us.

Light and Life

*Nature*, Volume 131, Number 3309, April 1, 1933 (p. 458)

**Bolton, Henry Carrington** 1843–1903

American chemist, bibliographer, and historian

...reliance on the dicta and data of investigators whose very names may be unknown lies at the very foundation of physical science, and without this faith in authority the structure would fall to the ground; not the blind faith in authority of the unreasoning kind that prevailed in the Middle Ages, but the rational belief in the concurrent testimony of individuals who have recorded the results of their experiments and observations, and whose statements can be verified...

In Joseph William Mellor

*Higher Mathematics for Students of Chemistry and Physics* (p. 291)

Dover Publications. New York, New York, USA. 1955

**Browning, Robert** 1812–89

English poet

Just an experiment first, for candor's sake.

*The Poems and Plays of Robert Browning*

Mr. Sludge, "The Medium"  
The Modern Library. New York, New York, USA. 1934

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Every cold empirick, when his heart is expanded by a successful experiment, swells into a theorist...

*The Works of Samuel Johnson, LL.D.* (Volume 2)

Preface to Shakespeare (p. 340)

H. G. Bohn. London, England. 1854

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

"The first thing I've got to do," said Alice to herself as she wandered in the woods, "is to grow to my right size again; and the second thing is to find my way into that lovely garden. I think that will be the best plan." It sounded an excellent plan, no doubt; the only difficulty was that she had not the smallest idea how to set about it...

*The Complete Works of Lewis Carroll*

Alice's Adventures in Wonderland

Chapter IV (p. 50)

The Modern Library. New York, New York, USA. 1936

**Charlie Chan**  
Fictional character

No experiment is failure until last experiment is success.

*Dark Alibi*

Film (1946)

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Never say no to an experiment.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 7, Section II (p. 81)

The Seabury Press. New York, New York, USA. 1977

**Cox, Gertrude M.** 1900–78  
Statistician

The statistician who supposes that his main contribution to the planning of an experiment will involve statistical theory, finds repeatedly that he makes his most valuable contribution simply by persuading the investigator to explain why he wishes to do the experiment, by persuading him to justify the experimental treatments, and to explain why it is that the experiment, when completed, will assist him in his research.

*Lecture III*

Lecture in Washington, 11 January 1951

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Experiment is the interpreter of nature. Experiments never deceive. It is our judgment which sometimes deceives itself because it expects results which experiment refuses.

We must consult experiment, varying the circumstances, until we have deduced general rules, for experiment alone can furnish reliable rules.

In Oswald Blackwood

*Introductory College Physics* (p. 47)

John Wiley & Sons, Inc. New York, New York, USA. 1939

Experience does not ever err, it is only your judgment that errs in promising itself results which are not caused by your experiments.

In Daniel J. Boorstin

*The Discoverers*

Part Ten (p. 337)

Random House, Inc. New York, New York, USA. 1983

In treating any particular subject I would first of all make some experiments, because my design is first to refer to experiments and then to demonstrate why bodies are constrained to act in such a manner. This is the method we ought to follow in investigating the phenomena of Nature. Theory is the general, experiments are the soldiers. Experiment is the interpreter of the artifices of Nature. It is never wrong; but our judgment is sometimes deceived because we are expecting results which experiment refuses to give. We must consult experiment and vary the circumstances, till we have deduced general laws, for it alone can furnish us with them.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VI (p. 129)

Macmillan & Company Ltd. London, England. 1918

**Dalton, John** 1766–1844  
English chemist and physicist

...my head is too full of triangles, chymical processes and electrical experiments, etc., to think much of marriage.

In H. Spencer Lewis (ed.)

*Rosicrucian Manual*

Letter to Jonathan Otley, 1796 (pp. 109–110)

Kessinger Publishing Company. Kila, Montana, USA. 2003

...those who are conversant in practical chemistry, know that not more than one new experiment in five is fit to be reported to the public; the rest are found, upon due reflection, to be some way or other defective, and are useful only as they shew the source of error, and the means of avoiding it.

*A New System of Chemical Philosophy* (Volume 1)

Part 2, Preface

R. Bickerstaff. London, England. 1810

**Darwin, Charles Robert** 1809–82  
English naturalist

Extravagant theories, however, in those parts of philosophy, where our knowledge is yet imperfect, are not without their use; as they encourage the execution of

laborious experiments, or the investigation of ingenious deductions, to conform or refute them.

In E. Krause

*Erasmus Darwin with a Preliminary Notice by Charles Darwin* (pp. 139–140)

John Murray. London, England. 1879

If you knew some of the experiments (if they may be so-called) which I am trying, you would have a good right to sneer, for they are so absurd even in my opinion that I dare not tell you.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

C. Darwin to J.D. Hooker [April 14<sup>th</sup>, 1855] (p. 415)

D. Appleton & Company. New York, New York, USA. 1896

### **Davy, John** 1790–1868

English chemist

Appearances in these things are most deceptive: in the theatre experiments are made for illustration, and are generally of a simple kind, and easily comprehended, and the minds of the audience are prepared by the lecturer to follow and understand them. In the laboratory, on the contrary, this aid is wanting when most necessary; and, in consequence, operations...of a very accurate kind, and carried on with a perfect design, may appear confused to the uninstructed, or to the uninitiated.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter V (pp. 259–260)

Smith, Elder & Company. London, England. 1839–1840

In the progress of an art, from its rudest to its more perfect state, the whole process depends upon experiment. Science is in fact nothing more than the refinement of common sense making use of facts already known to acquire new facts.

*Consolations in Travel, or the Last Days of a Philosopher*

Dialogue V (p. 234)

J. Murray. London, England. 1830

### **de Fontenelle, Bernard le Bovier** 1657–1757

French author

‘Tis no easy matter to be able to make an Experiment with accuracy. The least fact, which offers itself to our consideration, takes in so many other facts, which modify or compose it, that it requires the utmost dexterity to lay open the several branches of its composition, and no less sagacity to find ‘em out.

In Michael Roberts and E.R. Thomas

*Newton and the Origin of Colours*

Chapter I (p. 6)

G. Bell & Sons Ltd. London, England. 1934

### **Deming, William Edwards** 1900–93

American statistician, educator, and consultant

We must know more about a plan than the probabilities of selection. We must know also the procedure by which

to draw the sampling units, and the formula or procedure by which to calculate the estimate.

*Sample Design in Business Research* (p. 39)

John Wiley & Sons, Inc. New York, New York, USA. 1960

### **Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The experiment serves two purposes, often independent one from the other: it allows the observation of new facts, hitherto either unsuspected, or not yet well defined; and it determines whether a working hypothesis fits the world of observable facts.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Experimentation (p. 13)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...he is an incorruptible watch-dog who will not allow anything to pass which is not observationally true.

*The Philosophy of Physical Science*

Chapter VII, Section II (p. 112)

The Macmillan Company. New York, New York, USA. 1939

### **Edison, Thomas Alva** 1847–1931

American inventor

The only way to keep ahead of the procession is to experiment. If you don't, the other fellow will. When there's no experimenting there's no progress. Stop experimenting and you go backward. If anything goes wrong, experiment until you get to the very bottom of the trouble.

In Frank Lewis Dyer

*Edison — His Life and Inventions* (Volume 2)

Chapter XXIV (p. 617)

Harper & Brothers. New York, New York, USA. 1929

### **Ehrlich, Paul**

Much testing; accuracy and precision in experiment; no guesswork or self-deception.

In Martha Marquardt

*Paul Ehrlich*

Chapter XIII (p. 134)

Henry Schuman. New York, New York, USA. 1951

### **Eldridge, Paul** 1888–1982

American educator

Those who fear muddy feet will never discover new paths.

*Maxims for a Modern Man*

1286

T. Yoseloff. New York, New York, USA. 1965

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The lessons of science should be experimental also. The sight of the planet through a telescope is worth all the course on astronomy: the shock of the electric spark in the elbow outvalues all the theories; the taste of the nitrous oxide, the firing of an artificial volcano, are better than volumes of chemistry.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

New England Reformers (p. 594)

The Library of America. New York, New York, USA. 1983

**Faraday, Michael** 1791–1867

English physicist and chemist

Nothing is too wonderful to be true, if it be consistent with the laws of nature, and in such things as these, experiment is the best test of such consistency.

In T. Martin (ed.)

*Diary*

March 19, 1849

Publisher undetermined

Let the imagination go, guiding it by judgment and principle but holding it in and directing it by experiment.

In L. Pearce Williams

*Michael Faraday: A Biography* (p. 467)

Basic Books, Inc. New York, New York, USA. 1965

As an experimentalist, I feel bound to let experiment guide me into any train of thought which it may justify; being satisfied that experiment, like analysis, must lead to strict truth if rightly interpreted; and believing also that it is in its nature far more suggestive of new trains of thought and new conditions of natural power.

In Sylvanus P. Thompson

*Michael Faraday: His Life and Work*

Chapter VI (p. 242)

Cassell & Company Ltd. London, England. 1901

**Ferris, Timothy** 1944–

American science writer

Science is distinguished not for asserting that nature is rational, but for constantly testing claims to that or any other affect by observation and experiment.

*The Whole Shebang: A State-of-the Universe's Report*

Cosmic Evolution (p. 201)

Simon & Schuster. New York, New York, USA. 1996

**Feynman, Richard P.** 1918–88

American theoretical physicist

If science is to progress, what we need is the ability to experiment, honestly in reporting the results — the results must be reported without somebody saying what they would like the results to have been — and finally — an important thing — the intelligence to interpret the results. An important point about this intelligence is that it should not be sure ahead of time what must be. It cannot be prejudiced, and say “That is very unlikely; I don’t like that.”

*The Character of Physical Law*

Chapter 6 (p. 148)

BBC. London, England. 1965

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

A lady declares that by tasting a cup of tea made with milk she can discriminate whether the milk or the tea infusion was first added to the cup. We will consider the problem of designating an experiment by means of which this assertion can be tested.

*The Design of Experiments*

I, 5 (p. 11)

Hafner Publishing Company. New York, New York, USA. 1971

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

To consult the statistician after an experiment is finished is often merely to ask him to conduct a post mortem examination. He can perhaps say what the experiment died of.

Presidential Address, First Indian Statistical Conference, 1938

*Sankhya*, Volume 4, 1938 (p. 17)

**Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

Let the experiment be made.

In I. Bernard Cohen

*Benjamin Franklin's Experiments*

Letter XVII

Letter to Dr. L —

March 18, 1755 (p. 334)

Harvard University Press. Cambridge, Massachusetts, USA. 1941

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

One cannot repeat experiments too often when the problem is one of determining a relationship.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 70)

Cambridge University Press. Cambridge, England. 1978

**Giddings, Franklin H.** 1855–1931

American sociologist

In scientific experimentation we control everything that happens. We determine when it shall occur and where. We arrange circumstances and surroundings, atmosphere and temperatures; possible ways of getting in and possible ways of getting out. We take something that has been in, or put in something that has been out, and see what happens.

*The Scientific Study of Human Society*

Chapter III (p. 55)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1924

**Gleick, James** 1954–  
American author, journalist, and essayist

Theorists conduct experiments with their brains. Experimenters have to use their hands, too. Theorists are thinkers, experimenters are craftsmen. The theorist needs no accomplice. The experimenter has to muster graduate students, cajole machinists, flatter lab assistants. The theorist operates in a pristine place free of noise, of vibration, of dirt. The experimenter develops an intimacy with matter as a sculptor does with clay, battling it, shaping it, and engaging it. The theorist invents his companions, as a naive Romeo imagined his ideal Juliet. The experimenter's lovers sweat, complain, and fart.

*Chaos: Making a New Science*  
Strange Attractors (p. 125)  
The Viking Press. New York, New York, USA. 1987

**Gonseth, Ferdinand** 1890–1975  
Swiss mathematician

An experiment is a question which man asks of nature; one result of the observation is an answer which nature yields to man.

*The Primeval Atom*  
Preface (p. 8)  
D. Van Nostrand Company, Inc. New York, New York, USA. 1950

**Gore, George** 1826–1909  
English electrochemist

In scientific study also, as in other abstruse meditations, the mind soon becomes exhausted by intense thinking, but is usually relieved by preparing and making experiments.

*The Art of Scientific Discovery*  
Chapter XXXIII (p. 313)  
Longmans, Green & Company. London, England. 1878

**Green, Celia** 1935–  
English philosopher and psychologist

There are some things that are sure to go wrong as soon as they stop going right.

*The Decline and Fall of Science*  
Aphorisms (p. 171)  
Hamilton. London, England. 1976

**Gregg, Alan** 1890–1957  
American medical educator and philosopher

Experiments are like cross-questioning a witness who will tell the truth but not the whole truth.

*The Furtherance of Medical Research*  
Chapter III (p. 89)  
Yale University Press. New Haven, Connecticut, USA. 1941

Experiment as compared with mere observation has some of the characteristics of cross-examining nature rather than merely overhearing her.

*The Furtherance of Medical Research*

Chapter I (p. 7)  
Yale University Press. New Haven, Connecticut, USA. 1941

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

The hope that new experiments will lead us back to objective events in time and space is about as well-founded as the hope of discovering the end of the world in the unexplored regions of the Antarctic.

In Nick Herbert  
*Quantum Reality: Beyond the New Physics*  
Chapter 2 (p. 17)  
Anchor Press. Garden City, New York, USA. 1985

**Hooke, Robert** 1635–1703  
English physicist

If you're trying to establish cause-and-effect relationships, do try to do so with a properly designed experiment.

In J.M. Tanur  
*Statistics: A Guide to the Unknown*  
Statistics, Sports, and Some Other Things (p. 195)  
Wadsworth & Brooks. Pacific Grove, California, USA. 1989

**Hume, David** 1711–76  
Scottish philosopher and historian

...[it is] justly esteemed an unpardonable temerity to judge the whole course of nature from one single experiment, however accurate or certain.

In *Great Books of the Western World* (Volume 35)  
*An Enquiry Concerning Human Understanding*  
Section VII, Part II (p. 476)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hunter, John** 1728–93  
Scottish surgeon

Why think? Why not try the experiment?

*The Life of Edward Jenner*  
Chapter 2 (p. 33)  
Letter to Edward Jenner, August 2, 1775  
H. Colburn. London, England. 1837

**Huxley, Thomas Henry** 1825–95  
English biologist

Ancient traditions, when tested by the severe processes of modern investigation, commonly enough fade away into mere dreams: but it is singular how often the dream turns out to have been a half-waking one, presaging a reality.

*Man's Place in Nature and Other Anthropological Essays*  
Chapter I (p. 1)  
D. Appleton & Company. New York, New York, USA. 1896

**James, P. D.**  
No biographical data available

There comes a time when every scientist, even God, has to write off an experiment.

*Devices and Desires*

Book Five, Chapter 8 (p. 330)  
Alfred A. Knopf. New York, New York, USA. 1990

**Jefferson, Thomas** 1743–1826  
3<sup>rd</sup> president of the United States

...in the full tide of successful experiment ...  
*The Inaugural Addresses of the Presidents of the United States*  
First Inaugural Address at Washington DC, March 4, 1801

**Jevons, William Stanley** 1835–82  
English economist and logician

When we merely note and record the phenomena which occur around us in the ordinary course of nature we are said to observe. When we change the course of nature by the intervention of our will and muscular powers, and thus produce unusual combinations and conditions of phenomena, we are said to experiment. Sir John Herschel has justly remarked that we might properly call these two modes of experience passive and active observation.... [A]n experiment differs from a mere observation in the fact that we more or less influence the character of the events which we observe.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book III, Chapter XVIII (p. 400)  
Macmillan & Company Ltd. London, England. 1887

**Kant, Immanuel** 1724–1804  
German philosopher

When Galileo let balls of a particular weight, which he had determined himself, roll down an inclined plane; or when Torricelli made the air carry a weight, which he had previously determined to be equal to that of a certain column of water; when at a still later stage Stahl changed metal into calx, and calx back again into metal, by first withdrawing something and then restoring it; then a new light was flashed on all students of nature.... Reason, holding in one hand its principles according to which concordant phenomena alone can be admitted as laws of nature, and in the other hand the experiment which it has devised according to those principles, must approach nature for instruction; but not as a pupil, to be taught just what the master pleases, but as a judge, who forces the witnesses to answer the questions he puts to them.... Thus after many centuries of groping, the study of nature was first made to walk along the sure path of a science.

In *Great Books of the Western World* (Volume 42)  
*Critique of Pure Reason*  
Second Preface  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Kapitza, Pyotr Leonidovich** 1894–1984  
Russian physicist

...theory is a good thing but a good experiment lasts forever.

Science East and West: Reflections of Peter Kapitza (Book Review by Nevill Mott)  
*Nature*, Volume 288, Number 5791, 11 December 1980 (p. 627)

**Kluckhohn, Clyde** 1905–60  
American anthropologist

Nonliterate societies represent the end results of many different experiments carried out by nature.

*Mirror For Man: The Relation of Anthropology to Modern Life*  
Chapter I (p. 15)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1949

**Latham, Peter Mere** 1789–1875  
English physician

Experiment is like a man traveling to some far off place, and finding no place by the way where he can sit down and rest himself, and few or no guide posts to tell him whether he be in the right direction for it or not. Still he holds on. Perhaps he has been there before, and is pretty sure of this being the direction in which he found it. Or, perhaps he has never been there, but some of his friends have, and they told him of this being the right road to it. And so it may be that, by his own sagacity and the help of well-informed friends, he reaches it at last. Or, after all his own pains, and all his friends can do for him, it may be that he never reaches it at all.

In William B. Bean  
*Aphorisms from Latham* (p. 91)  
Prairie Press. Iowa City, Iowa, USA. 1962

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

We ought, in every instance, to submit our reasoning to the test of experiment, and never to search for truth but by the natural road of experiment and observation.

*Elements of Chemistry in a New Systematic Order*  
Preface  
W. Creech. Edinburgh, Scotland. 1790

We must trust in nothing but facts. These are presented to us by nature and cannot deceive. We ought in every instance to submit our reasoning to the test of experiment. It is especially necessary to guard against the extravagances of imagination which incline to step beyond the bounds of truth.

In Bernard Jaffe  
*New World of Chemistry*  
Chapter 1 (p. 1)  
Silver, Burdett & Company. New York, New York, USA. 1935

...for nothing is created in the operations either of art or of nature, and it can be taken as an axiom that in every operation an equal quality and quantity of matter exists both before and after the operation, that the quality and quantity of the principles remain the same and that only changes and modifications occur. The whole art of making experiments in chemistry is founded on this principle:



we must always suppose an exact equality or equation between the principles of the body examined and those of the products of its analysis.

*Traite Elementaire de Chemie* (p. 130)

Dover Publications. New York, New York, USA. 1965

**Lederman, Leon** 1922–

American high-energy physicist

Colleague reader, please read this to your uncertain teenager con brio! Tell him or her that (1) experiments often fail, and (2) they don't always fail.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 9 (p. 396)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

If it were as easy in other matters to verify reasonings by experiments, there would not be such differing opinions. But the trouble is that experiments in physics are difficult and cost a great deal; and in metaphysics they are impossible, unless God out of love for us perform a miracle in order to acquaint us with remote immaterial things.

In Philip Wiener

*Selections*

The Method of Mathematics

Preface

Charles Scribner's Sons. New York, New York, USA. 1951

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

I am quite aware that this road is obscured by mists that may pass over it from time to time. Yet these mists will be easily dispersed as soon as it is possible to employ widely the light of experiments. For Nature remains always the same; when she seems to be different it is because of the inevitable defects of our observations.

In Johann Wolfgang von Goeth

*The Botanical Writings* (p. 30)

University of Hawaii Press. Honolulu, Hawaii, USA. 1952

**Loftus, Elizabeth**

No biographical data available

Science is based on a fundamental insight — that the degree to which an idea seems true has nothing to do with whether it is true, and the way to distinguish factual ideas from false ones is to test them by experiment.

Who Is the Cat That Curiosity Killed?

*Nature*, Nov/Dec 1998 (p. 60)

**Lomonosov, Mikhail** 1711–65

Russian poet, scientist, and grammarian

I value one experiment higher than a thousand opinions born of the imagination.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Moscow, Russia. 1979

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Experiments are never absolutely exact, but they at least may lead the inquiring mind to *conjecture* that...key which will clear up the connection of all the facts...

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter I, Part I, Section 6 (pp. 25–26)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Maxwell, James Clerk** 1831–79

Scottish physicist

An Experiment, like every other event which takes place, is a natural phenomenon; but in a Scientific Experiment the circumstances are so arranged that the relations between a particular set of phenomena may be studied to the best advantage. In designing an Experiment the agents and the phenomena to be studied are marked off from all others and regarded as the Field of Investigation.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

General Considerations Concerning Scientific Apparatus (p. 505)

At The University Press. Cambridge, England. 1890

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

It is a truism to say that a “good” experiment is precisely that which spares us the exertion of thinking: the better it is, the less we have to worry about its interpretation, about what it “really” means.

*Induction and Intuition in Scientific Thought*

Chapter I, Section 3 (p. 15)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

All experimentation is criticism. If an experiment does not hold out the possibility of causing one to revise one's views, it is hard to see why it should be done at all.

*Advice to a Young Scientist*

Chapter 11 (p. 94)

Basic Books, Inc. New York, New York, USA. 1979

**Mendeleyev, Dmitry** 1834–1907

Russian chemist

Under the all-penetrating control of experiment, a new theory, even if crude, is quickly strengthened, provided it be founded on a sufficient basis; the asperities are removed, it is amended by degrees, and soon loses the phantom light of a shadowy form or of one founded on mere prejudice; it is able to lead to logical conclusions and to submit to experimental proof.

The Periodic Law of the Chemical Elements

*Journal of the Chemical Society*, Volume 55, 1889 (p. 634)

**Mitchell, Silas Weir** 1829–1914

American physician and author

In science, all sorts of things present themselves and you watch them; the facts are tested, accepted, rejected, or set aside, and at last experiments are made following some apparently fruitful ideas.

*Weir Mitchell, His Life and Letters* (p. 76)

Duffield & Company. New York, New York, USA. 1929

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

We are certainly not to relinquish the evidence of experiments for the sake of dreams and vain fictions of our own devising; nor are we to recede from the analogy of Nature, which is wont to be simple, and always consonant to itself.

In *Great Books of the Western World* (Volume 34)

*Mathematical Principles of Natural Philosophy*

Book III, Comment to third rule (p. 270)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Panofsky, Wolfgang** 1919–

German-American physicist

As experimental techniques have grown from the top of a laboratory bench to the large accelerators of today, the basic components have changed vastly in scale but only little in basic function. More important, the motivation of those engaged in this type of experimentation has hardly changed at all.

Particle Substructure: A Common Theme of Discovery in this Century

*Contemporary Physics*, Volume 20, Number 1, 1982 (p. 23)

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541

Alchemist and mystic

Every experiment is like a weapon which must be used in its particular way — a spear to thrust, a club to strike. Experimenting requires a man who knows when to thrust and when to strike, each according to need and fashion.

In J. M. Stillman

The Contributions of Paracelsus to Medical Science and Practice

*The Monist*, Volume 27, 1917 (p. 398)

**Pasteur, Louis** 1822–95

French chemist

...marvelous experimental method, of which one can say, in truth, not that it is sufficient for every purpose, but that it rarely leads astray, and then only those who do not use it well. It...eliminates certain facts, brings forth others, interrogates nature, compels it to reply and stops only when the mind is fully satisfied. The charm of our studies, the enchantment of science, is that, everywhere and always, we can give the justification of our principles and the proof of our discoveries.

In René Dubos

*Pasteur and Modern Science*

Chapter I (p. 12)

Science Tech Publishers. Madison, Wisconsin, USA. 1988

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Experiment alone crowns the efforts of medicine, experiment limited only by the natural range of the powers of the human mind.

*Experimental Psychology and Other Essays*

Fusion of Principal, Branches of Medicine in Modern Experimentation as Demonstrated by the Example of Digestion (p. 488)

Philosophical Library. New York, New York, USA. 1957

...observation collects that which nature has to offer, whereas experiment takes from her that which it desires.

*Experimental Psychology and Other Essays*

Fusion of Principal, Branches of Medicine in Modern Experimentation as Demonstrated by the Example of Digestion (p. 488)

Philosophical Library. New York, New York, USA. 1957

**Pearson, Karl** 1857–1936

English mathematician

It is the old experience that a rude instrument in the hand of a master craftsman will achieve more than the finest tool wielded by the uninspired journeyman.

*Life, Letters and Labours of Francis Galton* (Volume 3) (p. 50)

University Press. Cambridge, England. 1914–30

**Pirsig, Robert M.** 1928–

American writer

The TV scientist who mutters sadly “The experiment is a failure: we have failed to achieve what we hoped for,” is suffering mainly from a bad scriptwriter. An experiment is never a failure solely because it fails to achieve predicted results. An experiment is a failure only when it also fails adequately to test the hypothesis in question, when the data it produces don’t prove anything one way or the other.

*Zen and the Art of Motorcycle Maintenance: An Inquiry Into Values*

Part II, Chapter 9 (pp. 109–110)

William Morrow & Company, Inc. New York, New York, USA. 1974

**Planck, Max** 1858–1947

German physicist

Experimenters are the shocktroops of science.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part III (p. 110)

Philosophical Library. New York, New York, USA. 1949

It is wholly absurd to maintain that an intellectual experiment is important only in proportion as it can be checked by measurement; for if this were so, there could be no exact geometrical proof. A line drawn on paper is not really a line but a more or less narrow strip, and a point a larger or smaller spot.

Translated by W.H. Johnston

*The Philosophy of Physics*

Chapter I (p. 27)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

An experiment is a question which science poses to Nature, and a measurement is the recording of Nature's answer.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part III (p. 110)  
Philosophical Library. New York, New York, USA. 1949

**Plato** 428 BCE–347 BCE

Greek philosopher

POLUS: O chaerephon, there are many arts among mankind which are experimental, and have their origin in experience, for experience makes the days of men to proceed according to art, and inexperience according to chance, and different persons in different ways are proficient in different arts, and the best persons in the best arts.

In *Great Books of the Western World* (Volume 7)

*Gorgias*

Section 448 (p. 253)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Experiment is the sole source of truth. It alone can teach us something new; it alone can give us certainty.

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 127)

The Science Press. New York, New York, USA. 1913

It is often said that experiments must be made without preconceived idea. That is impossible. Not only would it make all experiment barren, but that would be attempted which could not be done.

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 129)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

A mighty maze! but not without a plan...

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, l. 6

Houghton Mifflin Company. New York, New York, USA. 1903

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

I admit, of course, that we attempt to control the purely speculative elements of our theories by ingenious experiments. Nevertheless, all our experiments are guided by theory and they cannot be interpreted except by theory. It is our inventiveness, our imagination, our intellect, and especially the use of our critical faculties in discussing and comparing our theories that make it possible for our knowledge to grow.

In C.J. Whitrow

*Einstein: The Man and His Achievement*

Einstein: Early Years (p. 28)

BBC. London, England. 1967

**Portier, Paul**

No biographical data available

It seems to me to be useless for us to deliver passionate long verbal duels in order to establish who is right or wrong. It is necessary to search in good faith on the part of each other for the truth; there are two different points of view and only experiments carried out over a sufficient time will give us definitive scientific results.

In Jan Sapp

*Evolution by Association: A History of Symbiosis*

Chapter 7 (p. 97)

Oxford University Press, Inc. New York, New York, USA. 1994

**Priestley, Joseph** 1733–1804

English theologian and scientist

The history of science cannot but animate us in our attempts to advance still further, and suggest methods and experiments to assist us in our future progress.

In John G. McEvoy

Electricity, Knowledge, and the Nature of Progress in Priestley's Thought

*British Journal of the History of Science*, Volume 12, 1979 (p. 6)

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

We don't teach our students enough of the intellectual content of experiments — their novelty and their capacity for opening new fields.... My own view is that you take these things personally. You do an experiment because your own philosophy makes you want to know the result. It's too hard, and life is too short, to spend your time doing something because someone else has said it's important. You must feel the thing yourself...

Profiles—Physicists, I

*The New Yorker Magazine*, October 13, 1975

**Robertson, Howard P.**

No biographical data available

What is needed is a homely experiment which could be carried out in the basement with parts from an old sewing machine and an Ingersol watch, with an old file of Popular Mechanics standing by for reference!

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Geometry as a Branch of Physics (p. 326)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Röntgen, Wilhelm Conrad** 1845–1923

German physicist

The experiment is the most powerful and most reliable lever enabling us to extract secrets from nature.... The

experiment must constitute the final judgment as to whether a hypothesis should be retained or be discarded.

In O. Glasser

*Wilhelm Conrad Röntgen and the Early History of the Roentgen Rays*  
(p. 74)

Charles C. Thomas. Springfield. 1934

### **Rothman, Tony** 1953–

American cosmologist

Principle of Magnification: New discoveries follow on the heels of new equipment.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 2 (p. 56)

Ballantine Books. New York, New York, USA. 1995

The Physicist's Code: A single good observation is worth a century of bad philosophy.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Introduction (p. xii)

Ballantine Books. New York, New York, USA. 1995

### **Rumford, Benjamin**

No biographical data available

It frequently happens, that in the ordinary affairs and occupations of life, opportunities present themselves of contemplating some of the most curious operations of Nature; and very interesting philosophical experiments might often be made, almost without trouble or expense, by means of machinery contrived for the mere mechanical purposes of the arts and manufacturers.

Heat Is a Form of Motion: An Experiment in Boring Cannon

*Philosophical Transactions of the Royal Society of London*, Volume 88, 1798

### **Russell, Sir E. John** 1872–1965

English agriculturalist

A committee or an investigator considering a scheme of experiments should first...ask whether each experiment or question is framed in such a way that a definite answer can be given. The chief requirement is simplicity; only one question should be asked at a time.

*Journal of the Ministry of Agriculture of Great Britain*

Field Experiments: How They are Made and What They Are, Volume 32, 1926 (p. 989)

### **Rutherford, Ernest** 1871–1937

English physicist

Experiment without imagination or imagination without recourse to experiment, can accomplish little, but for effective progress, a happy blend of these two powers is necessary.

The Electrical Structure of Matter

*Science*, Volume 58, Number 1499, September 21, 1923 (p. 221)

If your experiment needs statistics, you ought to have done a better experiment.

In N.T. Bailey

*The Mathematical Approach to Biology and Medicine*

Chapter 2 (p. 23)

John Wiley & Sons, Inc. New York, New York, USA. 1967

### **Sagan, Carl** 1934–96

American astronomer and author

When theory is not adequate in science, the only realistic approach is experimental. Experiment is the touchstone of science on which the theories are framed. It is the court of last resort.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 5 (p. 37)

Dell Publishing, Inc. New York, New York, USA. 1975

Wherever possible, scientists experiment. Which experiments suggest themselves often depends on which theories currently prevail. Scientists are intent on testing those theories to the breaking point. They do not trust what is intuitively obvious. That the Earth is flat was once obvious. That heavy bodies fall faster than light ones was once obvious. That bloodsucking leeches cure most diseases was once obvious. That some people are naturally and by divine decree slaves was once obvious. That there is such a place as the center of the Universe, and that the Earth sits in that exalted spot was once obvious. That there is an absolute standard of rest was once obvious. The truth may be puzzling or counterintuitive. It may contradict deeply held beliefs. Experiment is how we get a handle on it.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 36)

Random House, Inc. New York, New York, USA. 1995

### **Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

We never experiment with just one electron or atom... any more than we can raise Ichthyosauria in the zoo.

*British Journal For the Philosophy of Science*, Volume III, Number 11, November 1952

### **Snyder, Solomon**

American physician

Of course, if you can predict the consequences of your own experiments before they commence, your research is very likely to be boring.

*Brainstorming*

Chapter 10 (p. 195)

Harvard University Press. Cambridge, Massachusetts, USA. 1989

### **Stenger, Victor J.** 1935–

American Physicist

The instruments of modern science have provided us with greatly enhanced capabilities for gathering data about the universe. With our microscopes, telescopes, and particle detectors, we are no longer bound by the limitations of human sensory apparatus or of our confinement to this tiny planet. And we have learned to

rely more on the rational interpretation of the reading of these instruments than on preconceived notions based on everyday experience.

*Physics and Psychics: The Search for a World Beyond the Senses*  
Chapter 14 (p. 296)  
Prometheus Books. Buffalo, New York, USA. 1990

### Swenson, Jr., Lloyd S.

No biographical data available

For sheer intellectual drama, nothing can surpass the encounter between a great experiment and a great theory.

*The Ethereal Aether*

Foreword (p. xix)

University of Texas Press. Austin, Texas, USA. 1972

### The Bible

Would any one of you think of building a tower without first sitting down and calculating the cost, to see whether he could afford to finish it?

*The Revised English Bible*

Luke 14:28

Oxford University Press, Inc. Oxford, England. 1989

### Thesiger, Ernest

My experiments did not turn out quite like yours, Henry. But science, like love, has her little surprises.

*Bride of Frankenstein*

Film (1935)

### Thomson, Sir George 1892–1975

English physicist

...in order to make an experiment meaningful one must have a theory as to what matters for the experiment.

*The Inspiration of Science*

Chapter II (p. 15)

Oxford University Press, Inc. London, England. 1961

### Titchener, Edward Bradford 1867–1927

English-born American psychologist

An experiment is an observation that can be repeated, isolated and varied. The more frequently you can repeat an observation, the more likely are you to see clearly what is there and to describe accurately what you have seen. The more strictly you can isolate an observation, the easier does your task of observation become, and the less danger is there of your being led astray by irrelevant circumstances, or of placing emphasis on the wrong point. The more widely you can vary an observation, the more clearly will be the uniformity of experience stand out, and the better is your chance of discovering laws.

*A Text-Book of Psychology*

Subject-Matter, Method and Problem of Psychology, Section 6 (p. 20)

The Macmillan Company. New York, New York, USA. 1912

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American writer and humorist

Tuesday. She has taken up with a snake now. The other animals are glad, for she was always experimenting with them and bothering them; and I am glad, because the snake talks, and this enables me to get a rest.

*Adam's Diary*

Tuesday (p. 39)

Harper & Brothers Publishers. New York, New York, USA. 1904

Some things you can't find out; but you will never know you can't by guessing and supposing: no, you have to be patient and go on experimenting until you find out that you can't find out. And it is delightful to have it that way, it makes the world so interesting. If there wasn't anything to find out, it would be dull. Even trying to find out and not finding out is just as interesting as trying to find out and finding out; and I don't know but more so.

*Eve's Diary*

Friday (p. 87)

Harper & Brothers Publishers. New York, New York, USA. 1906

It is best to prove things by actual experiment; then you know; whereas if you depend on guessing and supposing and conjecturing, you will never get educated.

*Eve's Diary*

Friday (p. 85)

Harper & Brothers Publishers. New York, New York, USA. 1906

### von Baeyer, Adolf 1835–1917

German-born physicist and author

I never undertook my experiments to see if I was right but to see how compounds behaved. This disposition accounts for my indifference to theories.

In Richard Willstätter

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 140)

W.A. Benjamin. New York, New York, USA. 1965

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

It is a calamity that the use of experiment has severed nature from man, so that he is content to understand nature merely through what artificial instruments reveal and by so doing even restricts her achievements.... Microscopes and telescopes, in actual fact, confuse man's innate clarity of mind.

In Ernst Lehrs

*Man or Matter: Introduction to a Spiritual Understanding of Nature on*

*the Basis of Goethe's Method of Training Observation and Thought*

Part II, Chapter IV (p. 111, 106)

Faber & Faber Ltd. London, England. 1958

### Wald, George 1906–97

American biologist and biochemist

I have often had cause to feel that my hands are cleverer than my head. That is a crude way of characterizing the dialectics of experimentation. When it is going well, it is like a quiet conversation with Nature. One asks a question and gets an answer; then one asks the next question,

and gets the next answer. An experiment is a device to make Nature speak intelligibly. After that one has only to listen.

*Nobel Lecture, Physiology or Medicine 1963–1970*

The Molecular Basis of Visual Excitation (p. 292)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Weinberg, Steven** 1933–

American nuclear physicist

It appears that anything you say about the way that theory and experiment may interact is likely to be correct, and anything you say about the way that theory and experiment must interact is likely to be wrong.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Chapter V (p. 128)

Pantheon Books. New York, New York, USA. 1992

**Weyl, Hermann** 1885–1955

German mathematician

Allow me to express now, once and for all, my deep respect for the work of the experimenter and for his fight to wring significant facts from an inflexible Nature, who says so distinctly “No” and so indistinctly “Yes” to our theories.

Translated by H.P. Robertson

*The Theory of Groups and Quantum Mechanics*

Introduction (p. xx)

Dover Publications, Inc. New York, New York, USA. 1950

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

There is always more chance of hitting upon something valuable when you aren't too sure what you want to hit upon.

In Lucien Price

*Dialogues of Alfred North Whitehead*

Dialogue XLII, September 11, 1945 (p. 344)

Little Brown. Boston, Massachusetts, USA. 1954

...experiment is nothing else than a mode of cooking the facts for the sake of exemplifying the law.

*Adventures of Ideas*

Chapter VI (p. 111)

The Macmillan Company. New York, New York, USA. 1956

**Willstätter, Richard** 1872–1942

German chemist

Our experiments are not carried out to decide whether we are right, but to gain new knowledge. It is for knowledge's sake that we plow and sow. It is not inglorious at all to have erred in theories and hypotheses. Our hypotheses are intended for the present rather than the future. They are indispensable for us in the explanation of the secured facts, to enliven and to mobilize them and above all, to blaze a trail into unknown regions towards new discoveries.

Willard Gibbs Medal address

American Chemical Society, September 1933

**Zinsser, Hans** 1878–1940

American bacteriologist

The life of a student of any science is a constant series of frustrations. From his own observations and those of others, a trellis of theory is built up beyond the solid stakes of fact. The investigator tests these, perched on scaffoldings of experiment which break down again and again and are, as often, reconstructed with the weak points reinforced. Eventually, as soon as he has tied down an elusive shoot, he loses interest and is lured by the ones a little higher up. There is never an end, and never a complete satisfaction — as there may be in the arts, when a perfect sonnet or a good statue is, in itself, final and forever.

*As I Remember Him: the Biography of R.S.*

Chapter XX (p. 330)

Little, Brown & Company. Boston, Massachusetts, USA. 1940

## EXPERIMENTAL METHOD

**Bernard, Claude** 1813–78

French physiologist

Considered by itself, the experimental method is nothing but reasoning by whose help we methodically submit our ideas to experience, — the experience of facts.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (p. 2)

Henry Schuman, Inc. New York, New York, USA. 1927

**Hacking, Ian** 1936–

Canadian-born philosopher of science

Philosophers of science constantly discuss theories and representation of reality, but say almost nothing about experiment, technology, or the use of knowledge to alter the world. This is odd, because “experimental method” used to be just another name for scientific method.... I hope [to] initiate a Back-to-Bacon movement, in which we attend more seriously to experimental science. Experimentation has a life of its own.

*Representing and Intervening: Introductory Topics in the Philosophy of Natural Science* (p. 143,f)

Cambridge University Press. Cambridge, England. 1983

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

The great intellectual division of mankind is not along geographical or racial lines, but between those who understand and practice the experimental method and those who do not understand and do not practice it.

*A History of Science* (p. 29)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1948

**Tolman, Edward Chance** 1886–1959  
American psychologist

I shall devote this paper to a description of experiments with rats. But I shall also attempt in a few words at the close to indicate the significance of these findings on rats for the clinical behavior of men. Most of the rat investigations, which I shall report, were carried out in the Berkeley laboratory. But I shall also include, occasionally, accounts of the behavior of non-Berkeley rats who obviously have misspent their lives in out-of-State laboratories.

Cognitive Maps in Rats and Men  
*The Psychological Review*, Volume 55, Number 4, 1948 (p. 189)

## EXPERIMENTER

**Bernard, Claude** 1813–78  
French physiologist

An experimenter facing natural phenomena is like a spectator watching a dumb show. He is in some sort the examining magistrate for nature; only instead of grappling with men who seek to deceive him by lying confessions or false witness, he is dealing with natural phenomena which for him are persons whose language and customs he does not know, persons living in the midst of circumstances unknown to him, yet persons whose designs he wishes to learn.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter II, Section I (p. 31)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Brillouin, Léon** 1889–1969  
French physicist

Perfect logic and faultless deduction make a pleasant theoretical structure, but it may be right or wrong; the experimenter is the only one to decide, and he is always right.

*Scientific Uncertainty and Information*  
Chapter III (p. 38)  
Academic Press. New York, New York, USA. 1964

**Deutsch, Martin** 1917–2002  
Austrian-born American physicist

It is of course the ambition of every experimenter...to make a discovery, to sail safely between the Scylla of intellectual prejudice which makes us reject evidence not really integrated without preconceived notions, and the Charybdis of irrelevance which has swallowed many working days spent in pursuit of instrumental artifice.

Evidence  
*Daedalus*, Fall 1958 (pp. 97–98)

**Pasteur, Louis** 1822–95  
French chemist

The illusions of an experimenter form a great part of his power. These are the preconceived ideas which serve to guide him. Many of them vanish in the long path which he must travel, but one fine day he discovers and proves that some of them are adequate to the truth. Then he finds himself master of facts and of new principles, the application of which sooner or later bestows their benefits.

In Graham Lusk  
Pasteur, the Man  
*Science*, Volume 57, Number 1466, February 2, 1923 (p. 149)

**Tyndall, John** 1820–93  
Irish-born British physicist

The child grows, but is still an experimenter: he grasps at the moon, and his failure teaches him to respect distance. At length, his little fingers acquire sufficient mechanical tact to lay hold of a spoon. He thrusts the instrument into his mouth, hurts his gums and thus learns the impenetrability of matter. He lets the spoon fall, and jumps with delight to hear it rattle against the table. The experiment made by accident is repeated with intention, and thus the young student receives his first lesson upon sound and gravitation. There are pains and penalties, however, in the path of the enquirer: he is sure to go wrong, and Nature is just as sure to inform him of the fact. He falls downstairs, burns his fingers, cuts his hand, scalds his tongue, and in this way learns the conditions of his physical well being. This is Nature's way of proceeding, and it is wonderful what progress her pupil makes.

*Fragments of Science* (Volume 1) (p. 283)  
D. Appleton & Company. New York, New York, USA. 1896

## EXPERT

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Always listen to experts. They'll tell you what can't be done, and why. Then do it.

*The Notebooks of Lazarus Long* (p. 1)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Mamet, David** 1947–  
American author, essayist and screenwriter

The poker player learns that sometimes both science and common sense are wrong; that the bumblebee can fly; that, perhaps, one should never trust an expert; that there are more things in heaven and earth than are dreamt of by those with an academic bent.

*Writing in Restaurants*  
Things I Have Learned Playing Poker on the Hill  
The Viking Press. New York, New York, USA. 1986

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

There is something inherently comforting about a panel of experts. One knows that the partial and inadequate and slanted and personal views that he expresses will be corrected by the less partial, less personal views of everyone else on the panel...

*The Open Mind*

Chapter VII (p. 119)

Simon & Schuster. New York, New York, USA. 1955

## EXPLANATION

**Atkins, Peter William** 1940–

English physical chemist and writer

I shall take your mind on a journey. It is a journey of comprehension, taking us to the edge of space, time, and understanding. On it I shall argue that there is nothing that cannot be understood, that there is nothing that cannot be explained, and that everything is extraordinarily simple.

A great deal of the universe does not need any explanation. Elephants, for example. Once molecules have learnt to compete and to create other molecules in their own image, elephants, and things resembling elephants, will in due course be found roaming through the countryside.

*The Creation*

Chapter 1 (p. 3)

W.H. Freeman. San Francisco, California, USA. 1981

**Bernal, John Desmond** 1901–71

Irish-born physicist and x-ray crystallographer

It is characteristic of science that the full explanations are often seized in their essence by the percipient scientist long in advance of any possible proof.

*The Origin of Life*

Appendix I

Comments on Haldane's Paper on the Origins of Life (p. 251)

The World Publishing Company, Cleveland, Ohio, USA. 1967

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Perhaps when a man has special knowledge and special powers like my own, it rather encourages him to seek a complex explanation when a simple one is at hand.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Abbey Grange (p. 498)

Wings Books. New York, New York, USA. 1967

**Jerome, Fred**

American journalist and science writer

Explain, explain, explain — but without resentment.

In Barbara Gastel

*Presenting Science to the Public*

Chapter 2 (p. 24)

ISI Press. Philadelphia, Pennsylvania, USA. 1983

**Mitchell, Maria** 1818–89

American astronomer and educator

...you cannot get a man of genius to explain steps, he leaps.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter VII (p. 138)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Scriven, Michael**

No biographical data available

...whatever an explanation actually does, in order to be called an explanation at all it must be capable of making clear something not preciously clear, *i.e.* of increasing or producing understanding of something. The difference between explaining and “merely” informing, does not, I shall argue, consist in explaining being something “more than” or even something intrinsically different from informing or describing, but in its being the appropriate piece of informing or describing, the appropriateness being a matter of its relation to a particular context.

In H. Feigl and G. Maxwell (eds.)

*Minnesota Studies in the Philosophy of Science* (Volume 3)

Scientific Explanation, Space and Time, Explanations, Predictions, and Laws (pp. 175–176)

University of Minnesota Press. Minneapolis, Minnesota, USA. 1962

**von Schlegel, Friedrich** 1772–1829

German philosopher, critic, and writer

There are three kinds of explanation in science: explanations which throw a light upon, or give a hint at a matter; explanations which do not explain anything; and explanations which obscure everything.

*Dialogue on Poetry and Literary Aphorisms*

Selected Aphorisms from the Athenaeum

Aphorism 82 (p. 138)

The Pennsylvania State University Press, University Park, Pennsylvania, USA. 1968

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

If we say there is a limit — the ultimate atom — then, as all size is comparative, we can imagine a being to whom this atom seems as large as an apple or even a house does to us; and we then find it quite unthinkable that this mass of matter should be in its nature absolutely indivisible even by an infinite force. It follows that all explanations of phenomena can only be partial explanations. They can inform us of the last change or the last series of changes which brought about the actual conditions now existing, and they can often enable us to predict future changes to a limited extent; but both the infinite past and the remote future are alike beyond our powers. Yet the explanations that the theory of evolution gives us are none the less real



and none the less important, especially when we compare its teachings with the wild guesses or the total ignorance of the thinkers of earlier ages.

Evolution

*The Sun (New York)*, 23 December, 1900 (p. 4a)

**Wolpert, Lewis** 1929–

British embryologist

There is a relevant story about Charles II, who once invited fellows of the Royal Society to explain to him why a fish when it is dead weighs more than when it was alive. The fellows responded with ingenious explanations, until the King pointed out that what he had told them was just not true.

*The Unnatural Nature of Science*

Chapter 5 (p. 98)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

**EXPLICIT**

**Alon, Noga**

Mathematician

There is an explicit way to define what explicit is.

International Congress of Mathematics 2002

Beijing

August 23, 2002

**EXPLORATION**

**Clarke, Arthur C.** 1917–

English science and science fiction writer

The urge to explore, to discover, to “follow knowledge like a sinking star,” is a primary human impulse which needs and can receive no further justification than its own existence.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 3)

Harper & Brothers Publishers. New York, New York, USA. 1959

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

We shall not cease from exploration  
And the end of all our exploring  
Will be to arrive where we started  
And know the place for the first time.  
Through the unknown, remembered gate  
When the last of earth left to discover  
Is that which was the beginning.

*The Collected Poems and Plays 1909–1950*

Little Gidding, Part V, stanza 2 (p. 145)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Feynman, Richard P.** 1918–88

American theoretical physicist

...the way I think of what we're doing is we're exploring, we're trying to find out as much as we can about

the world. People say to me, “Are you looking for the ultimate laws of physics?” No, I'm not, I'm just looking to find out more about the world and if it turns out there is a simple ultimate law which explains everything, so be it, that would be very nice to discover. If it turns out it's like an onion with millions of layers and we're just sick and tired of looking at the layers, then that's the way it is, but whatever way it comes out its nature is there and she's going to come out the way she is, and therefore when we go to investigate it we shouldn't predecide what it is we're trying to do except to try to find out more about it.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 1 (p. 23)

Perseus Books. Cambridge, Massachusetts, USA. 1999

**Gleick, James** 1954–

American author, journalist, and essayist

As Feynman said, the hadron-hadron work [in the Stanford Linear Accelerator Center, SLAC] was like trying to figure out a pocket watch by smashing two of them together and watching the pieces fly out.

*Genius: The Life and Science of Richard Feynman*

Caltec (p. 392)

Pantheon Books. New York, New York, USA. 1992

**Hunter, Mark**

No biographical data available

There has never been an age like ours. We rocket our spaceships to the dark side of the moon, and probe the mysteries at the very edge of the universe. We map mountain ranges buried beneath the sea. We journey to the strange world inside the atom, and dig out the secret of life from microscopic specks within the cell. We travel back in time to view the explosive birth of the universe. We peer into the heart of stars. This is an age of unparalleled exploration where man has never gone before, we go. To where man thought he could never go, we find a way. We find a way even to the center of the earth.

*Fantastic Journeys: Five Great Quests of Modern Science*

The Journey to the Center of the Earth (p. 1)

Walker. New York, New York, USA. 1980

**Lipmann, Fritz** 1899–86

German-born American biochemist

...the drive and urge to explore nature in all its facets is one of the most important functions of humanity.

*Les Prix Nobel. The Nobel Prizes in 1953*

Nobel banquet speech for award received in 1953

Nobel Foundation. Stockholm, Sweden. 1954

**Severinus, Petrus** 1540–1602

Swedish anatomist

Go, my sons, buy stout shoes, climb the mountains, search the valleys, the deserts, the seas shores, and the

deep recesses of the earth. Mark well the various kinds of minerals, note their properties and their mode of origin.

In Frank Dawson Adams

*The Birth and Development of the Geological Sciences*

Chapter VII (p. 210)

Dober Publications, Inc. 1938

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Thus far into the bowels of the land have we marched on without impediment.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Tragedy of King Richard the Third

Act V, Scene ii, l. 3–4

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Thomas, Lewis** 1913–93

American physician and biologist

It is fascinating that the word “explore” does not apply to the searching aspect of the activity, but has its origins in the sounds we make while engaged in it. We like to think of exploring in science as a lonely, meditative business, and so it is in the first stages, but always, sooner or later, before the enterprise reaches completion, as we explore, we call to each other, communicate, publish, send letters to the editor, present papers, cry out on finding.

*The Lives of a Cell: Notes of a Biology Watcher*

On Societies as Organisms (p. 15)

The Viking Press. New York, New York, USA. 1974

**Verne, Jules** 1828–1905

French novelist

Descend into the crater of Yocul of Sneffels, which the shade of Scartaris caresses, before the kalends of July, audacious traveler, and you will reach the center of the earth. I did it.

*A Journey to the Center of The Earth*

Chapter 3 (p. 21)

The Limited Editions Club. New York, New York, USA. 1966

**Waller, William H.**

No biographical data available

**Hodge, Paul W.**

No biographical data available

It is through intrepid seeking that our species has come this far. And it will be through our continuing exploration of the Solar System, Milky Way, and Universe that we will fulfill whatever cosmic role may await us. The adventure has just begun!

*Galaxies and the Cosmic Frontier*

Part III, Epilogue (p. 273)

Harvard University Press. Cambridge, Massachusetts, USA. 2003

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Ah who shall soothe these feverish children?

Who justify these restless explorations?

*The Complete Prose Works of Walt Whitman*

Passage to India

Small, Maynard & Company. Boston, Massachusetts, USA. 1898

**EXPONENTIAL**

**Hardin, Garrett** 1915–2003

American ecologist and microbiologist

[One must show the greatest respect towards] any thing that increases exponentially, no matter how small.

*Exploring New Ethics for Survival: The Voyage of the Spaceship Beagle*

Chapter 5 (p. 45)

Penguin Books. New York, New York, USA. 1973

**EXPOSITION**

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

...there is no scorn more profound, or on the whole more justifiable, than that of the men who make for the men who explain. Exposition, criticism, appreciation, is work for the second-rate minds.

*A Mathematician's Apology*

Chapter I (p. 61)

Cambridge University Press. Cambridge, England. 1969

**EXTERNAL WORLD**

**Saint-Hilaire, Étienne Geoffroy** 1772–1844

French Naturalist

The external world is all-powerful in alteration of the form of organized bodies...these [modifications] are inherited, and they influence all the rest of the organization of the animal, because if these modifications lead to injurious effects, the animals which exhibit them perish and are replaced by others of a somewhat different form, a form changed so as to be adapted to the new environment.

In Henry Fairfield Osborn

*From the Greeks to Darwin: An Outline of the Development of the Evolution Idea*

Section 5 (p. 199)

The Macmillan Company. New York, New York, USA. 1905

**EXTINCTION**

**Carlton, J. T.**

No biographical data available

The future historians of science may well find that a crisis that was upon us at the end of the 20<sup>th</sup> century was the extinction of the systematist, the extinction of the naturalist, the extinction of the biogeographer — those

who would tell the tales of the potential demise of global marine diversity.

Nonextinction of Marine Invertebrates  
*American Zoologist*, Volume 33, Number 6, 1993 (p. 507)

### **Clemens, William**

No biographical data available

...the impact theory of extinction? It's cods wallop.  
The Debate Over Dinosaur Extinction Takes an Unusually Rancorous Turn  
*New York Times*, January 19, 1988 (p. c3)

### **Cuppy, Will** 1884–1929

American humorist and critic

The Age of Reptiles ended because it had gone on long enough and it was all a mistake in the first place.

*How to Become Extinct*  
Dover Publications. New York, New York, USA. 1964

### **Darwin, Charles Robert** 1809–82

English naturalist

This wonderful relationship in the same continent between the dead and the living, will, I do not doubt, hereafter throw more light on the appearance of organic beings on our earth, and their disappearance from it, than any other class of facts.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter X (p. 365)  
D. Appleton & Company. New York, New York, USA. 1896

The extinction of species has been involved in the most gratuitous mystery. Some authors have even supposed that, as the individual has a definite length of life, so have species a definite duration. No one can have marveled more than I have done at the extinction of species. When I found in La Plata the tooth of a horse embedded with the remains of Mastodon, Megatherium, Toxodon and other extinct monsters, which all co-existed with still living shells at a very late geological period, I was filled with astonishment...

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter XI (p. 169)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **de Duve, Christian** 1917–

English cytologist and biochemist

The disappearance of living species is not just a blow to orchid growers, butterfly collectors, and beetle buffs. It is an irremediable loss of precious information, the biological equivalent of the burning of the library of Alexandria in 641. It is the destruction of a large part of the book of life before it can be read, the irreplaceable loss of vital clues to biological evolution and our own history. Resources of potentially great practical benefit may be

lost. With each daily shrinking of the biosphere, a valuable source of food or a molecule that could have cured malaria, AIDS, or some other scourge may be vanishing forever.

*Vital Dust: Life As a Cosmic Imperative*  
Chapter 30 (p. 275)  
Basic Books. New York, New York, USA. 1995

## **Editorial**

Terrestrial events, like volcanic activity or change in climate or sea level, are the most immediate possible cause of mass extinctions. Astronomers should leave to astrologers the task of seeking the causes of earthly events in the stars.

Miscasting the Dinosaur's Horoscope  
*New York Times*, April 2, 1985

### **Eldredge, Niles** 1943–

American paleontologist

Thus extinctions, in the abstract consideration of life's entire history, have paved the way for the truly new, including, of course, ourselves. But now that we are here, it is not inconsistent at all to want to see our own species survive. To hell with innovation, let's try to stick around.

*Life Pulse Episodes from the Story of the Fossil Record*  
Chapter 8 The Cenozoic (p. 240)  
Facts on File Publications, New York. 1987

### **Flanders, Michael** 1922–75

English actor and singer

### **Minale, Marcello**

No biographical data available

The Brontosaurus  
Had a brain  
No bigger than  
A crisp;  
The Dodo  
Had a stammer  
And the Mammoth  
Had a lisp;  
The Auk  
Was just too Aukward —  
Now they're none of them  
Alive.  
Each one,  
(like Man),  
Had shown himself  
Unfit to survive.  
This story  
Points a moral:  
Now it's  
We  
Who wear the pants.

The extinction  
Of these species  
Holds a lesson  
For us  
ANTS.

*Creatures Great and Small*

Introductory Poem

Holt, Rinehart & Winston. New York, New York, USA. 1965

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Extinction, for most people, carries many of the connotations attributed to sex not so long ago — a rather disreputable business, frequent in occurrence, but not to anyone's credit, and certainly not to be discussed in proper in circles. But, like sex, extinction is an ineluctable part of life. It is the ultimate fate of all species, not the lot of unfortunate and ill-designed creatures. It is no sign of failure.

*The Panda's Thumb: More Reflections in Natural History*

Chapter 25 (p. 266)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

**Hornaday, William Temple** 1854–1937

American naturalist

We have no right, legal, moral or commercial, to exterminate any valuable or interesting species; because none of them belong to us, to exterminate or not, as we please.

For the People of any civilized nation to permit the slaughter of the wild birds that protect its crops, its fruits and its forests from the insect hordes is worse than folly. It is sheer orneriness and idiocy. People who are either so lazy or asinine as to permit the slaughter of their best friends deserve to have their crops destroyed and their forests ravaged.

*Our Vanishing Wild Life*

Chapter VI (pp. 53–54)

Charles Scribner's Sons. New York, New York, USA. 1913

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–

1829

French biologist

I am still doubtful whether the means adopted by nature to ensure the preservation of species or races have been so inadequate that entire races are now extinct or lost.

If there really are lost species, it can doubtless only be among the large animals that live on the dry parts of the earth; where man exercises absolute sway, and has compassed the destruction of all the individuals of some species which he has not wished to preserve or domesticate.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter III (p. 44)

The University of Chicago Press. Chicago, Illinois, USA. 1984

One must therefore never expect to find among living species all those which are found in the fossil state, and yet one may not assume that any species has really been lost or rendered extinct. It is certainly possible that among the largest animals some species have been extinguished as a consequence of the multiplication of man in the places which they inhabited. But this conjecture cannot be established from the consideration of fossils alone: we shall only be sure on this point when all the habitable globe is perfectly known.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Introductory Lecture for 1800 (p. 433)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Leidy, Joseph** 1823–91

The utter desolation of the scene, the dried-up water-courses, the absence of any moving object, and the profound silence which prevailed, produced a feeling that was positively oppressive. When I then thought of the buttes beneath my feet, with their entombed remains of multitudes of animals forever extinct, and reflected upon the time when the country teemed with life, I truly felt that I was standing on the wreck of a former world.

*Contributions to the Extinct Vertebrate Fauna of the Western Territories*

U. S. Government Printing Office. Washington, D.C. 1873

**Lindbergh, Anne Morrow** 1906–2001

American aviator and writer

Wilderness is threatened everywhere. The extinction of animals is not the only danger; man faces the loss of a breathing space for all that is wild and free in his spirit. And not only his spirit, his physical welfare also, even his survival, is imperiled by the extermination of other life on this planet.

*Earth Shine*

Immersion in Life (p. 70)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Nash, Ogden** 1902–71

American writer of humorous poetry

Last night in the museum's hall  
The fossils gathered for a ball  
There were no drums or saxophones,  
But just the clatter of their bones,  
A rolling, rattling, carefree circus  
Of mammoth polkas and mazurkas.  
Pterodactyls and brontosaurus  
Sang ghostly prehistoric choruses.  
Amid the mastodonic wassail  
I caught the eye of one small fossil.  
Cheer up, sad world, he said, and winked —  
It's kind of fun to be extinct.

*Carnival of the Animals*  
Extinction  
Music by Saint-Saens

**Lyell, Sir Charles** 1797–1875  
English geologist

It appears, that from the remotest periods there has ever been a coming in of new organic forms, and an extinction of those which pre-existed on the earth; some species having endured for a longer, others for a shorter time; but none having ever reappeared after once dying out. The law which has governed the creation and extinction of species seems to be expressed in the verse of the poet.... Nature made it, and then broke the die.

*Elements of Geology*  
Chapter XIII (p. 275)  
John Murray. London, England. 1838

**Muir, John** 1838–1914  
American naturalist

Why ought man to value himself as more than an infinitely small composing unit of the one great unit of creation?... The universe would be incomplete without man, but it would also be incomplete without the smallest transmicroscopic creature that dwells beyond our conceptual eyes and knowledge.

*A Thousand Mile Walk to the Gulf*  
Chapter VI (p. 139)  
Houghton Mifflin Company. Boston Massachusetts, USA. 1916

**Raup, David Malcolm**  
American paleontologist

Mass extinction is box office, a darling of the popular press, the subject of cover stories and television documentaries, many books, even a rock song.... At the end of 1989, The Associated Press designated mass extinction as one of the “Top 10 Scientific Advances of the Decade.” Everybody has weighed in, from the *Economist* to *National Geographic*.

*Extinction: Bad Genes or Bad Luck?*  
Chapter 4 (p. 64)  
W.W. Norton & Company, Inc. New York, New York, USA. 1991

**Saunders, W. E.**  
Naturalist

What good reason is there for the extermination of any form of life because it sometimes kills what we are pleased to call “game?” Are we so narrow-minded that we can endure the existence of nothing but ourselves and the things we wish to kill?

In R.J. Rutter (ed.)  
*W.E. Saunders, Naturalist: A Memorial Volume*  
Saundersisms (p. 50)  
Federation of Ontario Naturalists. Toronto, Ontario, Canada. 1949

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

I love to see that Nature is so rife with life that myriads can be afforded to be sacrificed and suffered to prey on one another; that tender organizations can be so serenely squashed out of existence like pulp.

*The Writings of Henry David Thoreau* (Volume 2)  
Walden  
Chapter XVII (p. 490)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

...the first appearance of animals now existing can in many cases be traced, their numbers gradually increasing in the more recent formations, while species continually die out and disappear, so that the present condition of the organic world is clearly derived by a natural process of gradual extinction and creation of species from that of the latest geological periods.

*Natural Selection and Tropical Nature: Essays on Descriptive and Theoretical Biology*  
Chapter I (p. 4)  
Macmillan & Company Ltd. London, England. 1891

**Weisburd, Stefi**  
Poet

With all the paleontologists looking up to the stars for an explanation of what caused mass extinctions of life on our planet, and with all the astrophysicists looking at the rocks below their feet for clues to comet showers or asteroids that might have bombarded the earth, it's a wonder that more scientists aren't complaining of neckaches.

*Extinction Wars — Battle Over Cause of Dinosaurs' Demise*  
*Science News*, February 1, 1986

## EXTRATERRESTRIAL LIFE

**Abbot, Charles Greeley** 1872–1973  
American astrophysicist

If we could talk freely with intelligences existing on another world, having a history, social customs and laws, and religious faiths developed absolutely independently from those of this world our conversation would be not only one of surpassing interest to science and the humanities, but what a guide it might prove to statesmen and sociologists!

*Annual Report of the Board of Regents of the Smithsonian Institution, 1920*  
The Habitability of Venus, Mars, and Other Worlds (p. 171)  
Government Printing Office. Washington, D.C. 1922

**Abelson, Philip H.** 1913–2004  
American physicist

Often we are faced with a very large body of facts, and the problem is to know upon which facts to place a value. But it is not a matter of selecting *which* facts with regard to the existence of extraterrestrial life — the problem here is that there are virtually *no* facts. It is largely a speculative matter, and I speculate that there is *no* life.

In Shirley Thomas

*Men of Space; Profiles of the Scientists Who Probe for Life in Space* (Volume 6)

Philip H. Abelson (p. 1)

Chilton Books. Philadelphia, Pennsylvania, USA. 1963

### **Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Somewhere in the cosmos...along with all the planets inhabited by humanoids, reptiloids, fishoids, walking treeoids, and superintelligent shades of the color blue, there was also a planet entirely given over to ballpoint life forms. And it was to this planet that unattended ballpoints would make their way, slipping away quietly through wormholes in space to a world where they could enjoy the uniquely ballpointed life-style.

*The Ultimate Hitchhiker's Guide to the Galaxy*

The Hitchhiker's Guide to the Galaxy

Chapter 21 (p. 99)

The Ballantine Book Company. New York, New York, USA. 2002

### **Amend, Bill** 1962–

American cartoonist

I think that if advanced beings were visiting Earth, we'd know it by their laughter.

*Fox Trot*

Comic strip

### **Butler, Samuel** 1612–80

English novelist, essayist, and critic

Quoth She: Th' Inhabitants o' the Moon,  
Who when the Sun shines hot at Noon,  
Do live in Cellars underground  
Of eight Miles deep and eighty round  
(In which at once they fortify  
Against the Sun and th' Enemy)  
Which they count towns and Cities there,  
Because their People's civiller  
Than those rude Peasants, that are found  
To live upon the upper Ground,  
Call'd Privolvans, with whom they are  
Perpetually at open War.

In René Lamar (ed.)

*Satires and Miscellaneous Prose*

The Elephant in the Moon

The University Press. Cambridge, England. 1928

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

Nearly a hundred thousand million stars are turning in the circle of the Milky Way, and long ago other races on the world of other suns must have scaled and passed the heights that we have reached. Think of such civilizations, far back in time against the fading afterglow of Creation, masters of a universe so young that life as yet had come only to a handful of worlds. Theirs would have been a loneliness we cannot imagine, the loneliness of gods looking out across infinity and finding none to share their thoughts.

The Sentine

*10 Story Fantasy*, Spring 1951

### **Darling, David** 1953–

Freelance science writer

Unless astrobiologists are very much mistaken, or we lose the willpower to carry through these great projects, within two decades we'll be able to point to some stars in the night sky and say, "There live other creatures."

*Life Everywhere: The Maverick Science of Astrobiology*

Chapter 8 (p. 167)

Basic Books. New York, New York, USA. 2001

### **de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

So you, too, come from the sky! Which is your planet?

Translated by Katherine Woods

*The Little Prince*

Part III (p. 14)

Harcourt, Brace & Company. New York, New York, USA. 1943

### **Diamond, Jared** 1937–

American evolutionary biologist

Think again of those astronomers who beamed radio signals into Space from Arecibo, describing Earth's location and its inhabitants. In its suicidal folly that act rivaled the folly of the last Inca emperor, Atahualpa, who described to his gold-crazy Spanish captors the wealth of his capital and provided them with guides for the journey. If there really are any radio civilizations within listening distance of us, then for heaven's sake let's turn off our own transmitters and try to escape detection, or we are doomed.

Fortunately for us, the silence from Outer Space is deafening.... What woodpeckers teach us about flying saucers is that we're unlikely to ever see one.

*The Third Chimpanzee: The Evolution and Future of the Human Animal*

Part Three, Chapter 12 (pp. 214–215)

HarperCollins Publishers. New York, New York, USA. 1992

### **Dietrich, Marlene** 1901–92

German-born American actress and singer

Until they come to see us from their planet, I wait patiently. I hear them saying: Don't call us, we'll call you.

*Marlene Dietrich's ABC*

Venus

Ungar. New York, New York, USA. 1984

**Dyson, Freeman J.** 1923–  
American physicist and educator

I do not believe we yet know enough about stars, planets, life and mind to give us a firm basis for deciding whether the presence of intelligence in the universe is probable or improbable. Many biologists and chemists have concluded from inadequate evidence that the development of intelligent life should be a frequent occurrence in our galaxy. Having examined their evidence and heard their arguments, I consider it just as likely that no intelligent species other than our own has ever existed. The question can only be answered by unprejudiced observation.

Intelligence in the Universe

*Mercury*, November–December 1972

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator and author

So deep is the conviction that there must be life out there beyond the dark, one thinks that if they are more advanced than ourselves they may come across space at any moment, perhaps in our generation. Later, contemplating the infinity of time, one wonders if perchance their messages came long ago, hurtling into the swamp muck of the steaming coal forests, the bright projectile clambered over by hissing reptiles, and the delicate instruments running mindlessly down with no report.

*The Immense Journey*

Little Men and Flying Saucers (p. 144)

Vintage Books. New York, New York, USA. 1957

In a universe whose size is beyond human imagining, where our world floats like a dust mote in the void of night, men have grown inconceivably lonely. We scan the time scale and the mechanisms of life itself for portents and signs of the invisible. As the only thinking mammals on the planet — perhaps the only thinking animals in the entire sidereal universe — the burden of consciousness has grown heavy upon us. We watch the stars, but the signs are uncertain. We uncover the bones of the past and seek for our origins. There is a path there, but it appears to wander. The vagaries of the road may have a meaning, however; it is thus we torture ourselves.

*The Immense Journey*

Little Men and Flying Saucers (pp. 161–162)

Vintage Books. New York, New York, USA. 1957

...nowhere in all space or on a thousand worlds will there be men to share our loneliness. There may be wisdom; there may be power; somewhere across space great instruments, handled by strange, manipulative organs, may stare vainly at our floating cloud wrack, their owners yearning as we yearn. Nevertheless, in the nature of life and in the principles of evolution we have had our

answer. Of men, elsewhere, and beyond, there will be none forever.

*The Immense Journey*

Little Men and Flying Saucers (p. 162)

Vintage Books. New York, New York, USA. 1957

**Fuller, R. Buckminster** 1895–1983  
American engineer and architect

Sometimes I think we're alone. Sometimes I think we're not. In either case, the thought is quite staggering.

In James A. Haught (ed.)

*2000 Years of Disbelief: Famous People with the Courage to Doubt*

Part Seven: The Mid- and Late Twentieth Century Chapter 71 (p. 290)

Prometheus Books. Amherst, New York, USA. 1996

**Giraudoux, Jean** 1882–1944  
French novelist, playwright, and essayist

COUNTESS: ...are you so stupid as to think that just because we're alone here, there's nobody else in the room? Do you consider us so boring or so repulsive that of all the millions of beings, imaginary or otherwise, who are prowling around in space looking for a little company, there is not one who might possibly enjoy spending a moment with us? On the contrary, my dear — my house is full of guests...

English adaptation by Maurice Valency

*The Madwoman of Chaillot*

Act Two (p. 94)

Random House, Inc. New York, New York, USA. 1947

**Haber, Heinz** 1913–90  
German physicist

The far spaces of the galaxies are teeming with life; but the life-bearing planets are separated by awesome gaps of space and time. We are lost in space — marooned in the small section of the universe assigned to us.

*Stars, Men and Atoms*

Chapter 10 (p. 163)

Golden Press. New York, New York, USA. 1962

Science, no less than the poet and the preacher, knows how marvelous the phenomenon of life really is and the actual discovery of the marvelous spark on another world will be more soul-stirring and portentous than the wildest dreams of the generations before us.

*Stars, Men and Atoms*

Chapter 9 (p. 154)

Golden Press. New York, New York, USA. 1962

**Hey, Nigel S.** 1936–  
American science writer

We know of no other planet that has an environment that is even remotely like ours. We are protected by an invisible magnetic bubble, enlivened by the cycles of water and air, with the whole scenario perfected (from our perspective) by the forces of sunlight and the great heat source that lies deep below Earth's crust. Yet

when we looked at Io's fountains we knew they were volcanoes, and when we saw the terraced hills of Mars we knew that lakes must have lain there. Our knowledge of the universe is guided by our observations at home, on Planet Earth.

*Solar System*

Chapter 6 (p. 137)

Weidenfield & Nicolson. London, England. 2002

**Horowitz, Norman H.** 1915–2005

American scientist

There are doubtless some who, unwilling to accept the notion of a lifeless Mars, will maintain that the interpretation I have given is unproved. They are right. It is impossible to prove that any of the reactions detected by the Viking instruments were not biological in origin. It is equally impossible to prove from any result of the Viking instruments that the rocks seen at the landing sites are not living organisms that happen to look like rocks.... The field is open to every fantasy. Centuries of human experience warn us, however, that such an approach is not the way to discover the truth.

The Search for Life on Mars

*Scientific American*, Volume 237, Number 5, November 1977 (p. 61)

**Hoyle, Sir Fred** 1915–2001

English mathematician, astronomer, and writer

With so many possible planetary systems, should we not expect inhabited planets to be moving around some of the nearby stars? We certainly should.

*Lifecloud: The Origin of Life in the Universe*

Chapter 16 (pp. 145–146)

Harper & Row Publishers. New York, New York, USA. 1978

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

A Man that is of Copernicus's Opinion, that this Earth of ours is a planet, carry'd round and enlighten'd by the Sun, like the rest of them, cannot but sometimes have a fancy, that it's not improbable that the rest of the Planets have their Dress and Furniture, nay and their Inhabitants too as well as this Earth of ours.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Book the First (pp. 1–2)

Printed for T. Childe. London, England. 1698

**Jones, Sir Harold Spencer** 1890–1960

10<sup>th</sup> Astronomer Royal of England

We see the Earth as a small planet, one member of a family of planets revolving round the Sun; the Sun, in turn, is an average star situated somewhat far out from the centre of a vast system, in which the stars are numbered by many thousands of millions; there are many millions of such systems, more or less similar to each other, peopling

space to the farthest limits to which modern exploration has reached.

Can it be that throughout the vast deeps of space nowhere but on our own little Earth is life to be found?

*Life on Other Worlds*

Chapter I (p. 19)

The Macmillan Company. New York, New York, USA. 1954

**Lebowitz, Fran** 1951–

American comedian

Not too long ago the United States succeeded in landing on Mars an unmanned spacecraft, the chief purpose of which was to ascertain whether or not anyone lives there. The results are not all in yet but there is, I am afraid, little doubt that the answer will be in the affirmative. It is pointless to assume that the earth alone is afflicted with the phenomenon of life.

*Metropolitan Life*

Mars: Living in a Small Way (p. 134)

Fawcett Crest. New York, New York, USA. 1978

**Leonard, Jonathan Norton** 1903–75

No biographical data available

Now, for the first time in the stargazing history of man, the planets are within our reach. Guesses as to what we might find in that mystery-shrouded domain demand the utmost from our imagination.... In a sense they will also be excursions back through the millennia to the earliest eons of our native star system.

*How We Will Explore the Outer Planets*

Chapter 1 (p. 7)

G.P. Putnam's Sons. New York, New York, USA. 1973

Scientists point out that there is nothing miraculous or unrepeatable about the appearance of life on earth. They believe it would happen again, given the same sufficient time and the same set of circumstances. It would even happen under very different circumstances. There is no reason to believe that conditions in the atmosphere and oceans of the primitive earth were modified by any outside power to make them favorable for the development of life. They just happened that way, and it is likely that life would have appeared even if conditions had been considerably different.

In Martin Gardner (ed)

*The Sacred Beetle*

Other-Worldly Life (pp. 186–187)

Prometheus Books. Buffalo, New York, USA. 1957

**Lévi-Strauss, Claude** 1908–

French social anthropologist and structuralist

Just as the individual is not alone in the group, nor any one society alone among the others, so man is not alone in the universe.

*Tristes Tropiques*

Chapter 40 (p. 414)

Athenaeum. New York, New York, USA. 1974



**Lowell, Percival** 1855–1916  
American astronomer

Like the savage who fears nothing so much as a strange man, like Crusoe who grows pale at the sight of footprints not his own, the civilized thinker instinctively turns from the thought of mind other than the one he himself knows.

*Mars*

Chapter VI (p. 210)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1895

### **Metrodorus of Chios**

...it would be strange if a single ear of corn grew in a large plain or there were only one world in the infinite.

In F.M. Cornford

*The Classical Quarterly*

Innumerable Worlds in Pre-Socratic Philosophy, January 1934 (p. 13)

**Milton, John** 1608–74  
English poet

Dream not of other Worlds; what Creatures there Live, in what state, condition or degree...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VIII, l. 175–176

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Oliver, Bernard M.** 1916–1995  
First director of Hewlett-Packard Labs

The question of whether there is intelligent life out there depends, in the last analysis, upon how intelligent that life is.

The Search for Extraterrestrial Life

*Engineering and Science*, Dec 1974

**Oparin, Alexander Ivanovich** 1894–1980  
Russian biochemist

...there is every reason now to see in the origin of life not a “happy accident” but a completely regular phenomenon, an inherent component of the total evolutionary development of our planet. The search for life beyond Earth is thus only a part of the more general question which confronts science, of the origin of life in the universe.

In M Calvin and O.G. Gazenko (eds.)

*Theoretical and Experimental Prerequisites of Exobiology*

Foundations of Space Biology and Medicine, Volume I, Theoretical and Experimental Prerequisites of Exobiology, Chapter 7 (p. 321)

**Pallister, William Hales** 1877–1946  
Canadian physician

No one can yet show proof that there exists

A single planet save the solar ones.

But space is wide and high, and time is long,

And there are millions more of other suns.

So men imagine why they do not know

And they assume that surely there must be

Some other planets, peopled like our own;  
Some other worlds with creatures such as we.

*Poems of Science*

Other Worlds and Ours, Life on Other Planets (p. 210)

Playford Press. New York, New York, USA. 1931

**Pope, Alexander** 1688–1744  
English poet

He, who through vast immensity can pierce,  
See worlds on worlds compose one universe,  
Observe how system into system runs,  
What other planets circle other suns,  
What varied Being peoples every star,  
May tell why Heaven has made us as we are...

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, l. 23–28

Houghton Mifflin Company. New York, New York, USA. 1903

**Sagan, Carl** 1934–96  
American astronomer and author

To seek the beings of other worlds is the rarest of adventures — an adventure we will all be fortunate enough to share.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1964*

The Quest for Life Beyond the Earth (p. 306)

Government Printing Office. Washington, D.C. 1965

We are like the inhabitants of an isolated valley in New Guinea who communicate with societies in neighboring valleys (quite different societies, I might add) by runner and by drum. When asked how a very advanced society will communicate, they might guess by an extremely rapid runner or by an improbably large drum. They might not guess a technology beyond their ken. And yet, all the while, a vast international cable and radio traffic passes over them, around them, and through them... We will listen for the interstellar drums, but we will miss the interstellar cables. We are likely to receive our first messages — from the drummers of the neighboring galactic valleys — from civilizations only somewhat in our future. The civilizations vastly more advanced than [us], will be, for a long time, remote both in distance and in accessibility. At a future time of vigorous interstellar radio traffic, the very advanced civilizations may be, for us, still insubstantial legends.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 31 (pp. 224, 224–5)

Dell Publishing, Inc. New York, New York, USA. 1975

On some [planets], intelligent life may have evolved, reworking the planetary surface in some massive engineering enterprise. These are our brothers and sisters in the Cosmos. Are they very different from us? What is their form, biochemistry, neurobiology, history, politics, science, technology, art, music, religion, philosophy? Perhaps one day we will know them.

*Cosmos*

Chapter I (p. 11)

Random House, Inc. New York, New York, USA. 1980

Occasionally, I get a letter from someone who is in “contact” with extraterrestrials. I am invited to “ask them anything.” And over the year’s I’ve prepared a little list of questions. The extraterrestrials are very advanced, remember. So I ask things like, “Please provide a short proof of Fermat’s Last Theorem.” I write out the simple equation with the exponents.... It’s a stimulating exercise to think of questions to which no human today knows the answers, but where a correct answer would immediately be recognized as such. It’s even more challenging to formulate such questions in fields other than mathematics. Perhaps we should hold a contest and collect the best responses in “Ten Questions to Ask an Alien.”

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 6 (p. 100, fn)

Random House, Inc. New York, New York, USA. 1995

...there are a million other civilizations, all fabulously ugly, and all a lot smarter than us. Knowing this seems to me to be a useful and character-building experience for mankind.

In Richard Berendzen (ed.)

*Life Beyond Earth & the Mind of Man*

Sagan (p. 64)

National Aeronautics and Space Administration, Scientific and Technical Information Office. Washington, D.C. 1973

The discovery of life on some other world will, among many things, be for us a humbling experience...

*Intelligent Life in the Universe* (p. 22)

Holden-Day. San Francisco, California, USA. 1966

After centuries of muddy surmise, unfettered speculation, stodgy conservatism, and unimaginative disinterest, the subject of extraterrestrial life has finally come of age.

*Cosmic Connection: An Extraterrestrial Perspective*

Preface (p. viii)

Anchor Press/Doubleday. Garden City, New York, USA. 1973

**Sagan, Carl** 1934–96

American astronomer and author

**Newman, William I.**

No biographical data available

We think it possible that the Milky Way Galaxy is teeming with civilizations as far beyond our level of advance as we are beyond the ants, and paying us about as much attention as we pay to the ants.

The Solipsist Approach to Extraterrestrial Intelligence

*Quarterly Journal of the Royal Astronomical Society*, Volume 24, Number 3, June 1983 (p. 120)**Sakharov, Andrei** 1921–89

Soviet physicist and dissident

In infinite space many civilizations are bound to exist, among them societies that may be wiser and more “successful” than ours. I support the cosmological hypothesis which states that the development of the universe is repeated in its basic characteristics an infinite number of times.... Yet this should not minimize our sacred endeavors in this world of ours, where, like faint glimmers in the dark, we have emerged for a moment from the nothingness of dark unconscious into material existence.

*Nobel Lectures, Peace 1971–1980*

Nobel lecture for award received in 1975

Peace, Progress, Human Rights

World Scientific Publishing Company, Singapore. 1997

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

GLENOWER: I can call spirits from the vasty deep.

HOTSPUR: Why, so can I, or so can any man;

But will they come when you do call them?

In *Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)

The First Part of King Henry the Fourth

Act III, Scene i, l. 53–55

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

HORATIO: O day and night, but this is wondrous strange!

HAMLET: And therefore as a stranger give it welcome.

There are more things in heaven and earth, Horatio,

Than are dreamt of in your philosophy.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

Hamlet, Prince of Denmark

Act I, Scene v, l. 164–167

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

DRIER: Mr. Shaw, do you believe in life on other planets?

SHAW: Indeed I do.

DRIER: But, Mr. Shaw, what proof do you have?

Shaw: The proof is that they’re using us for an insane asylum.

*Chemistry*, Volume 42, Number 4, April 1969 (p. 2)**Teng Mu** 1247–1306

Chinese scholar

Heaven and earth are large, yet in the whole of space they are but as a small grain of rice.... It is as if the whole of empty space were a tree, and heaven and earth were one of its fruits. Empty space is like a kingdom, and heaven and earth no more than a single individual person in that kingdom. Upon one tree there are many fruits, and in one kingdom many people. How unreasonable it would be to suppose that besides the heaven and earth which we can see that are no other heavens and no other earths?

In Joseph Needham

*Science and Civilisation in China* (Volume 3)  
Chapter 20 (p. 221)  
Cambridge University Press. Cambridge, England. 1959

### Thomas, R. S.

No biographical data available

I am alone on the surface of a turning planet. What to do but, like Michelangelo's Adam, put my hand out into unknown space, hoping for the reciprocating touch?

*Between Here and Now*  
Threshold (p. 110)  
Macmillan & Company Ltd. London, England. 1981

### Tsiolkovsky, Konstantin Eduardovich 1857–1935

Russian research scientist

Is it probable for Europe to be inhabited and not the other parts of the world? Can one island have inhabitants and numerous other islands have none? Is it conceivable for one apple-tree in the infinite orchard of the Universe to bear fruit, while innumerable other trees have nothing but foliage?

In Adam Starchild (ed.)  
*The Science Fiction of Konstantin Tsiolkovsky*  
Dreams of the Earth and Sky (pp. 153–154)  
University Press of the Pacific, Inc. Seattle, Washington, USA. 1979

### von Braun, Wernher 1912–77

German-American rocket scientist

Our sun is one of 100 billion stars in our galaxy. Our galaxy is one of billions of galaxies populating the universe. It would be the height of presumption to think that we are the only living things in that enormous immensity.

Text of the Address by von Braun Before the Publishers' Group Meeting Here

*New York Times*, 29 April 1960, L 20, column 2

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

Those who have never seen a living Martian can scarcely imagine the strange horror of its appearance.

*Seven Famous Novels by H.G. Wells*  
The War of the Worlds, Book I, Chapter 4 (p. 276)  
Alfred A. Knopf. New York, New York, USA. 1934

No one would have believed in the last years of the nineteenth century that this world was being watched keenly and closely by intelligences greater than man's and yet as mortal as his own...

*Seven Famous Novels by H.G. Wells*  
The War of the Worlds, Book I, Chapter 1 (p. 265)  
Alfred A. Knopf. New York, New York, USA. 1934

## EYE

### Adams, George 1750–95

English instrument maker

The eyes are placed in the most eminent part of the body, near the brain, the seat of sensation.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
Lecture XVII (p. 273)  
Printed by R. Hindmarsh. London, England. 1794

The black and the blue are the most beautiful colours, and give the most fire and vivacity of expression to the eye. In black eyes there is more force and impetuosity; but the blue excel in sweetness and delicacy.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
Lecture XVII (pp. 279–280)  
Printed by R. Hindmarsh. London, England. 1794

The eyes are a faithful guard to the whole man, and are placed as in a friendly watch-tower, to discern his danger, and give him friendly warning, while it is yet far off.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
Lecture XVIII (p. 357)  
Printed by R. Hindmarsh. London, England. 1794

### Carroll, Lewis (Charles Dodgson) 1832–98

English writer and mathematician

"I see nobody on the road," said Alice.

"I only wish I had such eyes," the King remarked in a fretful tone. "To be able to see Nobody! And at that distance too! Why, it's as much as I can do to see real people by this light!"

*The Complete Works of Lewis Carroll*  
Through the Looking-Glass  
Chapter VII (p. 223)  
The Modern Library. New York, New York, USA. 1936

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

I have said that the science of the visible universe starts with a determination to use our eyes; but that does not mean that the primary use of the eye is for advancing science.

*Science and the Unseen World*  
Chapter VIII (p. 79)  
The Macmillan Company. New York, New York, USA. 1929

### von Helmholtz, Hermann 1821–94

German scientist and philosopher

If an optician sent it [the eye] to me as an instrument, I would send it back with reproaches for the carelessness of his work and demand the return of my money.

In J.B. Bury  
*A History of Freedom of Thought*  
Chapter VII (pp. 145–146)  
Oxford University Press, Inc. London, England. 1952

**EYELID**

**Adams, George** 1750–95  
English instrument maker

When the eye is wearied with its daily service, and the night spreads a veil of darkness over this lower world, the curtain that is hung before the eye falls down, and the

eye-lids are shut with a close seal, till we have renewed our strength, and the morning restores the world to our view: the eye-lid not only affording refreshment and rest to the eye, but defending it from the secret perils and invisible dangers of the night.

*Lectures on Natural and Experimental Philosophy* (Volume 2)

Lecture XVIII (p. 356)

Printed by R. Hindmarsh. London, England. 1794

## F

### FACE

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The face is the soul of the body.

Translated by Peter Winch

*Culture and Value* (p. 23e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

### FACT

#### A Traveler

When facts have been gathered, sorted, and piled, the mound is an observatory.

*Frost and Fire* (Volume 2)

Chapter XXVIII (p. 1)

Edmonston & Douglas. Edinburgh, Scotland. 1865

**Abbott, Edwin A.** 1838–1926  
English clergyman and author

From dreams I proceed to facts.

*Flatland* (p. 68)

Barnes & Noble, Inc. New York, New York, USA. 1963

**Adams, Henry Brooks** 1838–1918  
American man of letters

The facts seemed certain, or at least as certain as other facts; all they needed was explanation.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XXIX (p. 433)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

Philosophers and theologians have yet to learn that a physical fact is as sacred as a moral principle.

Evolution and Permanence of Type

*The Atlantic Monthly*, 1874 (p. 92)

Facts are stupid things until brought into connection with some general law.

In James Orton

*Comparative Zoology, Structural and Systematic*

Preceding Chapter XXI (p. 222)

Harper & Brothers. New York, New York, USA. 1877

The only true scientific system must be one in which the thought, the intellectual structure, rises out of, and is based upon, facts.

In Burt G. Wilder

Louis Agassiz, Teacher

*The Harvard Graduate's Magazine*, June, 1907

**Alcott, Louisa May** 1832–88  
American author

...entrenching himself behind an undeniable fact.

*Little Women*

Chapter XXXV (p. 304)

Books, Inc., Publishers. New York, New York, USA. 1950

#### American Museum of Natural History

Every specimen is a permanent fact.

Plaque at entrance to the Earth History Hall

**Ampere, Andre-Marie** 1775–1836  
French physicist

Those periods of history when phenomena previously thought to be due to totally diverse causes have been reduced to a single principle were almost always accompanied by the discovery of many new facts, because a new approach in the conception of causes suggests a multitude of new experiments to try and explanations to verify.

In Peter Louis Galison

*How Experiments End*

Chapter 2 (p. 28)

The University of Chicago Press. Chicago, Illinois, USA. 1987

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

...with a true view all the data harmonize, but with a false one the facts soon clash.

In *Great Books of the Western World* (Volume 9)

*The Nicomachean Ethics*

Book I, Chapter VIII, Section 1098b[10] (p. 13)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Arnold, Matthew** 1822–88  
English poet and critic

Deny the facts altogether, I think, he hardly can.

Literature and Science

*Nineteenth Century*, August 1882 (p. 216)

#### Author undetermined

Never base your argument on a fact: for if the fact is disproved what becomes of the argument.

In Robert John Strutt

*Life of John William Strutt: Third Baron Rayleigh* (fn, p. 270)

University of Wisconsin Press. Madison, Wisconsin, USA. 1968

My mind is like a coal chute down which many tons of facts have rumbled, leaving only a little dust behind.

In Edward Hodnett

*The Art of Problem Solving*

Part I, Chapter 6 (p. 42)

Harper & Brothers. New York, New York, USA. 1955

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Facts, however, will ultimately prevail; we must therefore take care that they be not against us.

In Jean Andrew de Luc

Translated by Henry De La Fite

*An Elementary Treatise on Geology*

Section 93 (p. 82)

F.C. & J. Rivington. London, England. 1809

**Balchin, Nigel** 1908–70

English novelist

“Well facts are facts” said Tilly sulkily.

“So they are, and figures are figures. Stop subtracting the date and get with it.”

*The Small Back Room* (p. 24)

Collins. London, England. 1943

Am I supposed to give all the facts, or some of the facts, or my opinions or your opinions or what?

*The Small Back Room* (p. 53)

Collins. London, England. 1943

**Barrie, Sir James M.** 1860–1937

Scottish journalist, writer, and dramatist

Facts were never pleasing to him. He acquired them with reluctance and got rid of them with relief. He was never on terms with them until he had stood them on their heads.

*The Greenwood Hat*

Love me Never or Forever (pp. 50–51)

Charles Scribner’s Sons. New York, New York, USA. 1938

**Barry, Frederick** 1876–1943

Historian of science

To an ordinary person a fact is a fact, and that is all there is to be said about it.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 91)

Columbia University Press. New York, New York, USA. 1927

A fact is no simple thing.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 91)

Columbia University Press. New York, New York, USA. 1927

Facts are to begin with, coercive.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 92)

Columbia University Press. New York, New York, USA. 1927

**Baruch, Bernard M.** 1870–1965

American presidential advisor

If you get all the facts, your judgment can be right; if you don’t get all the facts, it can’t be right.

*St. Louis Post Dispatch*, 21 June 1965 (p. 5a)

**Bates, Marston** 1906–74

American zoologist

Facts are the raw material of science — the bricks from which our model of the universe must be built — and we are rightly taught to search for sound and solid facts, for strong and heavy bricks that will serve us well in building foundations, for clean and polished bricks that will fit neatly into ornamental towers. But while accumulating the bricks may be a contribution to science, we must take care that the pile does not become a hopelessly discouraging jumble. For science itself is not brickmaking — it is, at the workaday and technical level, bricklaying; and at the creative and artistic level, architecture, the designing of an edifice that will utilize all the bricks to the very best of advantage.

*The Natural History of Mosquitoes*

Introduction (p. 1)

Macmillan Company. New York, New York, USA. 1949

**Beaumont, William** 1785–1853

American army surgeon

My opinions may be doubted, denied, or approved, according as they conflict or agree with the opinions of each individual who may read them; but their worth will be best determined by the foundation on which they rest — the incontrovertible facts.

*William Beaumont: A Pioneer American Physiologist*

Experiments and Observations on the Gastric Juice and the Physiology of Digestion, Preface (p. 200)

The C.V. Mosby Company. St. Louis, Missouri, USA. 1981

**Beebe, William** 1877–1962

American ornithologist

Scientific facts, more often than is known, are learned by accident.

*Half Mile Down*

Chapter 9 (p. 174)

Harcourt, Brace & Company. New York, New York, USA. 1934

**Belinsky, Vissarion Grigoryevich** 1811–48

Russian writer and literary critic

In science one must search for ideas. If there are no ideas, there is no science. A knowledge of facts is only valuable in so far as facts conceal ideas: facts without ideas are just the sweepings of the brain and the memory.

In S. A. Vengerov (ed.)

*Complete Collected Works of V. G. Belinsky* (Volume 2) (p. 348)

Publisher undetermined

**Bernard, Claude** 1813–78

French physiologist

When we meet a fact which contradicts a prevailing theory, we must accept the fact and abandon the theory, even when the theory is supported by great names and generally accepted.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter II, Section ii (p. 164)

Henry Schuman, Inc. New York, New York, USA. 1927

Facts are neither great nor small in themselves.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section II (p. 34)

Henry Schuman, Inc. New York, New York, USA. 1927

If the facts used as a basis for reasoning are ill-established or erroneous, everything will crumble or be falsified; and it is thus that errors in scientific theories most often originate in errors of fact.

*An Introduction to the Study of Experimental Medicine*

Part I, Chapter I, Section III (p. 13)

Henry Schuman, Inc. New York, New York, USA. 1927

A fact is nothing in itself, it has value only through the idea connected with it or through the proof it supplies.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section vii (p. 53)

Henry Schuman, Inc. New York, New York, USA. 1927

**Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

It is a statistikal fakt, that the wicked work harder tew reach Hell, than the righteous do tew git to heaven.

*Old Probability: Perhaps Rain — Perhaps Not*

April 1870 (Green Section)

G.W. Carleton & Company, Publishers. New York, New York, USA.

1879

**Bohm, David** 1917–92

American physicist

...it is important to note that facts are not to be considered as if they were independently existent objects that we might find or pick up in the laboratory.... In a certain sense, we “make” the fact. That is to say, beginning with immediate perception of an actual situation, we develop the fact by giving it further order, form and structure with the aid of our theoretical concepts.

*Wholeness and the Implicate Order*

Chapter 6 (p. 142)

Routledge. London, England. 1995

**Bradbury, Ray** 1920–

American writer

... facts quite often, I fear to confess, like lawyers, put me to sleep at noon. Not theories, however.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and

Walter Sullivan

*Mars and the Mind of Man*

Foreword (p. x)

Harper & Row, Publishers. New York, New York, USA. 1973

**Bradford, Gamaliel** 1863–1932

American biographer

Observed facts must be built up, woven together, ordered, arranged, systematized into conclusions and theories by reflection and reason, if they are to have full bearing on

life and the universe. Knowledge is the accumulation of facts. Wisdom is the establishment of relations. And just because the latter process is delicate and perilous, it is all the more delightful. The lofty scorn of the true philosopher for mere perception is well shown in Royer Collard’s remark: “There is nothing so despicable as a fact.” Which does not prevent philosophers or any one else from making facts the essential basis of all discussion of relations.

*Darwin*

Chapter II (p. 44)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1926

...the mere collection of facts, without some basis of theory for guidance and elucidation, is foolish and profitless.

*Darwin*

Chapter II (p. 47)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1926

**Bridgman, Percy Williams** 1882–1961

American physicist

...the fact has always been for the physicist the one ultimate thing from which there is no appeal, and in the face of which the only possible attitude is a humility almost religious.

*The Logic of Modern Physics*

Chapter I (pp. 2–3)

The Macmillan Company. New York, New York, USA. 1927

**Browning, Robert** 1812–89

English poet

... This plain, plump fact.

*The Poems and Plays of Robert Browning*

Mr. Sludge, “The Medium”

The Modern Library. New York, New York, USA. 1934

But facts are facts and flinch not.

*The Poems and Plays of Robert Browning*

The Ring and the Book

Part II, Half-Rome, I. 1049

The Modern Library. New York, New York, USA. 1934

**Buchner, Ludwig** 1824–99

German physician and philosopher

But enough of facts!

*Force and Matter*

Brain and Mind (p. 231)

Truth Seeker. New York, New York, USA. 1950

...in the long run there is no contending against facts; it is useless to “kick against the pricks.”

*Force and Matter*

Preface to the First Edition (p. vi)

Truth Seeker. New York, New York, USA. 1950

**Buckley, Arabella B.** 1840–1929

English naturalist and science writer

No one can love dry facts; we must clothe them with real meaning and love the truths they tell, if we wish to enjoy science.

*The Fairy-Land of Science*

Lecture I (p. 32)

D. Appleton & Company, New York, New York, USA. 1899

**Burns, Robert** 1759–96

Scottish poet

Facts are chieils that winna ding an' downa be disputed.

Facts are entities which cannot be manipulated or disputed.

*The Complete Poetical Works of Robert Burns*

A Dream, l. 30

Houghton Mifflin Company, Boston, Massachusetts, USA. 1897

**Burroughs, John** 1837–1921

American naturalist and writer

To treat your facts with imagination is one thing; to imagine your facts is quite another.

*The Heart of Burroughs's Journals*

October 24, 1907

Houghton Mifflin Company, Boston, Massachusetts, USA. 1928

**Butlerov, Aleksandr Mikhailovich** 1828–86

Russian chemist

Facts not explained by the existing theories are probably the most valuable for science, for their study is most likely to lead to its early advancement.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneiererson

Progress Publishers, Moscow, Russia. 1979

A seemingly trivial fact, singular and insignificant today, may tomorrow become the nucleus of a new, fruitful field of knowledge in connection with some new discovery.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiererson

Progress Publishers, Moscow, Russia. 1979

**Carlyle, Thomas** 1795–1881

English historian and essayist

I grow to honor facts more and more, and theory less and less. A fact, it seems to me, is a great thing — a sentence printed, if not by God, then at least by the Devil.

In Joseph Slater (ed.)

*The Correspondence of Emerson and Carlyle*

Letter to Ralph Waldo Emerson

April 29, 1836 (pp. 146–147)

Columbia University Press, New York, New York, USA. 1964

Conclusive facts are inseparable from inconclusive except by a head that already understands and knows.

*English and Other Critical Essays*

Chartism (p. 170)

J.M. Dent & sons Ltd, London, England. 1950

**Carpenter, William B.** 1813–85

English physiologist and naturalist

Were we able to ascertain facts regarding the changes which take place in the interior of the living body as easily as the astronomer observes the place of a planet, or the chemist the decomposition of a salt, there is no reason whatever to prevent these facts being generalized in the same manner and to the same degree with those of the physical sciences.

Review of A History of the Inductive Sciences, Physiology An Inductive Science

*British and Foreign Medical Review*, Volume 5, 1838 (p. 340)

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

First accumulate a mass of Facts: and then construct a Theory.

*The Complete Works of Lewis Carroll*

Sylvie and Bruno

Chapter XVIII (p. 423)

The Modern Library, New York, New York, USA. 1936

The Theory hardly rose to the dignity of a Working Hypothesis. Clearly more Facts were needed.

*The Complete Works of Lewis Carroll*

Sylvie and Bruno

Chapter XVIII (p. 424)

The Modern Library, New York, New York, USA. 1936

**Carson, Rachel** 1907–64

American marine biologist and author

If facts are the seeds that later produce knowledge and wisdom, then the emotions and the impressions of the senses are the fertile soil in which the seeds must grow.

*The Sense of Wonder* (p. 48)

Harper & Row, Publishers, New York 1984

**Charlie Chan**

Fictional character

Small things sometimes tell large tales.

*Charlie Chan at the Opera*

Film (1936)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

I thought it was the task of the natural sciences to discover the facts of nature, not to create them.

Quoted in Abir-Am, Pnina

The Politics of Macromolecules: Molecular Biologists, Biochemists, and Rhetoric

*Osiris*, Volume 7, 1992

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Science itself is only the exaggeration and specialisation of this thirst for useless fact, which is the mark of the



youth of man. But science has become strangely separated from the mere news and scandal of flowers and birds; men have ceased to see that a pterodactyl as a pterodactyl. The rebuilding of this bridge between science and human nature is one of the greatest needs of mankind. We have all to show that before we go on to any visions or creations we can be contented with a planet of miracles.

*The Apostle and the Wild Ducks, and other Essays*

Literature and Information (p. 130)

Elek. London, England. 1975

Facts as facts do not always create a spirit of reality, because reality is a spirit.

*Come to Think of It*

On the Classics (p. 49)

Methuen & Company Ltd. London, England. 1932

Facts by themselves can often feed the flames of madness, because sanity is spent.

*Come to Think of It*

On the Classics (p. 49)

Methuen & Company Ltd. London, England. 1932

The moment you step into the world of facts, you step into a world of limits.

*Orthodoxy*

Chapter III (p. 71)

John Lane Company. New York, New York, USA. 1918

The truths of religion are unprovable; the facts of science are unproved.

*The Uses of Diversity*

Christian Science (p. 52)

Methuen & Company Ltd. London, England. 1920

**Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

You must look at facts because they look at you.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Speech, Commons, May 7, 1925 (p. 132)

George Allen & Unwin Ltd. London, England. 1956

I like the martial and commanding air with which the right honorable Gentleman treats facts. He stands no nonsense from them.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Speech, Commons, February 19, 1909 (p. 132)

George Allen & Unwin Ltd. London, England. 1956

A balloon goes up quite easily for a certain distance, but after a certain distance it refuses to go up any further, because the air is too rarefied to float it and sustain it. And, therefore, I would say, let us examine the concrete facts.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Speech, St. Andrew's Hall, Glasgow, October 11, 1906 (p. 133)

George Allen & Unwin Ltd. London, England. 1956

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Some facts are so incredible that they are believed at once, for no one could possibly have imagined them.

*The Lost Worlds of 2001*

Chapter 30 (p. 175)

New American Library. New York, New York, USA. 1972

**Cohen, Jerome**

No biographical data available

Every lawyer knows that the name of the game is what label you succeed in imposing on the facts.

Tense Triangle — What to Do About Taiwan

*Time*, June 7, 1971 (p. 24)

**Cohen, Morris Raphael** 1880–1947

American philosopher

Begin with collecting the facts? Ay, but what facts?

*Reason and Nature*

Chapter Three, Section I (p. 76)

The Free Press, Publishers, Glencoe, Illinois, USA. 1931

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Facts...are not truths; they are not conclusions; they are not even premises, but in the nature and parts of premises. The truth depends on, and is only arrived at, by a legitimate deduction from all the facts which are truly material.

*The Table Talk and Omniana of Samuel Taylor Coleridge*

Table-Talk

December 27, 1831 (p. 147)

George Bell & Sons. London, England. 1884

**Collingwood, Robin George** 1889–1943

English historian and philosopher

Different kinds of facts, having different degrees of scientific value, are ascertainable in these two ways. Facts ascertainable by mere observation are what are called common-sense facts, *i.e.* facts accessible to a commonplace mind on occasions frequent enough to be rather often perceived and of such a kind that their characteristics can be adequately perceived without trouble: so that the facts concerning them can be familiar to persons not especially gifted and not especially alert.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*

Part II, Chapter XXXI, aphorism 31.47 (p. 250)

At The Clarendon Press. Oxford, England. 1942

**Collins, Wilkie** 1824–89

English novelist

“Facts?” he repeated. “Take a drop more grog, Mr. Franklin, and you’ll get over the weakness of believing facts!” “Foul play, Sir.”

*The Moonstone*

Second Narrative, Chapter IV (p. 275)

International Collectors Library. Garden City, New York, USA. 1900

**Conrad, Joseph** 1857–1924

Polish-born English novelist

They demand facts from him, as if facts could explain anything.

*Lord Jim*

Chapter IV (p. 21)

Rinehart &amp; Company, Inc. New York, New York, USA. 1957

...The language of facts, that are so often more enigmatic than the craftiest arrangement of words.

*Lord Jim*

Chapter XXXVI (p. 295)

Rinehart &amp; Company, Inc. New York, New York, USA. 1957

...it is impossible to lay the ghost of a fact.

*Lord Jim*

Chapter XIX (p. 169)

Rinehart &amp; Company, Inc. New York, New York, USA. 1957

**Cooke, Josiah Parsons** 1827–94

American chemist

In every physical science we have carefully to distinguish between the facts which form its subject-matter and the theories by which we attempt to explain these facts, and group them in our scientific systems.

*The New Chemistry*

Lecture I (p. 9)

D. Appleton &amp; Company. New York, New York, USA. 1876

**Courtney, Leonard Henry** 1832–1918

English politician

After all, facts are facts, and although we may quote one to another with a chuckle the words of the Wise Statesman, "Lies — damned lies — and statistics," still there are some easy figures the simplest must understand, and the astutest cannot wriggle out of.

To My Fellow-Disciples at Saratoga Springs

*The National Review [London]*, Volume 26, 1895 (p. 25)**Crawford, F. Marion** 1854–1909

American novelist

Facts make life long — not years.

*Don Orsino*

Chapter XV (p. 233)

The Macmillan Company. New York, New York, USA. 1926

**Cross, Hardy** 1885–1959

American professor of civil and structural engineering

The constant and insistent need that engineers feel for any scrap of fact from which they may predict natural phenomena tends to develop a hunger for anything that even resembles a fact. This in turn may lead to a wolfish and gluttonous attitude, a gobbling up of every statement or opinion, figure or formula, indiscriminately and incessantly. The result is often intellectual autointoxication from hunks and gobs of unselected, undigested and indigestible material.

*Engineers and Ivory Towers*

For Mans Use of God's Gifts (p. 99)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

In so far as engineers deal with facts that can be measured they use mathematics to combine these facts and to deduce their conclusions. But often the facts are not subject to exact measurement or else the combinations are of facts that are incommensurable.

*Engineers and Ivory Towers*

The Education of an Engineer (p. 64)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

...engineers need to select their mental diet carefully and when they go a-fishing after facts they want a fish fry and not a chowder.

*Engineers and Ivory Towers*

For Mans Use of God's Gifts (p. 99)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Crothers, Samuel McChord** 1857–1927

American clergyman and writer

The trouble with facts is that there are so many of them.

*The Gentle Reader*

That History Should Be Readable (p. 183)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Darwin, Charles Robert** 1809–82

English naturalist

Nothing is so vexatious to me, as so constantly finding myself drawing different conclusions from better judges than myself, from the same facts.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to J.D. Hooker, July 30, 1856 (p. 439)

D. Appleton &amp; Company. New York, New York, USA. 1896

One great source of perplexity to me is an utter ignorance whether I note the right facts, and whether they are of sufficient importance to interest others.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VI (p. 208)

D. Appleton &amp; Company. New York, New York, USA. 1896

False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for every one takes a salutary pleasure in proving their falseness: and when this is done, one path towards error is closed and the road to truth is often at the same time opened.

In *Great Books of the Western World* (Volume 49)*The Descent of Man*

Part III, Chapter XXI (p. 590)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...no one has a right to speculate without distinct facts...

*The Voyage of The Beagle*

Chapter XVII (p. 378)

Heron Books. 1968

**Davy, Sir Humphry** 1778–1829  
English chemist

When I consider the variety of theories that may be formed on the slender foundation of one or two facts, I am convinced that it is the business of the true philosopher to avoid them altogether. It is more laborious to accumulate facts than to reason concerning them; but one good experiment is of more value than the ingenuity of a brain like Newton's.

In Sir William Ramsay  
*Essays Biographical and Chemical*  
The Great London Chemists  
Section II (p. 46)  
Archibald Constable & Company Ltd. London, England. 1908

The human mind, deriving all its ideas from the senses when in a state of healthy exertion, sooner or later uniformly refers to facts. And when hypotheses are used merely as instruments for comparing facts and for ascertaining their minute relations, they promote in the highest degree the efforts of inventive genius and tend to impress on the understanding the true and unperverted images of nature.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*  
Lecture Seven (p. 102)  
The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

**de Unamuno, Miguel** 1864–1936  
Spanish philosopher and writer

Science is the most intimate school of resignation and humility, for it teaches us to bow for the seemingly most insignificant of facts.

Translated by J.E. Crawford Fitch  
*The Tragic Sense of Life in Men and in Peoples*  
Chapter IX (p. 197)  
Macmillan & Company Ltd. London, England. 1921

...science robs men of wisdom and usually converts them into phantom beings loaded up with facts.

*Essays and Soliloquies*  
Some Arbitrary Reflections Upon Europeanization (p. 55)  
Alfred A. Knopf. New York, New York, USA. 1925

**Deluc, Jean-André** 1727–1817  
Swiss geologist

It is true that a controversy approaches its conclusion by the accumulation of facts that impinge upon it, it is only so provided these "facts" are without ambiguity in their implications. For otherwise, twisted by the rival hypotheses, and sometimes with so many more words that they convey less sense, these "facts" so multiply the extraneous questions that controversies become endless. Thus prejudice and imagination freely hold sway and logic is replaced by fashion.

In Jan Golinski  
Precision Instruments and the Demonstrative Order of Proof in Lavoisier's Chemistry (p. 30)  
*Osiris*, 2<sup>nd</sup> Series, Volume 9, 1994

**Dewey, John** 1859–1952  
American philosopher and educator

It is not truly realistic or scientific to take short views, to sacrifice the future to immediate pressure, to ignore facts and forces that are disagreeable and to magnify the enduring quality of whatever falls in with immediate desire. It is false that the evils of the situation arise from absence of ideals; they spring from wrong ideals.

*Reconstruction In Philosophy*  
Chapter V (p. 130)  
Beacon Press. Boston, Massachusetts, USA. 1920

**Dickens, Charles** 1812–70  
English novelist

The labors of others have raised for us an immense reservoir of important facts.

*The Posthumous Papers of the Pickwick Club*  
Chapter IV (p. 39)  
Dodd, Mead & Company. New York, New York, USA. 1944

Now, what I want are facts.... Facts alone are wanted in life.

*Hard Times*  
Book the First, Chapter I (p. 1)  
J.M. Dent & Sons Ltd. London, England. 1966

"Fact, fact, fact!" said the gentleman. And "Fact, fact, fact!" repeated Thomas Gradgrind. "You are to be in all things regulated and governed," said the gentleman, "by fact. We hope to have, before long, a board of fact, composed of commissioners of fact, who will force the people to be a people of fact, and of nothing but fact. You must discard the word Fancy altogether. You have nothing to do with it."

*Hard Times*  
Book the First, Chapter II (p. 8)  
The Limited Edition Club. New York, New York, USA. 1966

Facts and Figures! Put 'em down.

*The Chimes*  
First Quarter  
Printed by G. W. Jones. London, England. 1931

**Dickinson, Frances**  
No biographical data available

I know no facts, when listed for scientific purposes, to be "indelicate, indecent, obscene, or nasty." These adjectives express relative conditions in social life. The varied conditions of human beings from physical and psychological standpoints should be handled without sentiment and prejudice if scientific conclusions are to be reached and present conditions bettered.

*The Gynecologic Consideration of the Sexual Act* (p. 49)  
The Henry O. Shepard Company. Chicago, Illinois, USA. 1900

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

There is nothing more deceptive than an obvious fact.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Boscombe Valley Mystery (p. 137)

Wings Books. New York, New York, USA. 1967

Some facts should be suppressed, or at least, a just sense of proportion should be observed in treating them. The only point in the case which deserved mention was the curious analytical reasoning from effects to causes, by which I succeeded in unraveling it.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Sign of the Four, Chapter 1 (p. 611)

Wings Books. New York, New York, USA. 1967

It is, of course, a trifle, but there is nothing so important as trifles.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Man with the Twisted Lip (p. 379)

Wings Books. New York, New York, USA. 1967

“I should have more faith,” he said; “I ought to know by this time that when a fact appears to be opposed to a long train of deductions, it invariably proves to be capable of bearing some other interpretation.”

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 7 (p. 194)

Wings Books. New York, New York, USA. 1967

“I find it hard enough to tackle facts, Holmes, without flying away after theories and fancies.”

“You are right,” said Holmes demurely; “you do find it very hard to tackle the facts.”

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Boscombe Valley Mystery (p. 144)

Wings Books. New York, New York, USA. 1967

If you will find the facts, perhaps others may find the explanation.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Problem of Thor Bridge (p. 601)

Wings Books. New York, New York, USA. 1967

It is of the highest importance in the art of detection to be able to recognize out of a number of facts which are incidental and which are vital.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Reigate Squires (p. 341)

Wings Books. New York, New York, USA. 1967

A further knowledge of facts is necessary before I would venture to give a final and definite opinion.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of Wisteria Lodge (p. 244)

Wings Books. New York, New York, USA. 1967

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

With fuller knowledge we should sweep away the references to probability and substitute the exact facts.

*The Nature of the Physical World*

Chapter XIV (p. 305)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

The justification for a physical concept lies exclusively in its clear and unambiguous relation to facts that can be experienced.

In A.P. French

*Einstein: A Centenary Volume*

Chapter 12 (p. 229)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

It seems that the human mind has first to construct forms independently before we can find them in things. Kepler’s marvelous achievement is a particularly fine example of the truth that knowledge cannot spring from experience alone, but only from the comparison of the inventions of the mind with observed fact.

*Ideas and Opinions*

Johannes Kepler (p. 266)

Crown Publishers, Inc. New York, New York, USA. 1954

**Eldridge, Paul** 1888–1982

American educator

We hew and saw and plane facts to make them dovetail with our prejudices, so that they become mere ornaments with which to parade our objectivity.

*Maxims for a Modern Man*

2098

T. Yoseloff. New York, New York, USA. 1965

Combining superstition with facts is often as efficacious as breaking rocks with fists.

*Maxims for a Modern Man*

2159

T. Yoseloff. New York, New York, USA. 1965

Facts only emphasize that men are guided by fancies.

*Maxims For a Modern Man*

2168

T. Yoseloff. New York, New York, USA. 1965

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

You seem to have a decided faculty for digesting facts as evidence.

*The George Eliot Letters* (Volume 2) (p. 205)

Yale University Press. New Haven, Connecticut, USA. 1954–1978

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

To the wise, therefore, a fact is true poetry, and the most beautiful of fables.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Prospects (p. 55)

The Library of America. New York, New York, USA. 1983

No facts are to me sacred; none are profane; I simply experiment, an endless seeker, with no Past at my back.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Circles (p. 412)

The Library of America. New York, New York, USA. 1983

No anchor, no cable, no fences, avail to keep a fact a fact.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

History (p. 240)

The Library of America. New York, New York, USA. 1983

Every known fact in natural science was divined by the presentiment of somebody, before it was actually verified.

*The Complete Works of Ralph Waldo Emerson (Volume 3)*

Essays: Second Series

Nature (p. 183)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

I distrust the facts and the inferences.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

Experience (p. 475)

The Library of America. New York, New York, USA. 1983

Is it any better if the student...aims to make a mechanical whole of...science...by a numerical addition of all the facts that fall within his vision.

*The Complete Works of Ralph Waldo Emerson (Volume 2)*

Essays: First Series

Chapter XI (p. 339)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

A little fact is worth a whole limbo of dreams...

*The Complete Works of Ralph Waldo Emerson (Volume 10)*

Lectures and Biographical Sketches

The Superlative (p. 166)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Fischer, Martin H.** 1879–1962

German-American physician

Facts are not science — as the dictionary is not literature.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 21)

C.C. Thomas. Springfield, Illinois, USA. 1944

**Faraday, Michael** 1791–1867

English physicist and chemist

I could trust a fact and always cross-question an assertion.

In Oswald Blackwood

*Introductory College Physics* (p. 413)

John Wiley & Sons, Inc. New York, New York, USA. 1939

...it is always safe and philosophic to distinguish, as much as is in our power, fact from theory; the experience of past ages is sufficient to show us the wisdom of such a course; and considering the constant tendency of the mind to rest on an assumption, and, when it answers every present purpose, to forget that it is an assumption, we ought to remember that it, in such cases, becomes a prejudice, and inevitably interferes, more or less, with a clear-sighted judgment. I cannot doubt but that he who, as a wise philosopher, has most power of penetrating the secrets of nature, and guessing by hypothesis at her mode of working, will also be most careful, for his own safe progress and that of others, to distinguish that knowledge which consists of assumption, by which I mean theory and hypothesis, from that which is the knowledge of facts and laws; never raising the former to the dignity or authority of the latter, nor confusing the latter more than is inevitable with the former.

A Speculation Touching Electric Conduction and the Nature of Matter  
*Philosophical Magazine*, Volume XXIV, January–June, 1844 (p. 136)

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

No theory ever agrees with all the facts in its domain, yet it is not always the theory that is to blame. Facts are constituted by older ideologies, and a clash between facts and theories may be proof of progress.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 5 (p. 55)

Verso. London, England. 1978

Facts contain ideological components, older views, natural interpretations, which have vanished from sight or perhaps never were formulated in an explicit manner. These components are highly suspicious, first because of their age, because of their archaic origin, and, secondly, because their very nature protects them from critical examination and always has protected them from such an examination.

In R.G. Colodny

*The Nature and Function of Scientific Theories*

Problems of Empiricism, Part II (p. 310)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1970

...science is not sacrosanct. The restrictions it imposes (and there are many such restrictions though it is not easy to spell them out) are not necessary in order to have general coherent and successful views about the world. There are myths, there are the dogmas of theology, there is metaphysics, and there are many other ways of constructing a world-view. It is clear that a fruitful exchange between science and such “non-scientific” world-views will be in even greater need of anarchism than is science itself. Thus anarchism is not only

possible, it is necessary both for the internal progress of science and for the development of our culture as a whole.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Chapter 15 (p. 180)  
Verso. London, England. 1978

**Foster, Sir Michael** 1836–1907

English physiologist and educator

...facts are things which the well-trained mind can pick up and make use of as it goes along at any time and in any place; whereas the mind which is not well trained will miss the facts or pick up the wrong ones, or put to a wrong use even the right ones which it has in hand.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*

Recent Advances in Science, and Their Bearing on Medicine and Surgery (pp. 340–341)  
Government Printing Office. Washington, D.C. 1899

**France, Anatole (Jean Jacques Brousseau)** 1844–

1924

French writer

Less facts! Less facts, if you please, and more figures.

*Anatole France Himself*

Less Facts (p. 71)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1925

**Freeman, R. Austin** 1862–1943

British physician and mystery novelist

...not only must all prejudices and preconceptions be avoided, but when information is received from outside, the actual undeniable facts must be carefully sifted from the inferences which usually accompany them.

*The Great Portrait Mystery*

Percival Bland's Proxy

Hodder & Stoughton. London, England. 1918

**Frege, Friedrich Ludwig Gottlob** 1848–1925

German logician

“Facts, facts, facts,” cries the scientist if he wants to emphasize the necessity of a firm foundation for science. What is a fact? A fact is a thought that is true. But the scientist will surely not recognize something which depends on men's varying states of mind to be the firm foundation of science.

In Michael Beaney (ed.)

*The Frege Reader*

Thought (p. 342)

Blackwell Publishers, Malden, Massachusetts, USA. 1997

**Froude, James Anthony** 1818–94

English historian and biographer

These are facts which no casuistry can explain away.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 11)

Charles Scribner's Sons. New York, New York, USA. 1890

We may make our own opinions, but facts were made for us; and, if we evade or deny them, it will be the worse for us.

*Short Studies on Great Subjects* (Volume 1)

Times of Erasmus, Desiderius and Luther (p. 41)

Longmans, Green & Company. London, England. 1879

Facts can be accurately known to us only by the most rigid observation and sustained and scrutinizing skepticism...

*Short Studies on Great Subjects* (Volume 2)

Scientific Method Applied to History (p. 453)

Charles Scribner's Sons. New York, New York, USA. 1890

The necessitarian falls back upon the experienced reality of facts.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 11)

Charles Scribner's Sons. New York, New York, USA. 1890

It is through a conviction of the inadequacy of all formulas to cover the facts of nature, it is by a constant recollection of the fallibility of the best instructed intelligence, and by an unintermittent skepticism which goes out of its way to look for difficulties, that scientific progress has been made possible.

*Short Studies on Great Subjects* (Volume 2)

The Grammar of Assent (pp. 89–90)

Charles Scribner's Sons. New York, New York, USA. 1890

**Gage, Simon Henry**

No biographical data available

...when one looks about him the plainest, largest fact he sees is that of the distinction between living and lifeless things.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Processes of Life Revealed by the Microscope; A Plea for Physiological Histology (p. 384)

Government Printing Office. Washington, D.C. 1898

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

Some years ago I discovered many astronomical facts till then unknown.

Their novelty and their antagonism to some physical propositions commonly received by the schools did stir up against me many who professed the vulgar philosophy, as if, forsooth, I had with my own hand placed these things in the heavens to obscure and disturb nature and science.

*The Authority of Scripture in Philosophical Controversies*

Section I

The Defenders of Fallacy

W.H. Wise. New York, New York, USA. 1910

SALVAIATI: Please observe...how facts which at first seem improbable will, even on scant explanation, drop

the cloak which has hidden them and stand forth in naked and simple beauty.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

First Day (p. 132)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I would rather discover a single fact, even a small one, than debate the great issues at length without discovering anything at all.

In David L. Goodstein and Judith R. Goodstein

*Feynman's Lost Lecture: The Motion of Planets Around the Sun*

Introduction (p. 17)

W.W. Norton & Company, Inc. New York, New York, USA. 1996

### **Gardner, Earl Stanley** 1889–1970

American author

Facts themselves are meaningless. It's only the interpretation we give those facts which counts.

*The Case of the Perjured Parrot* (p. 171)

Amereon Ltd. Mattituck, New York, USA. 1939

### **Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

In the natural sciences and especially in chemistry generalizations should result from the detailed knowledge of each fact, they should not precede it. It is really only after having acquired this knowledge that we can be assured whether they have something in common...

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 67)

Cambridge University Press. Cambridge, England. 1978

A fact is not novel if it has an analogue which could have some interest. A fact which does not fit in with a series of known facts is a fact which deserves particular attention. If the mind had to retain all individual facts, it could not manage and science would not exist; but when these facts can be connected by general laws and by theories, when a large number of these facts can be represented by a single one, one can remember them more easily, one can generalise one's ideas, one can compare one general fact with another general fact and discoveries can succeed each other. It is only when laws can be introduced into a science that it assumes the true character of science.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 70)

Cambridge University Press. Cambridge, England. 1978

### **George, William H.**

No biographical data available

...[while] the traditional way is to regard the facts of science as something like the parts of a jig-saw puzzle, which can be fitted together in one and only one way, I

regard them rather as the tiny pieces of a mosaic, which can be fitted together in many ways. A new theory in an old subject is, for me, a new mosaic pattern made with the pieces taken from an older pattern.

*The Scientist in Action: A Scientific Study of His Methods*

Personal Basis (p. 335)

Williams & Norgate Ltd. London, England. 1936

### **Giddings, Franklin H.** 1855–1931

American sociologist

The scientific study of any subject is a substitution of businesslike ways of "making sure" about it for the lazy habit of "taking it for granted" and the worse habit of making irresponsible assertions about it. To make sure it is necessary to have done with a careless "looking into it" and to undertake precise observations, many times repeated...[it] is necessary to make measurements and accountings, to substitute realistic thinking (an honest dealing with facts as they are) for wishful or fanciful thinking (a self-deceiving day-dreaming) and to carry on a systematic "checking up"...science is nothing more nor less than getting at facts, and trying to understand them...

Societal Variables

*The Journal of Social Forces*, Volume I, Number 4, May 1923 (p. 345)

### **Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

### **Sullivan, Arthur** 1842–1900

English composer

Her taste exact

For faultless fact

Amounts to a disease.

*The Complete Plays of Gilbert and Sullivan*

*The Mikado*

Act II (p. 334)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

### **Gilman, Charlotte Perkins** 1860–1935

American writer and feminist

The acts and facts of today continually diverge from the concepts of yesterday.

*Human Work*

Concept and Conduct (p. 41)

McClure, Philips & Company. New York, New York, USA. 1904

### **Gold, Thomas** 1920–2004

Austrian astrophysicist

If many years go by in a field in which no significant new facts come to light, the field sharpens up the opinions and gives the appearance that the problem is solved.

New Ideas in Science

*Journal of Scientific Exploration*, Volume 3, Number 2, 1989 (p. 107)

### **Gooday, Graeme**

No biographical data available

We have tables properly arranged in regard to light, microscopes and dissecting instruments, and we work through the structure of a certain number of animals and plants...the student has before him, first, a picture of the structure he ought to see; secondly the structure itself worked out, and if with these aids, and such needful explanations and practical hints as a demonstrator can supply, he cannot make out the facts for himself in the material supplied to him, he had better take to some other pursuit than that of biological science.

Nature in the Laboratory

*British Journal For the History of Science*, Volume 24, 1991 (pp. 339–340)

**Gore, George** 1826–1909

No biographical data available

Facts are crude knowledge and constitute the raw materials of science.

*The Art of Scientific Discovery*

Chapter VII (p. 83)

Longmans, Green & Company. London, England. 1878

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Facts do not “speak for themselves”; they are read in the light of theory. Creative thought, in science as much as in the arts, is the motor of changing opinion. Science is a quintessentially human activity, not a mechanized, robot-like accumulation of objective information, leading by laws of logic to inescapable interpretation.

*Ever Since Darwin: Reflections in Natural History*

Chapter 20 The Validation of Continental Drift (pp. 161–162)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

Gradualism, the idea that all change must be smooth, slow, and steady, was never read from the rocks. It was primarily a prejudice of nineteenth-century liberalism facing a world in revolution. But it continues to color our supposedly objective reading of life’s history.

*Natural History*

This View of Life, an Early Start, Volume 87, Number 2, February 1978 (p. 24)

Darwin has been vindicated by a rich Precambrian record, all discovered in the past thirty years. Yet the peculiar character of this evidence has not matched Darwin’s prediction of a continuous rise in complexity toward Cambrian life, and the problem of the Cambrian explosion has remained as stubborn as ever — if not more so, since our confusion now rests on knowledge, rather than ignorance about the nature of Precambrian life.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter II (p. 57)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

Theoretical arguments may be dazzling, but give me a good old fact any time.

*Leonardo’s Mountain of Clams and the Diet of Worms*

Part III, Chapter 8 (p. 176)

Harmon Brown. New York, New York, USA. 1998

Facts cannot be divorced from cultural contexts.

What Color Is a Zebra?

*Natural History*, Volume 90, Number 8, August 1981 (p. 16)

Moreover, “fact” doesn’t mean “absolute certainty”; there ain’t no such animal in an exciting and complex world. The final proofs of logic and mathematics flow deductively from stated premises and achieve certainty only because they are NOT about the empirical world. Evolutionists make no claim for perpetual truth, though creationists often do (and then attack us falsely for a style of argument that they themselves favor).

Evolution as Fact and Theory

*Discover*, May 1981

In science “fact” can only mean “confirmed to such a degree that it would be perverse to withhold provisional consent.” I suppose that apples might start to rise tomorrow, but the possibility does not merit equal time in physics classrooms.

Evolution as Fact and Theory

*Discover*, May 1981

**Greenstein, Jesse L.** 1909–2002

American astronomer

Knowing how hard it is to collect a fact, you understand why most people want to have some fun analyzing it.

Great American Scientists: The Astronomer

*Fortune*, Volume 61, Number 5, May 1960 (p. 149)

**Gregg, Alan** 1890–1957

American medical educator and philosopher

A statistical resume of 1000 opinions about gravity before Newton’s time would not have given us the law. You cannot always arrive at facts through other folks’ opinions or observations.

In Wilder Penfield

*The Difficult Art of Giving: The Epic of Alan Gregg*

Chapter 8 (p. 124)

Little, Brown & Company. Boston, Massachusetts, USA. 1967

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

Facts which seem trivial in themselves may be rich in suggestion to the thoughtful mind.

*Discovery; or, The Spirit and Service of Science*

Chapter IX (p. 244)

Macmillan & Company Ltd. London, England. 1918

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

...you must constantly be returning from the unfamiliar facts of science to the familiar facts of everyday experience. ... I think that popular science can be of real value



by emphasizing the unity of human knowledge and endeavor, at their best. This fact is hardly stressed at all in the ordinary teaching of science, and good popular science should correct this fault, both by showing how science is created by technology and creates it, and by showing the relation between scientific and other forms of thought.

In J. Maynard Smith (ed.)

*On Being the Right Size and Other Essays*

How To Write a Popular Scientific Article (p. 155, 158)

Oxford University Press, Inc. Oxford, England. 1985

### **Hanson, Norwood Russell** 1924–67

American philosopher of science

Facts are simply the things that happen; hard, sheer, plain and unvarnished.

*Patterns of Discovery*

Chapter II (p. 31)

At The University Press. Cambridge, England. 1958

### **Hare, Hobart Amory**

American sportsman

At first it is impossible for the novice to cast aside the minor symptoms, which the patient emphasizes as his major ones, and to perceive clearly that one or two facts that have been belittled in the narration of the story of the illness are in reality the stalk about which everything in the case must be made to cluster.

*Practical Diagnosis*

Introduction (p. 17)

Lea Brothers & Company. Philadelphia, Pennsylvania, USA. 1902

### **Harrison, Harry** 1925–

American science fiction writer

There was an explanation for everything, once you had your facts straight.

*Deathworld 1* (p. 88)

Little Brown Book Group Ltd. London, England. 1991

Just because you know a thing is true in theory doesn't make it true in fact.

*Deathworld* (p. 153)

Berkeley Books. New York, New York, USA. 1960

### **Heinlein, Robert A.** 1907–88

American science fiction writer

What are the facts? Again and again and again — what are the facts? Shun wishful thinking, ignore divine revelation, forget what 'the stars foretell,' avoid opinion, care not what the neighbors think, never mind the unguessable 'verdict of history,' — what are the facts, and to how many decimal places? You pilot always into an unknown future; facts are your only clue. Get the facts!

*Time Enough for Love*

Intermission (p. 264)

G.P. Putnam's Sons. New York, New York, USA. 1973

When an apparent fact runs contrary to logic and common sense, it's obvious that you have failed to interpret the fact correctly.

*Orphans of the Sky*

Part II (p. 116)

The New American Library. New York, New York, USA. 1965

A fact has no "why." There it stands, self demonstrating.

*The Menace from Earth*

The Year of the Jackpot (p. 22)

Dennis Dobson. London, England. 1959

A fact doesn't have to be understood to be true. Sure, any reasonable mind wants explanations, but it's silly to reject facts that don't fit your philosophy.

*Assignment in Eternity* (Volume 1)

Elsewhen (p. 111)

Fantasy Press. Reading, Pennsylvania, USA. 1953

### **Heyworth, Sir Geoffrey**

No biographical data available

The more facts one has, the better the judgment one can make, but one must never forget the corollary that the more facts one has, the easier it is to put them together wrong.

Inaugural Address

Royal Statistical Society, 1949

### **Hobbes, Thomas** 1588–1679

English philosopher and political theorist

...science is the knowledge of consequences, and dependence of one fact upon another...

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 5 (p. 60)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Hodnett, Edward** 1901–84

Illustration historian

What you call a fact may with good reason not seem a fact to the other fellow.

*The Art of Problem Solving*

Part I, Chapter 7 (p. 50)

Harper & Brothers. New York, New York, USA. 1955

The necessity for getting facts straight leads the professional problem solver to take what seems to the layman fantastic pains in checking even small details.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 48)

Harper & Brothers. New York, New York, USA. 1955

Much of the difficulty of problem solving comes from the impossibility of getting all the facts together before making a decision.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 43)

Harper & Brothers. New York, New York, USA. 1955

Ignorance of the significance of facts renders us as blind to the solution of a problem as if we were matching colors in the dark.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 43)

Harper & Brothers. New York, New York, USA. 1955

A fact not recognized for what it signifies has no more value than a precious stone in a savage's collection of shells and pebbles.

*The Art of Problem Solving*

Part I, Chapter 6 (p. 43)

Harper & Brothers. New York, New York, USA. 1955

### Hoffer, Eric 1902–83

American longshoreman and philosopher

The war on the present is usually a war on fact. Facts are the toys of men who live and die at leisure. They who are engrossed in the rapid realization of an extravagant hope tend to view facts as something base and unclean. Facts are counterrevolutionary.

*The Passionate State of Mind, and Other Aphorisms*

No. 73

Harper & Brothers. New York, New York, USA. 1955

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

Scientific knowledge, even in the most modest persons, has mingled with it a something which partakes of insolence. Absolute, peremptory facts are bullies.

*The Autocrat of the Breakfast-Table*

Chapter III (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Facts always yield the place of honor in conversation, to thoughts about facts; but if a false note is uttered, down comes the finger on the key and the man of facts asserts his true dignity.

*The Autocrat of the Breakfast-Table*

Chapter VI (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

All generous minds have a horror of what are commonly called "facts." They are the brute beasts of the intellectual domain.

*The Autocrat of the Breakfast-Table*

Chapter I (p. 5)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

A Pseudo-science does not necessarily consist wholly of lies.... When we have one fact found us, we are very apt to supply the next out of our own imagination.

*The Professor at the Breakfast Table*

Chapter VIII (p. 249)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

### Hooker, Worthington 1806–67

American physician

The physician who narrows his view down to a certain set of facts is in danger of becoming enamored of them. And if he does, he is straightway in the fog and mists of error. He forsakes the practical for a fruitless will o' the wisp pursuit of the ideal, all the while believing that he has found vast mines of truth, and very confident that his search is to be still more abundantly rewarded.

*Lessons from the History of Medical Delusions* (p. 35)

Baker & Scribner. New York, New York, USA. 1850

### Hugo, Victor 1802–85

French author, lyric poet, and dramatist

To look facts in the face is the duty of every sensible person.

*The Man Who Laughs* (II.4.iv)

G. Routledge & Sons. London, England. 1889

Every fact is a logarithm; one added term ramifies it until it is thoroughly transformed. In the general aspect of things, the great lines of creation take shape and arrange themselves into groups; beneath lies the unfathomable.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 405)

The Heritage Press. New York, New York, USA. 1961

### Husserl, Edmund 1859–1938

German philosopher

Merely fact-minded sciences make merely fact-minded people.

Translated by David Carr

*The Crisis of European Sciences and Transcendental Phenomenology:*

*An Introduction to Phenomenological Philosophy*

Part I, Section 1 (p. 6)

Northwestern University Press. Evanston, Illinois, USA. 1970

### Huxley, Aldous 1894–1963

English writer and critic

Facts do not cease to exist because they are ignored.

*Proper Studies*

A Note on Dogma (p. 205)

Chatto & Windus. London, England. 1957

Facts are ventriloquists' dummies. Sitting on a wise man's knee they may be made to utter words of wisdom; elsewhere they say nothing or talk nonsense...

*Time Must Have a Stop*

Chapter XXX (p. 301)

The Sun Dial Press. Garden City, New York, USA. 1944

### Huxley, Julian 1887–1975

English biologist, philosopher, and author

To speculate without facts is to attempt to enter a house of which one has not the key, by wandering aimlessly round and round, searching the walls and now and then peeping through the windows. Facts are the key.

*Essays in Popular Science*

Heredity, the Behavior of the Chromosomes (pp. 1–2)  
Chatto & Windus. London, England. 1926

...facts are too bulky to be lugged about conveniently except on the wheels of theory.

*Essays of a Biologist*

Progress, Biological and Other (p. 32)  
Alfred P. Knopf. New York, New York, USA. 1929

**Huxley, Thomas Henry** 1825–95

English biologist

The great danger which besets all men of large speculative faculty, is the temptation to deal with the accepted statements of facts in natural science, as if they were not only correct, but exhaustive; as if they might be dealt with deductively, in the same was a proposition in Euclid may be dealt with.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)  
The Monograph of the Cirripedia (pp. 315–316)  
D. Appleton & Company. New York, New York, USA. 1896

Sit down before fact as a little child... follow humbly and to whatever abysses Nature leads, or you shall learn nothing.

In Leonard Huxley (ed.)

*Life and Letters of Thomas Henry Huxley* (Volume 1)  
Huxley to Kingsley, September 23, 1860 (p. 235)  
D. Appleton & Company. New York, New York, USA. 1901

Spencer's idea of a tragedy is a deduction killed by a fact.

In William Irvine

*Apes, Angels, and Victorians*  
Chapter III (p. 30)  
McGraw-Hill Book Company, Inc., New York, New York, USA, 1955

God give me the strength to face a fact though it slay me.

In George Seldes

*The Great Quotations* (p. 344)  
Citadel Press. Secaucus, New Jersey, USA. 1996

Men of science do not pledge themselves to creeds; they are bound by articles of no sort; there is not a single belief that it is not a bounden duty with them to hold with a light hand and to part with cheerfully, the moment it is really proved to be contrary to any fact, great or small.

*Collected Essays* (Volume 2)

*Darwiniana*

On Our Knowledge of the Causes of the Phenomena of Organic Nature, Lecture VI (pp. 468–469)  
Macmillan & Company Ltd. London, England. 1904

If you go buzzing about between right and wrong, vibrating and fluctuating, you come out nowhere; but if you are absolutely and thoroughly and persistently wrong, you must, some of these days, have the extreme good fortune of knocking your head against a fact, and that sets you straight again.

*Science and Education*

On Science and Art in Relation to Education (p. 100)  
Kessinger Publishing. Whitefish, Montana, USA. 2004

...he had one eye upon fact, and the other on Genesis.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 127)  
Macmillan & Company Ltd. London, England. 1904

...those who refuse to go beyond fact rarely get as far as fact...

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 62)  
Macmillan & Company Ltd. London, England. 1904

**Jacks, L. P.** 1860–1955

English educator, philosopher, and Unitarian minister

Facts are popularly regarded as antidotes to mysteries. And yet, in sober earnest, there is nothing so mysterious as a fact.

Is There a Foolproof Science?

*The Atlantic Monthly*, Volume 133, Number 2, February 1924 (p. 229)

**James, Henry**

American-born British author and literary critic

The fatal futility of Fact.

*The Spoils of Poynton*

Preface

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**James, William** 1842–1910

American philosopher and psychologist

“Facts” are the bounds of human knowledge, set for it, not by it.

*The Will to Believe and Other Essays in Popular Philosophy and Human Immortality*

On Some Hegelisms (p. 202)

Dover Publications, Inc. New York, New York, USA. 1956

I have to forge every sentence in the teeth of irreducible and stubborn facts.

Letter to brother Henry James

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

There are some current “theories” that, when divested of begged questions, reduce to the non-controversial statement, “Here are some facts and there may be some relation between them.”

*Theory of Probability*

Chapter VIII, Section 8.5 (p. 419)

Clarendon Press. Oxford, England. 1961

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

We should never over-estimate our own accomplishments because it is more than possible that new facts obtained

from studies of nature can modify and improve many of our own well-established theories.

*Short Stories of Science and Invention: A Collection of Radio Talks by C.F. Kettering*

Underwater Powerhouse (p. 109)

General Motors, Detroit, Michigan, USA. 1955

**Keynes, John Maynard** 1883–1946

British economist

When the facts change, I change my mind. What do you do, sir?

*The Economist*, December 18, 1999 (p. 47)

**Kingsley, Charles** 1819–75

English clergyman and author

The fact is novel, and I am more obliged to any one who gives me that, than if he gave me a bank-note. The money gets spent and done with; but I cannot spend the fact: it remains for life as permanent capital, returning interest and compound interest ad infinitum.

*Alton Locke, Taylor and Poet*

Chapter XVII (p. 139)

Macmillan & Company Ltd. London, England. 1911

**Kipling, Rudyard** 1865–1936

British writer and poet

Just statin' evidential facts beyon' all argument.

*Rudyard Kipling's Verse*

McAndrew's Verse

Hodder & Stroughton. London, England. 1919

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Artists treat facts as stimuli for the imagination, while scientists use their imagination to coordinate facts.

*Insight and Outlook: An Inquiry into the Common Foundations of Science, Art and Social Ethics*

Preface (p. vii)

University of Nebraska Press. Lincoln, Nebraska, USA. 1949

**Kough, A.**

No biographical data available

Facts are necessary, of course, but unless fertilized by ideas, correlated with other facts, illuminated by thought, I consider them as only material for science.

The Progress of Physiology

*Science*, Volume 70, Number 1809, August 30, 1929 (p. 203)

**Kratovil, Robert** 1920–

Attorney

An impartial and reliable research substitutes facts for hunches.

*Real Estate Law* (4<sup>th</sup> edition) (p. 419)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1952

**Kuhn, Thomas S.** 1922–96

American historian of science

Scientific fact and theory are not categorically separable, except perhaps within a single tradition of normal-scientific practice. That is why the unexpected discovery is not simply factual in its import and why the scientist's world is qualitatively transformed as well as quantitatively enriched by fundamental novelties of either fact or theory.

*The Structure of Scientific Revolutions*

Chapter I (p. 7)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Langer, Susanne Knauth** 1895–1985

American philosopher

Our world “divides into facts” because we so divide it.

*Philosophy in a New Key*

Chapter X (p. 273)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Had man restricted himself to a mere compilation of facts, the sciences would present nothing but a barren nomenclature, and a knowledge of the great laws of nature would never have been attained.

*System of the World* (Volume 1)

Book I, Chapter XI (p. 72)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

**Le Sage, Alan Rene**

No biographical data available

Facts are stubborn things.

Translated by T. Smollett

*The Adventure of Gil Blas of Santillane*

Second Book, Chapter VIII, Section 2 (p. 46)

Cunningham. London, England. 1826

**Latham, Peter Mere** 1789–1875

English physician

People in general have no notion of the sort and amount of evidence often needed to prove the simplest fact.

*The Collected Works of Dr. P.M. Latham* (Volume 2) (p. 525)

The New Sydenham Society. London, England. 1876078

Bear in mind then, that abstractions are not facts; and next bear in mind that opinions are not facts.

In William B. Bean

*Aphorisms from Latham* (p. 36)

Prairie Press. Iowa City, Iowa, USA. 1962

**Latour, Bruno** 1947–

French sociologist of science

...a fact is what is collectively stabilised from the midst of controversies when the activity of later papers does not consist only of criticism or deformation but also of confirmation.

*Science in Action: How to Follow Scientists and Engineers Through Society*

Literature (p. 42)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

**Laut, Agnes C.** 1871–1936  
Canadian journalist

The ultimate umpire of all things in Life is — Fact.  
*The Conquest of the Great Northwest*  
Part III, Chapter XX (p. 391)  
The Outing Publishing Company. New York, New York, USA. 1908

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

We must trust to nothing but facts: These are presented to us by Nature, and cannot deceive.  
*Elements of Chemistry in a New Systematic Order*  
Preface of the Author (p. xviii)  
Printed for William Creech. Edinburgh, Scotland. 1790

**Lukasiewicz, J.**  
No biographical data available

Facts whose effects have disappeared altogether, and which even an omniscient mind could not infer from those now occurring, belong to the realm of possibility. One cannot say about them that they took place, but only that they were possible.  
In L. Borkowski (ed.)  
*Selected Works*  
On Determinism (p. 128)  
North-Holland Publishing Company. Amsterdam, Netherlands. 1970

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

One can never lose one's footing, or come into collision with facts, if one always keeps in view the path by which one has come.  
*History and Root of the Principle of the Conservation of Energy*  
Chapter I (p. 17)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1911

The ultimate unintelligibilities on which science is founded must be facts, or, if they are hypotheses, must be capable of becoming facts. If the hypotheses are so chosen that their subject ... can never appeal to the senses and therefore also can never be tested, as is the case with the mechanical molecular theory, the investigator has done more than science, whose aim is facts, requires of him — and this work of supererogation is an evil.  
*History and Root of the Principle of the Conservation of Energy*  
Chapter III (p. 57)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1911

As long as the pursuit of the facts of a given province of phenomena is in the hands of a few isolated investigators, as long as every experiment can be easily repeated, the fixing of the collected facts by provisional description is ordinarily sufficient. But the case is different when the whole world must make use of the results reached

by many, as happens when the science acquires broader foundations and scope, and so particularly so when it begins to supply intellectual nourishment to an important branch of the practical arts, and to draw from that province in return stupendous empirical results.  
*Popular Scientific Lectures*  
On the Fundamental. Concepts of Electrostatics (pp. 107–108)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Maier, N. R. F.**  
American psychologist

The method of how psychologists as scientists dispose of facts is of special interest. One of the most common is to give the facts a new name. In this way they are given a special compartment and therefore cease to infringe on the privacy of the theory.  
Maier's Law  
*The American Psychologist*, March 1960 (p. 208)

If the facts do not conform to the theory, they must be disposed of.  
Maier's Law  
*The American Psychologist*, March 1960 (p. 208)

**Marshall, Alfred** 1842–1924  
English economist

...facts by themselves are silent. Observation discovers nothing directly of the actions of causes, but only of sequences in time.  
In A. C. Pigou (ed.)  
*Memorials of Alfred Marshall*  
Chapter VI (p. 166)  
Macmillan & Company Ltd. London, England. 1925

**Maury, Matthew Fontaine** 1806–73  
American hydrographer and naval officer

Physical facts are the language of Nature, and every expression uttered by her is worthy of our most attentive consideration.  
*The Physical Geography of the Sea*  
Chapter IX (p. 180)  
Harper & Brothers. New York, New York, USA. 1855

**Mayo, William J.** 1861–1939  
American physician

The man of science in searching for the truth must ever be guided by the cold logic of facts, and be animated by scientific imagination.  
Perception  
*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 20, 1928

**McArthur, Peter** 1866–1924  
Canadian poet

The golden rule of science is: Make sure of your facts and then lie strenuously about your modesty.  
*To Be Taken with Salt: An Essay on Teaching One's Grandmother to*

*Suck Eggs* (p. 150)  
Limpus, Bacon London, England. 1903

**McCarthy, Mary** 1912–89  
American writer

...in science, all facts, no matter how trivial or banal,  
enjoy democratic equality.

*On the Contrary*  
The Fact in Fiction (p. 266)  
Farrar, Straus & Cudahy. New York, New York, USA, 1961

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and social critic

The common view of science is that it is a sort of machine  
for increasing the race's store of dependable facts. It is  
that only in part; in even larger part it is a machine for  
upsetting undependable facts.

In Will Durant  
*Living Philosophies*  
Chapter XII (p. 187)  
Simon & Schuster. New York, New York, USA. 1931

Science, at bottom, is really anti-intellectual. It always  
distrusts pure reason, and demands the production of  
objective fact.

*Minority Report: H.L. Mencken's Notebooks*  
No. 412 (p. 277)  
Alfred A. Knopf. New York, New York, USA. 1956

**Miall, L. C.**  
English entomologist

Natural history is encumbered by multitudes of facts  
which are recorded only because they are easy to record.

In Marston Bates  
*The Natural History of Mosquitoes*  
Introduction (p. 1)  
The Macmillan Company. New York, New York, USA. 1949

**Millay, Edna St. Vincent** 1892–1950  
American poet

Upon this gifted age, in its dark hour,  
Rains from the sky a meteoric shower  
Of facts...they lie unquestioned, uncombined,  
Wisdom enough to leach us of our ill  
Is daily spun; but there exists no loom  
To weave it into fabric ...

*Collected Sonnets*  
Three Sonnets in Tetrameter, Sonnet III (p. 697)  
Harper & Row, Publishers. New York, New York, USA. 1950

**Moulton, Forest Ray** 1872–1952  
American astronomer

How greatly fact often transcends fancy!  
In H.H. Newman (ed.)  
*The Nature of the World and of Man*  
Astronomy (p. 23)  
The University of Chicago Press. Chicago, Illinois, USA. 1927

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

It may be so, there is no arguing against facts and  
experiments.

In David Brewster  
*Memoirs of the Life, Writings, and Discoveries of Sir Isaac Newton*  
(Volume 2)  
Chapter XXVII (p. 407)  
Hamilton, Adams & Company. London, England. 1855

**Nightingale, Florence** 1820–1910  
British nursing pioneer and statistician

What you want are facts, not opinions —  
*Notes on Nursing: What It Is and What It Is Not*  
Chapter XIII (p. 59)  
Harrison. London, England. 1859

**Obruchev, Vladimir** 1863–1956  
Russian geologist and geographer

Facts are the bricks of human experience, your imple-  
ment in creation. Search for facts tirelessly, collect them  
in nature and in books, and read good textbooks from  
cover to cover.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

**O'Malley, Austin** 1858–1932  
American physician and humorist

Facts are carpet-tacks under the pneumatic tires of  
theory.

*Keystones of Thought*  
The Devin Adair Company. New York, New York, USA. 1918

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

...when technical people talk they always emphasize the  
facts [of which] they are not sure.

The Tree of Knowledge  
*Harper's Magazine*, Volume 217, October 1958 (p. 57)

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Fed on the dry husks of facts, the human heart has a  
hidden want which science cannot supply...

*Science and Immortality*  
The Teresians (p. 41)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1905

**Ozick, Cynthia** 1928–  
American novelist and short story writer

I'm not afraid of facts. I welcome facts — but a congeries  
of facts is not equivalent to an idea. This is the essential  
fallacy of the so-called "scientific" mind. People who

mistake facts for ideas are incomplete thinkers; they are gossips.

Quoted in Francis Klagsbrun

*The First Ms. Reader*

We are the Crazy Lady and Other Feisty Feminist Fables (p. 67)

Warner Paperback Library. New York, New York, USA. 1973

**Pallister, William Hales** 1877–1946

Canadian physician

Facts are hard, stubborn things; so relative, so rare.

They limit all we know. Let us, my friend, beware!

*Poems of Science*

De Ipsa Natura, The Law of Logic (p. 235)

Playford Press. New York, New York, USA. 1931

**Parsons, Talcott** 1902–79

American sociologist

...a fact is not itself a phenomenon at all, but a proposition about one or more phenomena.

*The Structure of Social Action*

Part I, Chapter 1 (p. 41)

The Free Press. Glencoe, Illinois, USA. 1949

**Pasteur, Louis** 1822–95

French chemist

When I am in my laboratory...I begin by shutting the door on materialism and on spiritualism; I observe facts alone; I seek but the scientific conditions under which life manifests itself.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter 1 (p. 11)

Macmillan & Company Ltd. London, England. 1918

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Facts are the air of a scientist. Without them you never can fly. Without them your “theories” are vain efforts.

Bequest of Pavlov to the Academic Youth of His Country

*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Do not become the archivist of facts. Try to penetrate to the secret of their occurrence, persistently search for the laws which govern them.

Bequest of Pavlov to the Academic Youth of His Country

*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Learn, compare, collect facts!

Bequest of Pavlov to the Academic Youth of His Country

*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

**Pearson, Karl** 1857–1936

English mathematician

The classification of facts, the recognition of their sequence and relative significance is the function of science, and the habit of forming a judgment upon these facts unbiased by personal feeling is characteristic of what may be termed the scientific frame of mind.

*The Grammar of Science*

Introductory, Section 2 (p. 8)

Charles Scribner’s Sons. London, England. 1892

The smallest group of facts, if properly classified and logically dealt with, will form a stone which has its proper place in the great building of knowledge, wholly independent of the individual workman who has shaped it.

*The Grammar of Science*

Introductory, Section 5 (p. 16)

Charles Scribner’s Sons. London, England. 1892

**Peers, John**

No biographical data available

Gross’s Postulate. Facts are not all equal. There are good facts and bad facts. Science consists of using good facts.

*1001 Logical Laws, Accurate Axioms, Profound Principles, Trusty*

*Truisms, Homey Homilies, Colorful Corollaries, Quotable Quotes, and*

*Rambunctious Ruminations for All Walks of Life* (p. 35)

Doubleday & Company, Inc. Garden City, New York, USA. 1979

**Pirandello, Luigi** 1867–1936

Italian author

PRODUCER: Let’s get to the point, let’s get to the point. This is all chat.

FATHER: Right then! But a fact is like a sack — it won’t stand up if it’s empty. To make it stand up, first you have to put in it all the reasons and feelings that caused it in the first place.

Translated by John Linstrym

*Six Characters in Search of an Author*

Act One (p. 21)

Eyre Methuen. London, England. 1979

**Pisarev, Dmitry**

No biographical data available

For one man to discover a fruitful fact a hundred must burn up their lives in unsuccessful search and sad error.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Planck, Max** 1858–1947

German physicist

Nothing is more interesting to the true theorist than a fact which directly contradicts a theory generally accepted up to that time, for this is his particular work.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

New Paths of Physical Knowledge (p. 46)

Methuen & Company Ltd. London, England. 1925

**Plautus** ca. 254 BCE–184 BCE

Roman playwright

*Res ipsa testit.*

Facts speak for themselves.

*Aulularia*

1, 421

B.G. Trubner. Stuttgart, Germany. 1983

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Well, this is one of the characteristics by which we recognize the facts which yield great results. They are those which allow of these happy innovations of language. The crude fact then is often of no great interest; we may point it out many times without having rendered great services to science. It takes value only when a wiser thinker perceives the relation for which it stands, and symbolizes it by a word.

*The Foundations of Science*

Science and Method, Book I

Chapter II (p. 375)

The Science Press. New York, New York, USA. 1913

The importance of a fact is known by its fruits, that is to say, by the amount of thought which it enables us to economize.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 125)

Government Printing Office. Washington, D.C. 1910

The historian, the physicist, even, must make a choice among facts; the head of the scientist, which is only a corner of the universe, could never contain the universe entire; so that among the innumerable facts nature offers, some will be passed by, others retained.

*The Foundations of Science*

Science and Method, Book I

Chapter II (p. 369)

The Science Press. New York, New York, USA. 1913

The facts of greatest outcome are those we think simple; may be they really are so, because they are influenced only by a small number of well-defined circumstances, may be they take on an appearance of simplicity because the various circumstances upon which they depend obey the laws of chance and so come to mutually compensate.

*The Foundations of Science*

Science and Method, Book IV

General Conclusion (pp. 544–545)

The Science Press. New York, New York, USA. 1913

Science is built up of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house.

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 127)

The Science Press. New York, New York, USA. 1913

Facts are sterile until there are minds capable of choosing between them and discerning those which conceal something and recognizing that which is concealed; minds which under the bare fact see the soul of the fact.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (pp. 124–125)

Government Printing Office. Washington, D.C. 1910

The mere fact is oftentimes without interest; it has been noted many times, but has rendered no service to science; it becomes of value only on that day when some happily advised thinker perceives a relationship which he indicates and symbolizes by a word.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 128)

Government Printing Office. Washington, D.C. 1910

The scientific fact is only the crude fact translated into a convenient language.

*The Foundations of Science*

The Value of Science, Part III

Chapter X (p. 330)

The Science Press. New York, New York, USA. 1913

An isolated fact can be observed by all eyes; by those of the ordinary person as well as of the wise. But it is the true physicist alone who may see the bond which unites several facts among which the relationship is important though obscure.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 124)

Government Printing Office. Washington, D.C. 1910

...the most interesting facts are those which may serve many times; these are the facts which have a chance of coming up again. We have been so fortunate as to be born in a world where there are such.

*The Foundations of Science*

Science and Method, Book I

Chapter I (p. 363)

The Science Press. New York, New York, USA. 1913

A fact is a fact.

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 128)

The Science Press. New York, New York, USA. 1913

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist philosopher and social scientist

Just as the eye sees details that are not there if they fit in with the sense of the picture, or overlooks them if they make no sense, so also very little inherent certainty will suffice to secure the highest scientific value to an alleged fact, if only it fits in with a great scientific generalization, while the most stubborn facts will be set aside if there is no place for them in the established framework of science.

*Personal Knowledge*

Chapter 6, Section 2 (p. 138)

Harper &amp; Row, Publishers. New York, New York, USA. 1962



**Queneau, Raymond** 1903–76  
French poet, novelist, and publisher

I beg to advise you of the following facts of which I happen to be the equally impartial and horrified witness.

*Exercises in Style*

Official Letter (p. 54)

New Direction Publishing Corporation. New York, New York, USA. 1981

**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

Without facts we have no science. Facts are to the scientist what words are to the poet. The scientist has a love of facts, even isolated facts, similar to a poet's love of words. But a collection of facts is not a science any more than a dictionary is poetry. Around his facts the scientist weaves a logical pattern or theory which gives the facts meaning, order and significance.

*Atlantic Monthly*

Faith in Science, Volume 187, January 1951

**Ramón y Cajal, Santiago** 1852–1934  
Spanish neuropathologist

Hypotheses pass, but facts remain. Theories desert us, facts defend us.

*Advice for a Young Investigator*

Chapter 5 (p. 86)

The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rhodes, Frank H. T.**

No biographical data available

**Stone, Richard O.**

No biographical data available

Science, it is generally asserted, is concerned with facts. But ultimately there is nothing in Nature labeled "fact." Facts represent human abstractions, and our recognition and understanding of facts are based upon individual perception and experience.

*Language of the Earth*

Chapter 2 (p. 45)

Pergamon Press. New York, New York, USA. 1981

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

With solid facts on hand one may have only one undisputed explanation; with no facts, there can be a dozen argumentative ones.

*Encyclopedia of Thoughts*

Aphorisms 2411

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Russell, Bertrand Arthur William** 1872–1970  
British philosopher, logician, and social reformer

A fact, in science, is not a mere fact, but an instance.  
*The Scientific Outlook*

Chapter II (p. 59)

George Allen & Unwin Ltd. London, England. 1931

**Sayers, Dorothy L.** 1893–1957  
English novelist and essayist

To suppress a fact is to publish a falsehood.

*Gaudy Night*

Chapter XVII (p. 257)

Victor Gollancz Ltd. London, England. 1949

Yes, my lord. My old mother...always says...that facts are like cows. If you look them in the face hard enough they generally run away. She is a very courageous woman, my lord.

*Clouds of Witness*

Chapter IV (p. 86)

Harper & Row, Publishers. New York, New York, USA. 1955

"Must have facts," said Lord Peter, "facts. When I was a small boy I always hated facts. Thought of 'em as nasty, hard things, all knobs. Uncompromisin'."

*Clouds of Witness*

Chapter IV (p. 86)

Harper & Row, Publishers. New York, New York, USA. 1955

...a false statement of fact, made deliberately, is the most serious crime a scientist can commit...

*Gaudy Night*

Chapter XVII (p. 259)

Victor Gollancz Ltd. London, England. 1949

**Schneer, Cecil J.** 1923–  
American science historian and mineralogist

...science crossed the divide from the tidy, cultivated garden of classical thought to a new thicket of stubborn, irreducible fact.

*Mind and Matter: Man's Changing Concepts of the Material World*

Chapter 13 (p. 220)

Grove Press. New York, New York, USA. 1969

**Schuchert, C.**

No biographical data available

Facts are facts and it is from facts that we make our generalizations, from the little to the great, and it is wrong for a stranger to the facts he handles to generalize from them to other generalizations.

In W.A.J.M. Waterschoot van der Gracht, et. al.(eds.)

*Theory of Continental Drift: A Symposium on The Origin and Movement of Land Masses...*

The Hypothesis of Continental Displacement (p. 139)

The American Association of Petroleum Geologists. Tulsa, Oklahoma, USA. 1928

**Shamos, Morris H.**

No biographical data available

Perhaps the greatest injustice that can be done to science is to regard it merely as a collection of facts, and the practice of science as little more than the routine

accumulation of minutiae. It is true that science deals with hard, inflexible facts, but it has also to do with very general ideas and abstract principles; and it is the co-ordination of these ideas and observed facts that is the essence of modern science. Facts alone do not constitute a science. Nature Study is not the same as the study of nature.

*Rethinking Science Education*

Science and the Humanities (p. 5)

National Society for the Study of Education. 1960

### Shapere, Dudley

No biographical data available

One of the chief motivations behind the attempt to defend a distinction between theoretical and observational terms has been the desire to explain how a theory can be tested against the data of experience, and how one theory can be said to “account for the facts” better than another; that is, to give a precise characterization of the idea, almost universally accepted in modern times, that the sciences are “based on experience,” that they are “empirical.”

*Philosophical Problems of Natural Science*

Introduction, Section VI (p. 15)

The Macmillan Company. New York, New York, USA. 1965

### Shaw, George Bernard 1856–1950

Irish comic dramatist and literary critic

PATIOKIM: In Russia we face facts.

EDSTATON: In England, sir, a gentleman never faces any fact if they are unpleasant facts.

PATIOKIM: In real life, all facts are unpleasant.

*Complete Plays with Prefaces* (Volume 4)

Great Catherine, Scene I

Dodd, Mead. New York, New York, USA. 1963

Facts mean nothing by themselves. All the people at present crowding the Strand are facts. Nobody can possibly know the facts. Naturalists collect a few. Men of genius select a fewer few, and lo! a drama or a hypothesis. Genius is a sense of values and significances (the same thing). Without this sense facts are useless mentally. With it a Goethe can do more with ten facts than an encyclopedia compiler with ten thousand.

In J. Percy Smith (ed.)

*Selected Correspondence of Bernard Shaw*

Letter to H.G. Wells, 2 August 1929 (pp. 152–153)

University of Toronto Press. Toronto, Ontario, Canada. 1995

But an Englishman was not daunted by facts. To explain why all the lines in his rectilinear universe were bent, he invented a force called gravitation and thus erected a complete British universe and established it as a religion which was devoutly believed in for 300 years. The book of this Newtonian religion was not that oriental magic thing, the Bible. It was that British and matter-of-fact thing, a Bradshaw [a British railway timetable]. It gives the stations of all the heavenly bodies, their distances, the

rates at which they are traveling, and the hour at which they reach eclipsing points or crash into the earth like Sirius. Every time is precise, ascertained, absolute and English.

In B. Patch

*Thirty Years with G.B.S.*

Chapter Twelve (p. 235)

Dodd, Mead & Company. New York, New York, USA. 1951

A mere fact will never stop an Englishman.

Speech

October 28, 1930

### Siegel, Eli 1902–78

American philosopher, poet, critic and founder of Aesthetic Realism

The facts never give up.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #418 (p. 156)

Definition Press. New York, New York, USA. 1972

Facts are always whispering, uttering, and shouting advice.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #387 (p. 152)

Definition Press. New York, New York, USA. 1972

### Smedley, F. E.

No biographical data available

...the facts, the stubborn, immovable facts.

*Frank Fairleigh or, Scenes from the Life of a Private Pupil*

Chapter 49

A. Hall. London, England. 1850

### Smith, George Otis 1871–1944

American geologist

Facts that have aged in the course of their collection and preparation for consumption are likely to be too stale for practical use. Dating an egg doesn't keep it good.

What are the Facts?

*Civil Engineering*, Volume 2, Number 3, March 1932 (p. 155)

In this partnership of engineer and economist, it will be the engineer's part to furnish most of the facts. The engineer calls them “plain” facts, because they do not lend themselves to display as readily as theoretical phrases. He uses facts, not pieces on a chessboard to be moved back and forth in a contest of wits, but rather as foundation stones to be assembled in orderly fashion to hold up the superstructure of conclusions.

What are the Facts?

*Civil Engineering*, Volume 2, Number 3, March 1932 (p. 155)

...statistics need to be much more than the output of a battery of adding machines. The ideal collection of facts is the man who has spent years as a specialist in the work and in this way knows the reality behind the words and figures. Only the personal touch that comes from intimate familiarity with facts at their source can give life to statistics.

What are the Facts?

*Civil Engineering*, Volume 2, Number 3, March 1932 (p. 154)

**Smollett, Tobias George** 1721–71

Scottish novelist

Facts are facts, as the saying is.

*The Life and Adventures of Sir Launcelot Greaves*

Chapter III (p. 20)

Oxford University Press, Inc. London, England. 1973

**Snow, Charles Percy** 1905–80

English novelist and scientist

I saw a medley of haphazard facts fall into line and order...“But it’s true,” I said to myself. “It’s very beautiful. And it’s true.”

*The Search* (p. 27)

Charles Scribner’s Sons. New York, New York, USA. 1958

A fact is a fact is a fact.

*The Two Cultures: And a Second Look*

Chapter 4 (p. 45)

At The University Press. Cambridge, England. 1964

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

...you have your little handful of facts, little bits of a puzzle, and you sit and think, and fit ‘em together this way and that, and get up and throw ‘em down, and say damn, and go out for a walk.

*The Letters of Robert Louis Stevenson*

Chapter XII

Letter to Edmund Gosse

June 10, 1893 (p. 211)

Charles Scribner’s Sons. New York, New York, USA. 1917

**Stoppard, Tom** 1937–

Czech-born English playwright

Comment is free but facts are an expense.

*Night and Day*

Act 2

Faber & Faber Ltd. London, England. 1978

**Streatfield, Mr. Justice Geoffrey**

No biographical data available

Facts speak louder than statistics.

Sayings of the Week

*The Observer*, 19 March, 1950

**Szilard, Leo** 1898–1964

Hungarian-born American nuclear physicist

“I don’t intend to publish it; I am merely going to record the facts for the information of God.”

“Don’t you think God knows the facts?” Bethel asked.

“Yes,” said Szilard. “He knows the facts, but He does not know this version of the facts.”

*The Collected Works of Leo Szilard: Scientific Papers* (Volume 1)

Preface (p. xix)

MIT Press. Cambridge, Massachusetts, USA. 1972

**Tansley, A. G.** 1917–

English ecologist

We must never conceal from ourselves that our concepts are creations of the human mind which we impose on the facts of nature, that they are derived from incomplete knowledge, and therefore will never exactly fit the facts, and will require constant revision as knowledge increases.

The Classification of Vegetation and the Concept of Development

*Journal of Ecology*, Volume 8, Number 2, June 1920 (p. 120)

**Teall, J. J. Harris** 1849–1924

British geologist

Armchair philosophy, apart from actual work in the field, the laboratory, and the museum, is by no means to be commended. But the worship of fact, as fact, may easily be overdone. The number of discoverable facts is practically infinite, and it is therefore possible to get into such a condition as not to be able to see the wood for the trees, to lose the due sense of proportion, and to become mere machines for tabulating interminable trivialities.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

The Evolution of Petrological Ideas (p. 289)

Government Printing Office. Washington, D.C. 1903

**Terence** 190 BCE–158 BCE

Roman comic dramatist

Let us look at the facts.

*Adelphoe*, 1. 796

Cambridge University Press. Cambridge, England. 1976

**Thompson, Elihu** 1853–1937

American electrical engineer

Scientific facts are of little value in themselves. Their significance is their bearing upon other facts, enabling us to generalize and so to discover principles, just as the accurate measurement of the position of a star may be without value in itself, but in relation to other similar measurement of other stars may become the means of discovering their proper motions. We refine our instruments; we render more trustworthy our means of observation; we extend our range of experimental inquiry, and thus lay the foundation for the future work, with the full knowledge that, although our researches can not extend beyond certain limits, the field itself is, even within those limits, inexhaustible.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*

The Field of Experimental Research (p. 130)

Government Printing Office. Washington, D.C. 1901

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Conventionalities are at length as bad as impurities. Even the facts of science may dust the mind by their dryness, unless they are in a sense effaced each morning, or rather rendered fertile by the dews of fresh and living truth.

*The Writings of Henry David Thoreau* (Volume 4)

Life Without Principle (p. 475)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Let us not underrate the value of a fact; it will one day flower in a truth. It is astonishing how few facts of importance are added in a century to the natural history of any animal. The natural history of man himself is still being gradually written.

*The Writings of Henry David Thoreau* (Volume 9)

Natural History of Massachusetts (p. 161)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

## Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910

American author and humorist

For a forgotten fact is news when it comes again.

*Following the Equator* (Volume 2)

Chapter XXII (p. 259)

Harper & Brothers Publishers. New York, New York, USA. 1899

Get your facts first and...then you can distort them as much as you please.

In Rudyard Kipling

*From Sea to Sea*

An Interview with Mark Twain (p. 180)

Doubleday, Page & Company. Garden City, New York, USA. 1912

The mere knowledge of a fact is pale; but when you come to realize your fact, it takes on color. It is all the difference between hearing of a man being stabbed to the heart, and seeing it done.

*A Connecticut Yankee in King Arthur's Court*

Chapter VI (p. 42)

Harper & Brothers Publishers. New York, New York, USA. 1899

How empty is theory in the presence of fact!

*A Connecticut Yankee in King Arthur's Court*

Chapter XLIII (p. 396)

Harper & Brothers. New York, New York, USA. 1899

In the space of one hundred and seventy six years, the Lower Mississippi has shortened itself two hundred and forty two miles. That is an average of a trifle over one mile and a third per year. Therefore, any calm person, who is not blind or idiotic, can see that in the Old Oolitic Silurian Period, just a million years ago next November, the Lower Mississippi river was upwards of one million three hundred miles long, and stuck out over the Gulf of Mexico like a fishing rod. And by the same token any person can see that seven hundred forty two years from now the Lower Mississippi will be only a mile and three quarters long, and Cairo and New Orleans will have joined their streets together, and be plodding comfortably along under a single mayor and a mutual board of

aldermen. There is something fascinating about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact.

*Life on the Mississippi*

Chapter XVII (p. 156)

Harper & Row, Publishers. New York, New York, USA. 1951

...if you are going to find out the facts of a thing, what's the sense in guessing out what ain't the facts and wasting ammunition? I didn't lose no sleep.

*Tom Sawyer Abroad; Tom Sawyer, Detective and Other Stories, etc., etc.*

Tom Sawyer, Detective

Chapter II (p. 123)

Harper & Brothers. New York, New York, USA. 1902

...always dress a fact in tights, never in an ulster...

*Life on the Mississippi*

Chapter XXXIV (pp. 294–295)

Harper & Row, Publishers. New York, New York, USA. 1951

## Tyndall, John 1820–93

Irish-born English physicist

It is as fatal as it is cowardly to blink facts because they are not to our taste.

*Fragments of Science* (Volume 2)

Chapter XIV (p. 378)

P.F. Collier & Son. New York, New York, USA. 1902

...the brightest flashes in the world of thought are incomplete until they have been proved to have their counterparts in the world of facts.

*Fragments of Science* (Volume 2)

Chapter VI (p. 84)

P.F. Collier & Son. New York, New York, USA. 1902

## Valéry, Paul 1871–1945

French poet and critic

A faultily observed fact is more treacherous than a faulty train of reasoning.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

Moralites, Analects (p. 191)

Princeton University Press. Princeton, New Jersey, USA. 1971

## Virchow, Rudolf Ludwig Karl 1821–1902

German pathologist and archaeologist

The naked facts are doubtful weapons.

Translated by Leland J. Rather

*Disease, Life, and Man*

Scientific Method and Therapeutic Standpoints (p. 45)

Stanford University Press. Stanford, California, USA. 1958

## von Helmholtz, Hermann 1821–94

German scientist and philosopher

It is not enough to be acquainted with the facts; scientific knowledge begins only when their laws and their causes are unveiled.

*Popular Lectures on Scientific Subjects*

Lecture I

Volume 2, 1846 (p. 13)  
D. Appleton & Company. New York, New York, USA. 1885

Isolated facts and experiments have in themselves no value, however great their number may be. They only become valuable in a theoretical or practical point of view when they make us acquainted with the law of a series of uniformly recurring phenomena.

*Popular Lectures on Scientific Subjects*  
Lecture VIII (p. 368)

D. Appleton & Company. New York, New York, USA. 1885

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

With the simplest statements of scientific facts there must ever mingle a certain eloquence. Nature herself is sublimely eloquent. The stars as they sparkle in the firmament fill us with delight and ecstasy, and yet they all move in orbits marked out with mathematical precision.

In Julius Löwenberg, Robert Avé-Lallemant, Alfred Wilhelm Dove (ed.)  
Translated by Jane and Caroline Lassell  
Life of Alexander von Humboldt: Compiled in Commemoration of the Centenary of His Birth (Volume 2)  
Letter 28 April 1841 Varnhagen von Ense  
Longman's, Green & Company, New York, New York, USA; 1873

**Webb, Jack** 1920–82  
American actor and television producer

Just the facts, Ma'm.  
*Dragnet*  
Television program

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian and sociologist

Facts are the raw materials and not the substance of science.

*The Discovery of the Future* (p. 35)  
B.W. Huebsch. New York, New York, USA. 1913

**West, Jessamyn** 1902–84  
American writer

We want the facts to fit the preconceptions. When they don't, it is easier to ignore the facts than change the preconceptions.

*The Quaker Reader*  
Introduction (p. 2)  
The Viking Press. New York, New York, USA. 1962

**Whatley, Richard** 1787–1863

No matter of fact can be mathematically demonstrated, though it may be proved in such a manner as to leave no doubt on the mind.

*The Elements of Logic*  
IV  
John W. Parker & Son. London, England. 1853

**Whewell, William** 1794–1866  
English philosopher and historian

When we inquire what Facts are to be made the materials of Science, perhaps the answer which we should most commonly receive would be, that they must be True Facts, as distinguished from any mere inferences or opinions of our own.

*Novum Organon Renovatum*  
Chapter III (pp. 50–51)  
John W. Parker & Son. London, England. 1858

...in order that the facts obtained by observation and experiment may be capable of being used in furtherance of our exact and solid knowledge, they must be apprehended and analysed according to some Conception which, applied for this purpose, gives distinct and definite results, such as can be steadily taken hold of and reasoned from...

*The Philosophy of the Inductive Sciences Founded Upon their History*  
(Volume 2)  
Book XI, Chapter III (p. 39)  
John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

They remain "stubborn fact" ...  
*Adventures of Ideas*  
Chapter XV (p. 405)  
The Macmillan Company. New York, New York, USA. 1956

There is nothing in the real world which is merely an inert fact...

*Process and Reality: An Essay in Cosmology*  
Part IV, Part IV, Section I (p. 472)  
The Macmillan Company. New York, New York, USA. 1929

...irreducible and stubborn facts...  
*Science and the Modern World*  
Chapter I (p. 4)  
The Macmillan Company. New York, New York, USA. 1929

A chain of facts is like a barrier reef. On one side there is wreckage, and beyond it harborage and safety.

*Process and Reality: An Essay in Cosmology*  
Part III, Chapter I, Section IV (p. 341)  
The Macmillan Company. New York, New York, USA. 1929

**Whyte, Lancelot Law** 1896–1972  
Scottish Physicist

Science does not begin with facts; one of its tasks is to uncover the facts by removing misconceptions.

*Accent on Form: An Anticipation of the Science of Tomorrow*  
Chapter IV (p. 60)  
Harper & Brothers. New York, New York, USA. 1954

The true aim of science is to discover a simple theory which is necessary and sufficient to cover the facts, when they have been purified of traditional prejudices.

*Accent on Form: An Anticipation of the Science of Tomorrow*

Chapter IV (p. 59)  
Harper & Brothers Publishers. New York, New York, USA. 1954

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Facts fled before philosophy like frightened forest things.

*The Picture of Dorian Gray*  
Chapter 3 (p. 47)  
The Modern Library. New York, New York, USA. 1992

Facts are not merely finding a footing-place in history, but they are usurping the domain of Fancy, and having invaded the kingdom of Romance. Their chilling touch is over everything. They are vulgarizing mankind.

*The Works of Oscar Wilde* (Volume 10)  
Intentions  
The Decay of Lying (p. 27)  
AMS Press. New York, New York, USA. 1909

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

The world divides into facts.  
Translated by D.F. Pears & B.F. McGuinness  
*Tractatus Logico-Philosophicus*  
1.2 (p. 7)  
Routledge & Kegan Paul. London, England. 1961

The world is the totality of facts, not of things.  
Translated by D.F. Pears & B.F. McGuinness  
*Tractatus Logico-Philosophicus*  
1.1 (p. 7)  
Routledge & Kegan Paul. London, England. 1961

**Wright, Chauncey** 1830–75  
American philosopher of science

True science deals with nothing but questions of facts...  
In James Bradley Thayer  
*Letters of Chauncey Wright, with Some Account of His Life*  
Letter of August 13, 1867 to F.E. Abbot (p. 113)  
Press of John Wilson & Son. Cambridge, England. 1878

## FACTOR

**Milne, A. A. (Alan Alexander)** 1882–1956  
English poet, children's writer, and playwright

Suddenly Christopher Robin began to tell Pooh about some of the things: People called Kings and Queens and something called Factors...

*The Complete Tales & Poems of Winnie-the-Pooh*  
The House at Pooh Corner (p. 337)  
Dutton Children's Books. New York, New York, USA. 2001

...and then, as Pooh seemed disappointed, he added quickly, "but it's grander than Factors."

*The Complete Tales & Poems of Winnie-the-Pooh*  
The House at Pooh Corner (p. 175)  
Dutton Children's Books. New York, New York, USA. 2001

## FAILURE

**Dewey, John** 1859–1952  
American philosopher and educator

Failure is instructive. The person who really thinks learns quite as much from his failures as from his successes.

In Larry H. Hickman and Thomas M. Alexander (eds.)  
*Essential Dewey* (Volume 2) (p. 142)  
Indiana University Press. Bloomington, Indiana, USA. 1998

**Huxley, Thomas Henry** 1825–95  
English biologist

...there is the greatest practical benefit in making a few failures early in life.

*Collected Essays* (Volume 3)  
*Science and Education*  
On Medical Education (p. 306)  
Macmillan & Company Ltd. London, England. 1904

**Rossman, Joseph**  
Inventor

One seldom perfects an idea without many failures...  
*Industrial Creativity: The Psychology of the Inventor*  
Chapter IV (p. 45)  
University Books. New Hyde Park, New York, USA. 1964

**Ruskin, John** 1819–1900  
English writer, art critic, and social reformer

Failure is less attributable to either insufficiency of means or impatience of labours than to a confused understanding of the thing actually to be done.

In Henry Attwell  
*Thoughts from Ruskin*  
17 (p. 12)  
Longman's, Green & Company, New York, New York, USA; 1901

**Starling, E. H.**  
No biographical data available

Every discovery, however important and apparently epoch-making, is but the natural and inevitable outcome of a vast mass of work, involving many failures, by a host of different observers, so that if it is not made by Brown this year it will fall into the lap of Jones, or of Jones and Robinson simultaneously, next year or the year after.

Discovery and Research  
*Nature*, Volume 113, Number 2843, April 1924 (p. 606)

## FAITH OF SCIENCE

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Reasoning leads us from premises to conclusion; it cannot start without premises.... [W]e...must believe that we have an inner sense of values which guides us as to what is to be heeded, otherwise we cannot start on our

survey even of the physical world.... At the very beginning there is something which might be described as an act of faith — a belief that what our eyes have to show us is significant.

*Science and the Unseen World*

Chapter VI (pp. 73–74)

The Macmillan Company. New York, New York, USA. 1929

**Ferris, Timothy** 1944–

American science writer

To say that nature is comprehensible to us, that science is not deluding itself, is an assertion of faith — ‘reason is one of the articles of faith,’ said Eddington — but there is nothing wrong with that. After all, we are part of the universe. And the faith of science — that the seamless wave of nature will reveal itself to our reasoned inquiry — that faith is part of the universe too.

*The Red Limit: The Search for the Edge of the Universe*

Chapter 10 (p. 245)

William Morrow & Company, Inc. New York, New York, USA. 1977

**Planck, Max** 1858–1947

German physicist

Science demands also the believing spirit. Anybody who has been seriously engaged in scientific work of any kind realizes that over the entrance to the gates of the temple of science are written the words: Ye must have faith. It is the quality which the scientist cannot dispense with.

*Where Is Science Going?*

Epilogue (p. 214)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

...if we did not have faith but could solve puzzle in life by an application of the human reason, what an unbearable burden life would be.

*Where Is Science Going?*

Epilogue (p. 218)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

There cannot be any issue between faith and science, for science and faith mutually exclude one another; not in the sense that the one renders the other impossible, or vice versa, but rather that so far as science extends faith does not exist, and faith begins where science leaves off.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 52)

Macmillan & Company Ltd. London, England. 1918

**Wiener, Norbert** 1894–1964

American mathematician

A faith which we follow upon orders imposed from outside is no faith, and a community which puts its

dependence upon such a pseudo-faith is ultimately bound to ruin itself because of the paralysis which the lack of a healthily growing science imposes upon it.

The Human Use of Human Beings

Chapter XI (p. 193)

Da Capo Press. New York, New York, USA. 1988

**FALLACY**

**Goddard, Robert H.** 1882–1945

American physicist

The only antidote for fallacies is — in a word — to take nothing for granted.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted (p. 64)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Huxley, Thomas Henry** 1825–95

English biologist

There are men (and I think Priestley was one of them) to whom the satisfaction of throwing down a triumphant fallacy is as great as that which attends the discovery of a new truth; who feel better satisfied with the government of the world, when they have been helping Providence by knocking an imposture on the head; and who care even more for freedom of thought than for mere advance of knowledge. These men are the Carnots who organise victory for truth, and they are, at least, as important as the generals who visibly fight her battles in the field.

*Collected Essays* (Volume 3)

*Science and Education*

Joseph Priestley (p. 13)

Macmillan & Company Ltd. London, England. 1904

**FAME**

**Rubin, Vera** 1928–

American astronomer

Fame is fleeting. My numbers mean more to me than my name. If astronomers are still using my data years from now, that’s my greatest compliment.

*Discover*, October 1990

**FART**

**Maxwell, Gavin** 1914–69

Scottish naturalist

Then it came again, thunderous, earthshattering, the longest, loudest and most superbly stupendous fart that I have ever heard in my life, a sound of such magnificent and prolonged volume as to appear utterly beyond human capability.

*Raven Seek Thy Brother* (p. 38)

E.P. Dutton & Company. New York, New York, USA. 1969

**FAULT****The Bible**

...the Mount of Olives...will be cleft in two by an immense valley running east and west; half the mount will move northward and half southwards.

*The Revised English Bible*

Zechariah 14:4

Oxford University Press, Inc. Oxford, England. 1989

**FEE**

**da Costa, J. Chalmers** 1863–1933

American physician

A fashionable surgeon, like a pelican, can be recognized by the size of his bill.

*The Trials and Triumphs of the Surgeon*

Chapter 1 (p. 38)

Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

**de Mondeville, Henri** 1260–1320

French pioneer surgeon

Never dine with a patient who is in your debt, but get your dinner at an inn, otherwise he will deduct his hospitality from your fee.

In Samuel Evans Massengill

*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 307)

The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

**Dunne, Finley Peter** 1867–1936

American journalist and humorist

I wondher why ye can always read a doctor's bill an' ye niver can read his purscription?

*Mr. Dooley Says*

Drugs (pp. 93–94)

Charles Scribner's Sons. New York, New York, USA. 1910

**Fielding, Henry** 1707–54

English novelist, playwright, and barrister

So little then did our doctors delight in death that they discharged the corpse after a single fee.

*The History of Tom Jones: A Foundling* (Volume 1)

Book II, Chapter 9 (p. 86)

P.F. Collier & Son Company. New York, New York, USA. 1917

**Graves, Richard**

No biographical data available

Three doctors, met in consultation,  
Proceed with great deliberation;  
The case was desperate, all agreed,  
But what of that? they must be fee'd.  
They write then (as't was fit they shou'd)  
But for their own, not patients' good.  
Consulting wisely (don't mistake, sir)

Not what to give, but what to take, sir.

In William Davenport Adams

*English Epigrams*

The Consultation, cclxxxii

G. Routledge. London, England. 1878

**Hazlitt, William Carew** 1834–1913

English bibliographer

A Physitian demanded money of another for one of his patients that was dead long before. He was answered that it was a worke of chairty to visit the sick; but if he was so earnest for money, the only way was for him to visit the dead, and then he would never want money more.

*Shakespeare Jest Books* (Volume 3)

Conceit, Clichés, Flashes and Whimzies, Number 176

Willis & Sotheran. London, England. 1864

One asked a man whether he had swallowed a Doctor of Phisickes bill, because hee spoke such hard words.

*Shakespeare Jest Books* (Volume 3)

Conceit, Clichés, Flashes and Whimzies, Number 9

Willis & Sotheran. London, England. 1864

**Hood, Thomas** 1582–98

English poet and editor

The doctor and saw the case

Plain as the nose not on his face.

“O! hum — ha — yes — I understand.”

But then arose a long demur,

For not a finger would he stir

Till he was paid his fee in hand;

That matter settled, there they were,

With Hunks well strapp'd upon his chair.

*The Complete Poetical Works of Thomas Hood*

A True Story, Stanza 12

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**McElwee, Tom**

No biographical data available

Cardiologist's Fee — Heart-earned money.

*Quote, the Weekly Digest*, June 2, 1968 (p. 437)

**Morris, Robert Tuttle** 1857–1945

American abdominal surgeon

One must not count upon all of his patients being willing to steal in order to pay doctor's bills.

*Doctors versus Folks*

Chapter 3

Doubleday, Page & Company. Garden City, New York, USA. 1915

**Syminges, John**

Before you meddle with him, make your bargain wisely, now he is in pain, for he is but a bad pay-master, and therefore follow this rule: Get your money while he's ill, for when he's well you never will.

*John Donne and the Ancient Catholic Nobility*



Part I, Chapter 4 (p. 75)  
Indiana University Press. Bloomington, Indiana, USA. 1995

## FERMAT'S THEOREM

**de Fermat, Pierre** 1601–65  
French mathematician

But it is impossible to divide a cube into two cubes, or a fourth power into two fourth powers, or generally any power beyond the square into two like powers; of this I have found a remarkable demonstration. This margin is too narrow to contain it.

*Oeuvres*  
Volume 1 (p. 291)  
Gauthier-Villars et Fils. Paris. 1891

**Wiles, Andrew** 1953–  
English-born American mathematician

I had this very rare privilege of being able to pursue in my adult life what had been my childhood dream. I know it's a rare privilege, but if you can tackle something in adult life that means that much to you, then it's more rewarding, than anything imaginable. Having solved this problem there's certainly a sense of loss, but at the same time there is this tremendous sense of freedom. I was so obsessed by this problem that for eight years I was thinking about it all the time — when I woke up in the morning to when I went to sleep at night. That's a long time to think about one thing. That particular odyssey is not over. My mind is at rest.

In Simon Singh  
*Fermat's Enigma*  
Epilogue (p. 285)  
Walker & Company. New York, New York, USA. 1997

## FERMENTATION

**Boorse, Christopher**  
Philosopher

...the actual function in fermentation is to produce enzymes which catalyze the conversion of sugar to carbon dioxide and alcohol. Presumably, then, that has always been the function of yeast in brewing devices. It did not suddenly acquire this function with the advent of chemical theory. But brewers with no knowledge of enzymes cannot intend their yeast to produce them.

Wright on Functions  
*The Philosophical Review*, Volume 85, Number 1, January 1976 (p. 73)

## FETUS

**Bagnold, Enid** 1889–1981  
English novelist and playwright

Hanging head downwards between cliffs of bone, was the baby, its arms all but clasped about its neck, its face

aslant upon its arms, hair painted upon its skull, closed, secret eyes, a diver poised in albumen, ancient and epic, shot with delicate spasms, as old as a Pharaoh in its tomb.

*The Door of Life*  
Chapter 2  
W. Morrow & Company. New York, New York, USA. 1938

## FEVER

**Colman, George (The Younger)** 1762–1836  
English playwright

The doctor looked wise: — “A slow fever,” he said: Prescribed sudorifics, — and going to bed.

“Sudorifics in bed,” exclaim'd Will, “are humbugs! I've enough of them there, without paying for drugs!”

In Helen and Lewis Melville  
*An Anthology of Humorous Verse*  
Lodgings for Single Gentlemen  
Dodd, Mead & Company New York, New York, USA. 1924

**Herold, Don** 1889–1966  
Cartoonist

The sweetest words of tongue or pen: The child is 98.6 again.

*The Happy Hypochondriac* (p. 12)  
Dodd, Mead & Company. New York, New York, USA. 1962

**Kipling, Rudyard** 1865–1936  
British writer and poet

An' that blasted Henglish drizzle wakes the fever in my bones...

*The Sahib Edition of Rudyard Kipling: Poems and Ballads*  
Mandalay (p. 133)  
P.F. Collier & Son Company. New York, New York, USA. No date

**MacFadden, Bernard** 1868–1955  
American physical culturist

If you feed a cold, as often done, you frequently have to starve a fever.

When a Cold Is Needed  
*Physical Culture*, February 1934

**Milton, John** 1608–74  
English poet

Fever, the eternal reproach to the physicians.

*The Reason of Church-Government*  
Preface  
Printed by E.G. for John Rothwell. London, England. 1641

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

Humanity has but three great enemies: fever, famine and war; of these by far the greatest, by far the most terrible, is fever.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)  
Chapter XVI (p. 435)  
Clarendon Press. Oxford, England. 1925

**Paulos, John Allen** 1945–  
American mathematician

Consider a precise number that is well known to generations of parents and doctors: the normal human body temperature of 98.6 Fahrenheit. Recent investigations involving millions of measurements reveal that this number is wrong; normal human body temperature is actually 98.2 Fahrenheit. The fault, however, lies not with Dr. Wunderlich's original measurements — they were averaged and sensibly rounded to the nearest degree: 37 Celsius. When this temperature was converted to Fahrenheit, however, the rounding was forgotten and 98.6 was taken to be accurate to the nearest tenth of a degree. Had the original interval between 36.5 and 37.5 Celsius been translated, the equivalent Fahrenheit temperatures would have ranged from 97.7 to 99.5. Apparently, discalculia can even cause fevers.

*A Mathematician Reads the Newspaper*  
Ranking Health Risks: Experts and Laymen Differ (p. 139)  
Basic Books. New York, New York, USA. 1995

**Ransom, John Crowe** 1888–1974  
American poet

Here lies a lady of beauty and high degree.  
Of chills and fever she dies, of fever and chills,  
The delight of her husband, her aunts, an infant of three,  
And of medicos marveling sweetly on her ills.

*The Poetry of John Crowe Ransom*  
Here Lies a Lady (p. 64)  
Rutgers University Press. New Brunswick, New Jersey, USA. 1972

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

He had a fever when he was in Spain,  
And when the fit was on him, I did mark  
How he did shake....

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume One)  
Julius Caesar  
Act I, Scene ii, l. 119–121  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## FIELD

**Dantzig, Tobias** 1884–1956  
Russian mathematician

Today we know that possibility and impossibility have each only a relative meaning; that neither is an intrinsic property of the operation but merely a restriction which human tradition has imposed on the field of the operand. Remove the barrier, extend the field, and the impossible becomes possible.

*Number: The Language of Science* (4<sup>th</sup> edition)  
Chapter Five, 12 (p. 89)  
The Macmillan Company. New York, New York, USA. 1954

## FIELD STUDY

**Brooks, W. K.**  
No biographical data available

Is not the biological laboratory which leaves out the ocean and the mountains and meadows a monstrous absurdity? Was not the greatest scientific generalization of your times reached independently by two men who were eminent in their familiarity with living things in their homes?

*The Foundations of Zoology*  
Lecture 2 (p. 41)  
Macmillan & Company Ltd. London, England. 1899

## FIELD THEORY

**Dijkstra, Edsger Wybe** 1930–2002  
Dutch computer scientist

The fathers of the field had been pretty confusing: John von Neumann speculated about computers and the human brain in analogies sufficiently wild to be worthy of a medieval thinker, and Alan Turing thought about criteria to settle the question of whether machines can think, a question of which we now know that it is about as relevant as the question of whether submarines can swim.

ACN South Central Regional Conference  
Austin, Texas, 16–18 November 1984

## FIELD WORK

**Woolley, Sir Charles Leonard** 1880–1960  
English archaeologist

All about one as one digs there is the atmosphere of the historic past and of the still living world wherein that history took shape; and if out of all this a man cannot reap a harvest for the widening and the delight of his own soul he must be a purblind creature and poorly suited to his task — for him and through him there can be no stirring and murmur of new life in the valley of dry bones where he works.

*Dead Towns and Living Men: Being Pages from an Antiquary's Notebook*  
Introduction (p. 10)  
Philosophical Library. New York, New York, USA. 1956

## FIELDS

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

One could say that gravitational forces, like electromagnetic forces, are long range, in that they fall off slowly with distance, and that this suggests one make a theory of gravitation, which is a natural analogue of the intuitive pictures of Faraday and the equations of Maxwell which describe electromagnetism, electromagnetic waves, and the fields around magnets and charges. The principle point of difference for which one must allow from the beginning is this: that two like charges repel each other, whereas all masses attract each other.

*The Flying Trapeze: Three Crises for Physics*

Space and Time (p. 26)

Oxford University Press, Inc. London, England. 1964

## FIGURE

**Carlyle, Thomas** 1795–1881

English historian and essayist

A witty statesman said you might prove anything by figures.

*English and Other Critical Essays*

Chartism, Chapter II (p. 170)

J. M. Dent & sons Ltd. London, England. 1950

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

Grown-ups love figures. When you tell them that you have made a new friend, they never ask you any questions about essential matters. They never say to you, “What does his voice sound like? What games does he love best? Does he collect butterflies?” Instead, they demand: “How old is he? How many brothers has he? How much does he weigh? How much money does his father make?” Only from these figures do they think they have learned anything about him.

Translated by Katherine Woods

*The Little Prince*

Chapter IV (p. 17)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Hopkins, Harry**

No biographical data available

Figures are faceless and incestuous.

*The Numbers Game: The Bland Totalitarianism*

Chapter 1 (p. 15)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Huxley, Aldous** 1894–1963

English writer and critic

“Give them a few figures, Mr. Foster,” said the Director, who was tired of talking.

*Brave New World*

Chapter One (p. 11)

Harper & Brothers. New York, New York, USA. 1950

**Le Fèvre, Nicaise** 1610–69

Chemist and alchemist

[Fire is] the most potent Agent that Nature hath furnished us withal under Heaven, to perform the Anatomy of Mixt Bodies.

*A Compleat Body of Chemistry*

Part I (p. 75)

Printed for O. Pullyn. London, England. 1640

**Sage, M.**

No biographical data available

...battalions of figures are like battalions of men, not always as strong as is supposed.

Translated by Noraile Robertson

*Mrs. Piper and the Society for Psychological Research*

Chapter XV (p. 151)

Scott-Thaw Company. New York, New York, USA. 1904

**Tarbell, Ida** 1857–1944

American historian, journalist, and reformer

There is no more effective medicine to apply to feverish public sentiment than figures. To be sure, they must be properly proposed, must cover the case, must confine themselves to a quarter of it, and they must be gathered for their own sake, not for the sake of a theory.

*The Ways of Woman*

Chapter I (p. 3)

The Macmillan Company. New York, New York, USA. 1915

## FILTER

**Aristotle** 384 BCE–322 BCE

Greek philosopher

Make a vessel of wax and put it in the sea, fastening its mouth in such a way as to prevent any water getting in. Then the water that percolates through the wax sides of the vessel is sweet, the earth stuff, the admixture of which makes the water salt, being separated off as it were by a filter.

In *Great Books of the Western World* (Volume 8)

*Meteorology*

Book II, Chapter 3, 359a [35]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## FIRE

**Adams, George** 1750–95

English instrument maker

When the spark or atom of fire lies hid in primary matter, it is dark, deformed, and in no ways promising such a fair contexture and life as it will be clothed with when it has built it's house or body, in which it seems dormant awhile. In this sense it was *Vulcan deformis*.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture IX (p. 417)

Printed by R. Hindmarsh. London, England. 1794

**Dickinson, Emily** 1830–86

American lyric poet

Fire exists the first in light,

And then consolidates —

Only the chemist can disclose

Into what carbonates.

*The Complete Poems of Emily Dickinson*

No. 1063 (p. 484)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Fire is beautiful; some day it will be useful, I think.

*Eve's Diary*

Tuesday (p. 65)

Harper & Brothers. New York, New York, USA. 1906

## FIRMAMENT

**van Gogh, Vincent Willem** 1853–90

Dutch painter

...the stars always makes me dream, as simply as I dream over the black dots representing towns and villages on a map. Why, I ask myself, shouldn't the shining dots of the sky be as accessible as the black dots on the map of France?

*The Complete Letters of Vincent Van Gogh with Reproductions of all the Drawings in the Correspondence* (Volume 2)

Letter 506 (p. 605)

New York Graphic Society. Greenwich, Connecticut, USA. 1958

## FISSION

**Cowan, George A.**

American physical chemist

...in the design of fission reactors man was not an innovator but an unwitting imitator of nature.

A Natural Fission Reactor

*Scientific American*, Volume 235, Number 1, July 1976 (p. 47)

**Fermi, Laura** 1907–77

Italian-born American writer

The counters stepped up; the pen started its upward rise. It showed no tendency to level off. A chain reaction was taking place in the pile. In the back of everyone's mind was one avoidable question, "When do we become scared?"

*Atoms in the Family*

Part I, Chapter 13 (p. 118)

The University of Chicago Press. Chicago, Illinois, USA. 1954

**Lovelock, James Ephraim** 1919–

English scientist

In the current fashionable denigration of technology, it is easy to forget that nuclear fission is a natural process. If something as intricate as life can assemble by accident, we need not marvel at the fission reactor, a relatively simple contraption, doing likewise.

*Gaia: A New Look at Life on Earth*

Chapter 2 (p. 15)

Oxford University Press, Inc. Oxford, England. 2000

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

**Teller, Wendy**

No biographical data available

F stands for fission

That is what things do

When they get wobbly and big

And must split in two.

And just to complete

The atomic confusion,

What fission has done

Can be undone by fusion.

*Conversations on the Dark Secrets of Physics*

Epilogue (p. 215)

Plenum Press. New York, New York, USA. 1991

## FLATULENCE

**Aristophanes** 448 BCE–380 BCE

Greek playwright

My wind exploded like a thunder-clap.

...Iaso blushed a rosy red

And Panacea turned away her head

Holding her nose: my wind's not frankincense.

*Plutus*

699

At The University Press. Cambridge, England. 1913

**Sagan, Carl** 1934–96

American astronomer and author

...bovine flatulence — the intimate intestinal activities of cows, reindeer, elephants, and elk — is detectable over interplanetary distances, while the bulk of the activities of mankind are invisible. We would not ordinarily consider the flatulence of cattle as a dominant manifestation of life on Earth, but there it is.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 22 (p. 150)

Dell Publishing, Inc. New York, New York, USA. 1975

## FLIGHT

**Wilkins, Bishop John** 1614–72

Co-founder of the Royal Society

There are four several ways whereby this flying in the air hath been or may be attempted. Two of them by the strength of other things, and two of them by our own

strength: (1) By spirits, or angels. (2) By the help of fowls. (3) By wings fastened immediately to the body. (4) By a flying chariot.

In Charles Balchford Mansfield

*Aerial Navigation*

Part the Second, Chapter II (p. 191)

Macmillan & Company Ltd. London, England. 1877

## FLOWER

**Barrett-Browning, Elizabeth** 1806–61

English poet

...those tall flowering-reeds which stand

In Arno, like a sheaf of scepters left

But some remote dynasty of dead gods

To suck the stream for ages and get green.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book VII, l. 937–940

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

Flowers have an expression of countenance as much as men or animals. Some seem to smile; some have a sad expression; some are pensive and diffident; others again are plain, honest and upright, like the broad-faced sun-flower and the hollyhock.

*Star Papers*

A Discourse on Flowers (p. 100)

Books for Libraries Press. Freeport, New York, USA. 1972

He who only does not appreciate floral beauty is to be pitied like any other man who is born imperfect.

*Star Papers*

A Discourse on Flowers (p. 94)

Books for Libraries Press. Freeport, New York, USA. 1972

**Blake, William** 1757–1827

English poet, painter, and engraver

To create a little flower is the labor of ages.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell, l. 56

University of California Press. Berkeley, California, USA. 1982

Ah Sun-flower! weary of time,

Who countest the steps of the Sun:

Seeking after that sweet golden clime

Where the traveler's journey is done.

*The Complete Poetry and Prose of William Blake*

Ah! Sun-Flower

University of California Press. Berkeley, California,

USA. 1982

**Borlase, William** 1696–1772

Cornish antiquary

...the flowers and ground together make so pretty a piece of tapestry, that one might be surprised to find such colouring and workmanship hid, as it were industriously,

under a rock; but the works of Nature are every where well finished, and can not be otherwise than exact and beautiful in their degree...

*British Tunicata*, Volume 3, 1911

Printed for the Ray Society

**Bryant, William Cullen** 1794–1878

American poet

That delicate forest flower,

With scented breath and look so like a smile,

Seems, as it issues from the shapeless mould,

An emanation of the indwelling Life,

A visible token of the upholding Love,

That are the soul of this great universe.

*Poems*

A Forest Hymn

D. Appleton. New York, New York, USA. 1874

Where are the flowers, the fair young flowers,

That lately sprang and stood

In brighter light and softer airs, a beauteous sisterhood?

*Poems*

The Death of the Flowers

D. Appleton. New York, New York, USA. 1874

Loveliest of lovely things are they,

On earth, that soonest pass away.

The rose that lives its little hour

Is prized beyond the sculptured flower.

*Poems*

A Scene on the Banks of the Hudson

D. Appleton. New York, New York, USA. 1874

The little wind-flower, whose just opened eye

Is blue as the spring heaven it gazes at.

*Poems*

A Winter Piece

D. Appleton. New York, New York, USA. 1874

**Child, Lydia M.** 1802–80

American author and abolitionist

Flowers have spoken to me more than I can tell in written words. They are the hieroglyphics of angels, loved by all men for the beauty of the character, though few can decipher even fragments of their meaning.

*Letters from New York*

Letter XXVI, September 1, 1842

C.S. Francis & Company. New York, New York, USA. 1845

**Collins, Wilkie** 1824–89

English novelist

I haven't much time to be fond of anything... But when I have a moment's fondness to bestow, most times...the roses get it.

*The Moonstone*

First Period, Chapter XII (p. 86)

International Collectors Library. Garden City, New York, USA. 1900

**Cranch, Christopher Pearse** 1813–92

Unitarian minister, poet, and author

Majestic flower! How purely beautiful  
 Thou art, as rising from thy bower of green,  
 Those dark and glossy leaves so thick and full,  
 Thou standest like a high-born forest queen  
 Among thy maidens clustering round so fair...  
 I breathe the perfume, delicate and strong,  
 That comes like incense from thy petal-bower;  
 My fancy roams those southern woods along,  
 Beneath that glorious tree, where deep among  
 The unsunned leaves thy large white flowers-cups hung!

*Collected Poems of Christopher Pearse Cranch*

Poem to the Magnolia Grandiflora

Scholars' Facsimiles & Reprints. Gainesville, Florida, USA. 1971

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

Flowers are weak creatures. They are naïve. They reassure themselves as best they can. They believe that their thorns are terrible weapons...

Translated by Katherine Woods

*The Little Prince*

Chapter VII (p. 26)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Dickens, Charles** 1812–70

English novelist

The rich, sweet smell of the hayricks rose to his chamber window; the hundred perfumes of the little flower-garden beneath scented the air around; the deep-green meadows shone in the morning dew that glistened on every leaf as it trembled in the gentle air: and the birds sang as if every sparkling drop were a fountain of inspiration to them.

*The Posthumous Papers of the Pickwick Club*

Chapter VII (p. 72)

Dodd, Mead & Company. New York, New York, USA. 1944

**Disraeli, Benjamin, 1<sup>st</sup> Earl of**

**Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

I could have brought you some primroses, but I do not like to mix violets with anything.

“They say primroses make a capital salad,” said Lord St.

Jerome.

*Lothair*

Chapter XIII (p. 57)

Longmans, Green & Company. London, England. 1920

**Embury, Emma** 1806–63

American author

The gathered rose and the stolen heart

Can charm but for a day.

*The Poems of Emma C. Embury*

Ballad

Hurd & Houghton. New York, New York, USA. 1869

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

In May, when sea-winds pierced our solitudes,  
 I found the fresh Rhodora in the woods,  
 Spreading its leafless blooms in a damp nook,  
 To please the desert and the sluggish brook.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

The Rhodora (p. 37)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Chide me not, laborious band,  
 For the idle flowers I brought;  
 Every aster in my hand

Goes home loaded with a thought.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

The Apology (p. 119)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Goodale, Dora Read** 1866–1953

American poet

Now about the rugged places  
 And along the ruined way,  
 Light and free in sudden graces  
 Comes the careless trend of May, —  
 Born of tempest, wrought in power,  
 Stirred by sudden hope and fear,  
 You may find a mystic flower

In the spring-time of the year!

*All Round the Year: Verses from Sky Farm*

Trillium

G.P. Putnam's Sons. New York, New York, USA. 1881

Whence is yonder flower so strangely bright?

Would the sunset's last reflected shine

Flame so red from that dead flush of light?

Dark with passion is its lifted line,

Hot, alive, amid the falling night.

*All Round the Year: Verses from Sky Farm*

Cardinal Flower

G.P. Putnam's Sons. New York, New York, USA. 1881

**Goodale, Elaine** 1863–1953

American poet

O bloodroot! in thy tingling veins

The sap of life runs cold and clear;

I break thy shining stem, and fear

No conscious guilt, no lasting stains.

*All Round the Year: Verses from Sky Farm*

Bloodroot

G.P. Putnam's Sons. New York, New York, USA. 1881

**Hood, Thomas** 1799–1845

English poet and editor

The cowslip is a country wench.

*The Complete Poetical Works of Thomas Hood*

Flowers, Stanza I

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Keats, John** 1795–1821

English Romantic lyric poet

Here are sweet peas, on tiptoe for a flight;

With wings of gentle flush o'er delicate white,

And taper fingers catching at all things,  
To bind them all about with tiny rings.

*The Complete Poetical Works and Letters of John Keats*  
I Stood Tiptoe Upon a Little Hill, l. 57–60  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Leland, Charles G.** 1824–1903

American author

I pray your Highness mark this curious herb:  
Touch it but lightly, stroke it softly, Sir,  
And it gives forth an odour sweet and rare;  
But crush it harshly and you'll make a scent  
Most disagreeable.

*The Music-Lesson of Confucius*  
Sweet Basil, Stanza 6  
J.R. Osgood & Company. Boston, Massachusetts, USA. 1872

**Longfellow, Henry Wadsworth** 1807–82

American poet

Look at this vigorous plant that lifts its head from the  
meadow,  
See how its leaves are turned to the north, as true as the  
magnet;  
This is the compass-flower, that the finger of God has  
planted.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 2)  
Evangeline  
Part II, Stanza IV, l. 140  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

O flower-de-luce, bloom on, and let the river  
Linger to kiss thy feet!

O flower of song, bloom on, and make forever  
The world more fair and sweet.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 33)  
Flower-de-luce  
Stanza 8  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**MacDonald, George** 1824–1905

Scottish novelist and poet

The flaming rose gloomed swarthy red;  
The borage gleams more blue;  
Dim starred with white flowers, a flowering bed  
Glimmer the rich dusk through.

*The Poetical Works of George MacDonald*  
Songs of the Summer Night, Part III  
Chatto & Windus. London, England. 1893

**Millay, Edna St. Vincent** 1892–1950

American poet

I will be the gladdest thing  
Under the sun!  
I will touch a hundred flowers  
And not pick one.

*Collected Poems*  
Afternoon on a Hill (p. 33)  
Harper & Row, Publishers. New York, New York, USA. 1950

**Milton, John** 1608–74

English poet

Immortal Amarant, a Flour which once  
In Paradise, fast by the Tree of Life,  
Began to bloom, but soon for man's offence,  
To Heav'n remov'd, where first it grew, there grows,  
And flours aloft shading the Fount of Life.

*In Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book III, l. 353–357  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Muir, John** 1838–1914

American naturalist

...the lovely arctic daisy with many blessed companions;  
charming plants, gentle mountaineers, Nature's darlings,  
which seem always the finer the higher and stormier their  
homes.

*Our National Parks*  
Chapter V (p. 149)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

For all the way up the long red slate slopes, that in the  
distance seemed barren, you find little garden beds and  
tufts of dwarf phlox, ivesia, and blue arctic daisies that go  
straight to your heart, blessed fellow mountaineers kept  
safe and warm by a thousand miracles.

*Our National Parks*  
Chapter III (p. 94)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Flowers are born every hour.

In Linnie Marsh Wolfe (ed.)  
*John of the Mountains*  
Chapter II, Section 1, April 9 (p. 48)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

Around your camp fire the flowers seem to be looking  
eagerly at the light, and the crystals shine unweariedly,  
making fine company as you lie at rest in the very heart  
of the vast, serene, majestic night.

*Our National Parks*  
Chapter V (p. 163)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Pope, Alexander** 1688–1744

English poet

E'en wild heath displays her purple dyes,  
And 'midst the desert fruitful fields arise.

*The Complete Poetical Works*  
Windsor Forest, l. 25–26  
Houghton Mifflin Company. New York, New York, USA. 1903

**Rossetti, Christina Georgina** 1830–94

English poet

Flowers preach to us if we will hear.

*The Complete Poems of Christina Rossetti* (Volume 1)  
Consider the Lilies of the Field (p. 76)  
Louisiana State University Press. Baton Rouge, Louisiana, USA. 1979

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

There's rosemary...for remembrance; pray, love, remember; and...pansies, that's for thoughts.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Hamlet, Prince of Denmark  
 Act IV, Scene v, l. 75–77  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The marigold...goes to bed wi' the sun,  
 And with him rising weeping.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 The Winter's Tale  
 Act IV, Scene iv, l. 104–105  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the camomile, the more it is trodden on the faster it grows...

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
 The First Part of King Henry the Fourth  
 Act II, Scene iv, l. 438–439  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The fairest flowers o' the season  
 Are our carnations and streak'd gillyvors,  
 Which some call nature's bastards.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 The Winter's Tale  
 Act IV, Scene iii, l. 81–83  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There is a Thorn, — it looks so old,  
 In truth, you'd find it hard to say  
 How it could ever have been young,  
 It looks so old and gray.

*The Complete Poetical Works of William Wordsworth*  
 The Thorn, Stanza I  
 Crowell. New York, New York, USA. 1888

**Shelley, Percy Bysshe** 1792–1822  
 English poet

And nearer to the river's trembling edge  
 There grew broad flag-flowers, purple  
 prankt with white;  
 And starry river buds among the sedge;  
 And floating water-lilies broad and bright.

*The Complete Poetical Works of Percy Bysshe Shelley*  
 The Question, Stanza IV  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Taylor, Bayard** 1825–78  
 American journalist and author

Around the pillars of the palm-tree bower  
 The orchids cling, in rose and purple spheres;  
 Shield-broad the lily floats; the aloe flower  
 Foredates its hundred years.

*The Poetical Works of Bayard Taylor*  
 Canopus, Stanza 11  
 Houghton, Osgood. Boston, Massachusetts, USA. 1880

**Thoreau, Henry David** 1817–62  
 American essayist, poet, and practical philosopher

Among the signs of autumn I perceive  
 The Roman wormwood (called by learned men  
*Ambrosia elatior*, food for gods, —  
 For to impartial science the humblest weed  
 Is as immortal once as the proudest flower — )  
 Sprinkles its yellow dust over my shoes.

In Robert Bly  
*The Winged Life. The Poetic Voice of Henry David Thoreau*  
 Part Two. Tall Ambrosia (p. 29)  
 Sierra Club Books. San Francisco, California, USA. 1986

**von Frisch, Karl** 1886–1982  
 Austrian zoologist

One can see that the colors of the flowers have been developed as an adaptation to the color sense of their visitors. It is evident that they are not designed for the human eye. But this should not prevent us from delighting in their beauty.

*Bees: Their Vision, Chemical Senses, and Language*  
 The Color Sense of Bees (p. 13)  
 Cornell University Press. Ithaca, New York, USA. 1950

**Wilcox, Ella Wheeler** 1850–1919  
 American poet and journalist

A weed is but an unloved flower!

*New Thought Pastels*  
 The Weed  
 E. Towne. Holyoke, Maine, USA. 1906

**Wilde, Oscar** 1854–1900  
 Irish wit, poet, and dramatist

Chrysanthemums from gilded argosy  
 Unload their gaudy scentless merchandise.

*Poems*  
 Humanitad, Stanza 11  
 George Munro's Sons. New York, New York, USA. 1896

**Williams, Carol**  
 No biographical data available

Usually, children spend more time in the garden than anybody else. It is where they learn about the world, because they can be in it unsupervised, yet protected. Some gardeners will remember from their own earliest recollections that no one sees the garden as vividly, or cares about it as passionately, as the child who grows up in it.

*Bringing a Garden to Life*  
 Bantam Books. New York, New York, USA. 1998

**Wordsworth, William** 1770–1850  
 English poet

I wandered lonely as a cloud  
 That floats on high o'er vales and hills,  
 When all at once I saw a crowd,  
 A host, of golden daffodils...

*The Complete Poetical Works of William Wordsworth*  
 I Wandered Lonely as a Cloud



Crowell. New York, New York, USA. 1888

For oft, when on my couch I lie  
In vacant or in pensive mood,  
They flash upon that inward eye,  
Which is the bliss of solitude,  
And then my heart with pleasure fills,  
And dances with the Daffodils.

*The Complete Poetical Works of William Wordsworth*

I Wandered Lonely as a Cloud

Crowell. New York, New York, USA. 1888

Nor will I then thy modest grace forget,  
Chaste Snowdrops, venturous harbinger of Spring,  
And pensive monitor of fleeting years!

*The Complete Poetical Works of William Wordsworth*

To a Snow-Drop

Crowell. New York, New York, USA. 1888

## FLU

### Beacock, Cal

No biographical data available

A bunch of germs were whooping it up  
In the Bronchial Saloon.  
The bacillus handling the larynx  
Was jazzing a gig-time tune,  
While back of the tongue in a solo game  
Sat Dangerous Ah Kerchoo.  
And watching his luck was his light of his love  
The malady known as Flu.

The Pundit

*Reader's Digest*, January 1986

## FLUID

### Lamb, Sir Horace 1848–1934

English applied mathematician

I am an old man now, and when I die and go to Heaven  
there are two matters on which I hope for enlightenment.  
One is quantum electrodynamics and the other is the tur-  
bulent motion of fluids. And about the former I am rather  
more optimistic.

In Anderson, Tannehill, and Pletcher

*Computational Fluid Mechanics and Heat Transfer* (p. 197)

## FLUOROCHEMISTRY

### de Ment, J.

No biographical data available

With the increasing number of researches and publications  
devoted to the applications of fluorescence to chemistry, a  
need is rapidly arising to identify this new branch of sci-  
ence as distinct and apart from related and often confused  
fields. Therefore, it seems expedient to propose the name  
fluorochemistry as described in this branch of science.  
The term fluorochemistry is in order with other terms

created to identify highly specialized fields which are still  
within the boundaries of chemistry and/or physics.

Discussion

*Science*, Volume 95, Number 2468, 17 April 1943 (p. 407)

## FLUXION

### Berkeley, George 1685–1753

Irish prelate and metaphysical philosopher

But he who can digest a second or third Fluxion, a second  
or third Difference, need not, methinks, be squeamish  
about any Point in Divinity.

*The Works of George Berkeley (Volume 3)*

The Analyst

Chapter V (p. 261)

At the Clarendon Press. Oxford England. 1871

## FLYING SAUCERS

### Feynman, Richard P. 1918–88

American theoretical physicist

“Listen, I mean that from my knowledge of the world  
that I see around me, I think that it is much more likely  
that the reports of flying saucers are the results of the  
known irrational characteristics of terrestrial intelli-  
gence than of the unknown rational efforts of extra-ter-  
restrial intelligence.” It is just more likely, that is all. It  
is a good guess. And we always try to guess the most  
likely explanation, keeping in the back of the mind the  
fact that if it does not work we must discuss the other  
possibilities.

*The Character of Physical Law*

Chapter 7 (p. 166)

BBC. London, England. 1965

## FOCUS

### MacLeod, G. Preston

No biographical data available

It is a great thing to be able to come to the point.

*The Interpreter's Bible* (p. 187)

Abingdon-Cokesbury Press. New York, New York, USA. 1951–57

## FOOL

### Feynman, Richard P. 1918–88

American theoretical physicist

The first principle is that you must not fool yourself —  
and you are the easiest person to fool. So you have to be  
very careful about that. After you've not fooled yourself,  
it's easy not to fool other scientists. You just have to be  
honest in a conventional way after that.

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*  
(Caltech commencement address, 1974) *Cargo Cult Science* (p. 343)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

## FOOTPRINT

### Bird, R. T.

No biographical data available

We left the woodlot, climbed a fence, and started for the bend in the river. Ryals told a lengthy tale of his experience in quarrying tracks.

“I’ve had a heap o’ fun at it,” he said. “Don’t put much food on the table, but then, what does? Hereabouts, ‘bout the only money-makin’ jobs is cuttin’ cedar posts, boot-leggin’, and quarryin’ dinosaur footprints. And the other two is hot, hard work.”

*Bones for Barnum Brown: Adventures of a Dinosaur Hunter*

Chapter 29 (p. 147)

Texas Christian University Press. Ft. Wroth, Texas, USA. 1985

### Doyle, Sir Arthur Conan 1859–1930

Scottish writer

There is no branch of detective science which is so important and so much neglected as the art of tracing footsteps.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 14 (p. 232)

Wings Books. New York, New York, USA. 1967

### Hitchcock, Edward 1793–1864

American geologist

Foot-marks on stone!

How plain and yet how strange!

A bird track truly though of giant bulk,

Yet of the monster every vestige else

Has vanished. Bird, a problem thou hast solved

Man never has: to leave his trace on earth

To deep for time and fate to wear away.

The Sandstone Bird

*American Midland Naturalist*, Volume 10, 1927

### Milne, A. A. (Alan Alexander) 1882–1956

English poet, children’s writer, and playwright

“Tracks,” said Piglet. “Paw-marks.” He gave a little squeak of excitement. “Oh, Pooh! Do you think it’s a — a — a Woozle?”

“It may be,” said Pooh. “sometimes it is, and sometimes it isn’t. You can never tell with paw-marks.”

*The Complete Tales & Poems of Winnie-the-Pooh*

Winnie-the-Pooh, Pooh and Piglet Go Hunting and Nearly Catch a Woozle (p. 34)

Dutton Children’s Books. New York, New York, USA. 2001

## FORCE

### Carlyle, Thomas 1795–1881

English historian and essayist

Force, Force, everywhere Force; we ourselves a mysterious Force in the centre of that. “There is not a leaf rotting on the highway but has Force in it; how else could it rot?”

*On Heroes and Hero Worship*

Lecture I (p. 12)

John B. Alden, Publisher. New York, New York, USA. 1887

### Carpenter, William B. 1813–85

English physiologist and naturalist

Should we not think it absurd on the part of any one who possesses in the use of his hands the means of detecting the error of his visual perceptions, if he were to base a superstructure of reasoning — still more...a whole system of philosophy — upon the latter alone? Yet such appears to me to be the position of those who deny our direct cognition of force.

The Force Behind Nature

*Popular Science Monthly*, Volume 16, 1880 (p. 620)

### Clifford, William Kingdon 1845–79

English philosopher and mathematician

Force is not a fact at all, but an idea embodying what is approximately the fact.

*The Common Sense of the Exact Sciences*

Preface (p. ix, fn 2)

B.J. Holdsworth. London, England. 1823

### DuBois-Reymond, Emil 1818–96

German physiologist

Fundamentally considered, there are neither forces nor matter. Both are merely abstractions, assumed from different points of view, of things as they are. They supplement and presuppose each other. Separately they do not exist. Matter is not like a carriage, to which the force, like horses, can be put or again removed from. A particle of iron is, and remains, the same, whether it crosses the horizon in the meteoric stone, rushes along in the wheel of the steam-engine, or circulates in the blood through the temples of the poet. These qualities are eternal, inalienable, and untransferable.

In Ludwig Buchner

*Force and Matter*

Chapter I (p. 1)

Trubner & Company. London, England. 1864

### Faraday, Michael 1791–1867

English physicist and chemist

I do not perceive in any part of space, whether (to use the common phrase) vacant or filled with matter, anything but forces and the lines in which they are exerted.

In Robert K. Adair

*The Great Design* (p. 49)

Oxford University Press, Inc. New York, New York, USA. 1987

### Feynman, Richard P. 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

One of the most important characteristics of force is that it has a material origin, and this is not just a definition.... If you insist upon a precise definition of force, you will never get it.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 12–1 (p. 12–2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...in dealing with force the tacit assumption is always made that the force is equal to zero unless some physical body is present.... One of the most important characteristics of force is that it has a material origin...

*The Feynman Lectures on Physics* (Volume 1)

Chapter 12–1 (p. 12–2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Graham, L. A.**

No biographical data available

Humpty Dumpty sat on a wall,  
Wondering how hard he would fall.  
Force times time, you will agree,  
Is equal to mass times velocity.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 15

Dover Publications, Inc. New York, New York, USA. 1959

Hey diddle, diddle,  
The cat and the fiddle,  
The cow jumped into the blue;  
Her leap into action  
Took plenty of traction,  
The product of Force times mew.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 8

Dover Publications, Inc. New York, New York, USA. 1959

**Gross, David** 1941–  
American particle physicist

One of the best of the many Pauli jokes tells of Pauli's arriving in Heaven and being given, as befits a theoretical physicist, an appointment with God. When granted the customary free wish, he requests that God explain to him why the value of the fine-structure constant,  $\alpha = e^2/(xc)$ , which measures the strength of the electric force, is 0.00729735.... God goes to the blackboards and starts to write furiously. Pauli watches with pleasure but soon starts shaking his head violently...

On the Calculation of the Fine-Structure Constant

*Physics Today*, Volume 142, Number 13, December 1989 (p. 9)

**Henry, John**

No biographical data available

...had Newton not been steeped in alchemical and other magical learning, he would never have proposed forces of attraction and repulsion between bodies as the major feature of his physical system.

In John Fauvel, Raymond Flood, Michael Shortland and Robin Wilson (eds.)

*Let Newton Be!*

Chapter Six (p. 144)

Oxford University Press, Inc. Oxford, England. 1988

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Whatever attempts have been made by metaphysical writers to reason away the connection of cause and effect, and fritter it down into the unsatisfactory relation of habitual sequence, it is certain that the conception of some more real and intimate connection is quite as strongly impressed upon the human mind as that of the existence of an external world, the vindication of whose reality has, strange to say, been regarded as an achievement of no common merit in the annals of this branch of philosophy. It is our own immediate consciousness of effort, when we exert a force to put matter in motion or to oppose and neutralize force, which gives us this internal conviction of power and causation, so far as it relates to the material world.

*Lardner's Cabinet Cyclopaedia*

Treatise on Astronomy, Volume 3 (p. 232)

London, England. 1830–1832

**Maxwell, James Clerk** 1831–79  
Scottish physicist

Gin a body meet a body  
Flyin' through the air,  
Gin a body hit a body,  
Wil it fly? and where?

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

In memory of Edward Wilson (p. 630)

Macmillan & Company Ltd. London, England. 1882

Force, then is Force, but mark you! not a thing,  
Only a Vector.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

Report on Tait's Lecture on Force (p. 647)

Macmillan & Company Ltd. London, England. 1882

An inextensible heavy chain  
Lies on a smooth horizontal plane,  
An impulsive force is applied at A,  
Required the initial motion of K.

In Lewis Campbell and William Garnett

*The Life of James Clerk Maxwell with Selections from His Correspondence and Occasional Writings*

A Problem in Dynamics (p. 625)

Macmillan & Company Ltd. London, England. 1882

**Michener, James A.** 1907–97  
American novelist

The Luna broke away to start its descent to what Tucker Thompson had told his readers was “the dark and dangerous chasm in which unknown forces threaten the life of any trespasser.” Dr. Mott, reading the report in Folks, growled, “The basic forces are identical with those which govern Brooklyn. Only the landscape is different.”

*Space*

Chapter IX (p. 480)

Random House, Inc. New York, New York, USA. 1982

**Moleschott, Jacob** 1822–93  
Dutch scientist, physiologist, and philosopher

Force is not an impelling God, not an essence separate from the material substratum of things. A force not united to matter, but floating freely above it, is an idle conception. Nitrogen, carbon, hydrogen, oxygen, sulphur, and phosphorus, possess their inherent qualities from eternity.

In Ludwig Bchner

*Force and Matter*

Chapter I (p. 1)

Truth Seeker. New York, New York, USA. 1950

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

The parts of all homogeneous hard bodies which fully touch one another stick together very strongly. And for explaining how this may be, some have invented hooked atoms, which is begging the question; and others tell us that bodies are glued together by rest...and others, that they stick together by conspiring motions.... I had rather infer from their cohesion that their particles attract one another by some force, which in immediate contact is exceedingly strong, at small distances performs the chemical operations above mentioned, and reaches not far from the particle with any sensible effect.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book Three, Chapter I (3/4 way through chapter)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...nor could the moon without some such force be retained in its orbit. If this force was too small, it would not sufficiently turn the moon out of a rectilinear course; if it were too great, it would turn it too much, and draw down the moon from its orbit towards the earth.

*Mathematical Principles of Natural Philosophy*

Definitions, Definition V

E.P. Dutton & Company. New York, New York, USA. 1922

**Robb, Alfred Arthur** 1873–1936  
English physicist

Here’s a health to Professor J.J.!

May he hunt for ions for many a day,

And take observations

And find the relations

Which forces obey.

Postprandial Proceedings of Cavendish Society

The Don of the Day

*The American Physics Teacher*, Volume 7, Number 3, June 1939

**Smoot, George** 1945–  
American astrophysicist

Using the forces we now know, you can’t make the universe we know now.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 32)

Random House, Inc. New York, New York, USA. 1991

**Stone, Samuel John** 1839–1900

Anglican clergyman and hymnist

All things are molded by some plastic force

Out of some atoms somewhere up in space.

Soliloquy of a Rationalistic Chicken

*Harper’s Monthly*, September 1875

**Tolstoy, Leo** 1828–1910  
Russian writer

A countless number of free forces (for nowhere is man freer than during a battle, where it is a question of life and death) influence the course taken by the fight, and that course never can be known in advance and never coincides with the direction of any one force. If many simultaneously and variously directed forces act on a given body, the direction of its motion cannot coincide with any one of those forces, but will always be a mean — what in mechanics is represented by the diagonal of a parallelogram of forces. If in the descriptions given by historians, especially French ones, we find their wars and battles carried out in accordance with previously formed plans, the only conclusion to be drawn is that those descriptions are false.

In *Great Books of the Western World* (Volume 51)

*War and Peace*

Book Thirteen, Chapter VII (p. 570)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

Forces, whose silent operations in elementary nature, and in the delicate cells of organic tissues, still escape our senses, will, when recognized, employed, and awakened to higher activity...enter within the sphere of the endless chain of means which enable man to...control separate domains of nature, and to approximate to a more animated recognition of the Universe as a Whole.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)

General Retrospect (p. 356)

Harper & Brothers. New York, New York, USA. 1869

**Weil, Simone** 1909–43  
French philosopher and mystic

Two forces rule the universe: light and gravity.  
*Gravity and Grace*  
Gravity and Grace (p. 1)  
Routledge & Kegan Paul. London, England. 1952

**Whewell, William** 1794–1866  
English philosopher and historian

Time, inexhaustible and ever accumulating his efficacy,  
can undoubtedly do much in geology: — but Force,  
whose limits we cannot measure, and whose nature we  
cannot fathom, is also a power never to be slighted: and  
to call in the one to protect us from the other is equally  
presumptuous to which ever side out superstition leans.  
*History of the Inductive Sciences, from the Earliest to the Present Time*  
(Volume 3)  
Chapter VIII, Section 2 (p. 616)  
John W. Parker. London, England. 1837

There is no force, however great,  
Can stretch a cord, however fine  
Into a horizontal line  
Which is accurately straight.  
In Charles Carroll Bombaugh  
*Gleaning for the Curious From the Harvest-field of Literature*  
Metric Prose (p. 228)  
A. D. Worthington & Company. Hartford, Connecticut, USA. 1875

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

You unseen force, centripetal, centrifugal, through  
space's spread,  
Rapport of sun, moon, earth, and all the constellations,  
What are the messages by you from distant stars to us?  
*Complete Poetry and Collected Prose*  
Fancies at Navesink  
The Library of America. New York, New York, USA. 1982

**Winsor, Frederick**  
No biographical data available

Little Miss Muffet  
Sits on her tuffet  
In a nonchalant sort of way.  
With her force field around her  
The spider, the bounder,  
Is not in the picture today.  
*The Space Child's Mother Goose*  
Simon & Schuster. New York, New York, USA. 1958

## FORECAST

**Aron, Raymond** 1905–83  
French sociologist and historian

Foreknowledge of the future makes it possible to manip-  
ulate both enemies and supporters.  
*The Opium of the Intellectuals*

Chapter IX (p. 284)  
Secker & Warburg. London, England. 1957

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

I wonder...that a soothsayer doesn't laugh when he sees  
another soothsayer.  
Translated by William Armistead Falconer  
*Cicero: De Senectute, De Amicitia, De Divinatione*  
De Divinatione, II, XXIV (p. 429)  
Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Prophecy is a dangerous and thankless business, fre-  
quently fatal to those who practice it.  
*The Challenge of the Spaceship*  
The Challenge of the Spaceship (p. 2)  
Harper & Brothers. New York, New York, USA. 1959

**de Jouvenel, Bertrand** 1903–87  
French man of letters

Forecasting in economics is an activity fully licensed in  
the City of Action and the City of Intellect. Sought and  
subsidized by executives in government and business, it  
is also recognized and accredited by the universities. For  
it to attain so remarkable a status, two suspicions had to  
be overcome: that of men of action “the speculative views  
of intellectuals who lack any experience of reality”; and  
that, even stronger, of men of learning about “intellectual  
adventurism which discredits science by going beyond  
the established facts.”  
Translated by Nikita Lary  
*The Art of Conjecture*  
Chapter 16 (p. 179)  
Basic Books, Inc. New York, New York, USA. 1967

**Fiedler, Edgar R.** 1916–2003  
American economist

When you know absolutely nothing about the topic, make  
your forecast by asking a carefully selected probability  
sample of 300 others who don't know the answer either.

...

The herd instinct among forecasters makes sheep look  
like independent thinkers.

...

Forecasting is very difficult, especially about the future.

...

The moment you forecast, you know you're going to be  
wrong, you just don't know when and in which direction.

...

If you have to forecast, forecast often.

...

He who lives by the crystal ball soon learns to eat ground glass.

The Three R's of Economic Forecasting — Irrational, Irrelevant and Irreverent

*Across the Board*, Volume 14, June 1977

### Harris, Ralph

No biographical data available

All forecasting is in an important sense backward-looking — vividly compared to steering a ship by its wake.

*Economic Forecasting — Models or Markets?: An Introduction to the Role of Econometrics in Economic Policy* (p. 86)

Institute of Economic Affairs. London, England. 1977

### Heilbroner, Robert

1919–2005

American economist

Rather than projecting the shadow of Tomorrow's unknowable realities, I propose to ask whether it is imaginable — I stress this crucial word — to exercise effective control over the future-shaping forces of Today. This rescues us from the impossible attempt to predict the shape of Tomorrow, and leaves us with the somewhat less futile effort of inquiring into the possibilities of changing or controlling the trends of the present... Can this intrusion of science and technology be bounded, confined to its needed applications, and kept from sucking the life out of our engagement with nature and with one another? I find that difficult to imagine.

*Visions of the Future: The Distant Past, Yesterday, Today, Tomorrow* Chapter 5 (pp. 95, 99)

Oxford University Press, Inc. New York, New York, USA. 1995

### Henry, Patrick

1736–1799

American revolutionary and governor of Virginia

I know of no way of judging the future but by the past.

Speech

Second Virginia Convention, March 23, 1775

### Mellor, J. W.

Chemist

Nearly every inference we make with respect to any future event is more or less doubtful. If the circumstances are favorable, a forecast may be made with a greater degree of confidence than if the conditions are not so disposed.

*Higher Mathematics for Students of Chemistry and Physics*

Probability and Theory of Errors (p. 498)

Dover Publications. New York, New York, USA. 1955

### Penjer, Michael

No biographical data available

We are making forecasts with bad numbers, but bad numbers are all we've got.

*The New York Times*, September 1, 1989

### Poincaré, Henri

1854–1912

French mathematician and theoretical astronomer

It is far better to foresee even without certainty than not to foresee at all.

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 129)

The Science Press. New York, New York, USA. 1913

### Strong, Lydia

No biographical data available

Two plus two is four? Not to this forecaster. He knows the sales manager (who hired him) wants a different answer.

...

Will he ever be able to correlate all these facts into one forecast that makes sense? What does it matter? He's just obtained a new and exclusive figure on discretionary consumer income in Hudson N.Y. — and he's sublimely happy.

...

Why fool around with market research? Why try to correlate economic indicators? The correct prediction will strike suddenly — like a bolt from the blue.

...

The charts rustle as the wind murmurs through the sacred grove. The high priest interprets the prophecy to the waiting supplicant. Business will improve, he says... unless it takes a turn for the worse.

...

His forecasts could have been presented at the deadline date — but he's held it up six weeks waiting for information which will clear up one "crucial" point — crucial only to him.

...

He's fed in enough data for a dozen forecasts — let the electronic brains do the rest. While the THINK machines grind out prophecies, he can relax and contemplate the cosmos.

...

A forecast is a forecast is a forecast. What if an important new trend developed? All the possibilities were considered three months ago, and it's too late to discuss any further changes in this year's projections.

*Sales Forecasting: Problems and Prospects*

*Management Review*, September 1956

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

It is said that the present is pregnant with the future.

*The Portable Voltaire*  
Philosophical Dictionary, Concatenation of Events (p. 99)  
The Viking Press. New York, New York, USA. 1959

**Walker, Marshall John**  
American physicist

Men have always valued the ability to predict future events, for those who can predict events can guard against them.

*The Nature of Scientific Thought*  
Chapter 1 (p. 2)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

## FORESIGHT

**Meyerson, Emile** 1859–1933  
Polish-born French chemist

...foresight is indispensable for action. Now action for any organism of the animal kingdom is an absolute necessity. Surrounded by hostile nature it must act, it must foresee, if it wishes to live. "All life, all action," says Fouillée, "is a conscious or an unconscious divining. Divine or you will be devoured."

Translated by Kate Loewenberg  
*Identity & Reality*  
Chapter 1 (p. 22)  
George Allen & Unwin Ltd. London, England. 1930

**Shewhart, Walter Andrew** 1891–1967  
American statistician

Hindsight supplements foresight: A view backward often adds materially to a view forward.

*Statistical Method from the Viewpoint of Quality Control*  
Epilogue (p. 149)  
The Graduate School. The Department of Agriculture. Washington, USA. 1939

## FORETHOUGHT

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

We are all aware, although we rarely think about it, that all human forethought depends on our recognizing or putting some kind of order into the world. As much as book-keeping, government, and doing the week-end shopping...science is an activity of putting order into our experience.... Science is to get rid of angels, blue fairies, and other agents whose intervention would reduce the explanation of physical events to other than physical terms...We must use science as it is, and that is an assembly of observations so ordered that they tell us

what we may expect in the future. Science is not only rational; it is also empirical. Science is experiment, that is, orderly and reasoned activity. The essence of experiment and of all science is that it is active. It does not watch the world, it tackles it.

*The Common Sense of Science*  
Chapter VII, Section 2 (p. 100)  
Harvard University Press. Cambridge, Massachusetts, USA. 1953

## FORM

**Narby, Jeremy**

Swiss anthropologist and author

Nature talks in signs and, to understand its language, one has to pay attention to similarities in form.

*The Cosmic Serpent: DNA and the Origins of Knowledge*  
Chapter 7 (pp. 96–97)  
Tarcher/Putnam. New York, New York, USA. 1998

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

...we rise from the conception of form to an understanding of the forces which gave rise to it...in the representation of form we see a diagram of forces in equilibrium, and in the comparison of kindred forms we discern the magnitude and the direction of the forces which have sufficed to convert the one form into the other.

*On Growth and Form* (Volume 2)  
Chapter XVII (p. 1027)  
At The University Press. Cambridge, England. 1951

...our own study of organic form, which we call by Goethe's name of Morphology, is but a portion of that wider still Science of Form which deals with the forms assumed by matter under all aspects and conditions, and, in a still wider sense, with forms which are theoretically imaginable.

*On Growth and Form* (Volume 2)  
Chapter XVII (p. 1026)  
At The University Press. Cambridge, England. 1951

## FORMULA

**Agnew, Ralph Palmer**  
American mathematician

One who feels that these formulas are complicated need not be disturbed; automobiles are much more complicated and we use them.

*Differential Equations*  
Chapter 1, Problem 1.391 (p. 11)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Barr, H. F.**

No biographical data available

The young engineer, for example, soon finds that a problem is not always clear or easily defined and that the

solution does not involve merely substituting known values into a standard formula.

Typical Problems in Engineering

*General Motors Engineering Journal*, Forward, Set 1, Number 1

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

...from the time of Kepler to that of Newton, and from Newton to Hartley, not only all things in external nature, but the subtlest mysteries of life and organization, and even of the intellect and moral being, were conjured within the magic circle of mathematical formulae.

*The Theory of Life*

On the Definitions of Life Hitherto Received (p. 375)

George Ball & Sons. London, England. 1892

**Dudley, Underwood** 1937–

American mathematician

Formulas should be useful. If not they should be astounding, elegant, enlightening, simple, or have some other redeeming value.

Formulas for Primes

*Mathematics Magazine*, Volume 56, Number 1, January 1983 (p. 22)

Authors who discover formulas should not rush into print. Even as in business and marriage, in mathematics not all that is true needs to be published.

Formulas for Primes

*Mathematics Magazine*, Volume 56, Number 1, January 1983 (p. 22)

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

Books on physics are full of complicated mathematical formulae. But thought and ideas, not formulas, are the beginning of every physical theory.

*The Evolution of Physics*

The Waves of Matter (p. 277)

Simon & Schuster. New York, New York, USA. 1961

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The formulas of science are like the papers in your pocketbook, of no value to any but their owner.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Beauty (p. 1100)

The Library of America. New York, New York, USA. 1983

**Guyau, Jean-Marie**

No biographical data available

Mathematicians fancy that their formulas are infallible because they are drawn from mathematics, and they have a formula for everything: everything is classed, ticketed,

and in such a way as to preclude discussion. How can one dispute with a formula?

*Education and Heredity: A Study In Sociology*

Chapter VI (p. 245)

Walter Scott. London, England. 1891

**Hodnett, Edward** 1901–84

Illustration historian

What you do to a situation when you use a formula approach is to schematize it. You impose a pattern on it...

*The Art of Problem Solving*

Part II, Chapter 12 (p. 89)

Harper & Brothers. New York, New York, USA. 1955

A formula is like a basket. Try to pick up a dozen apples from the ground and carry them in your hands. It is well-nigh impossible. With a basket you can carry as many as you can lift.

*The Art of Problem Solving*

Part II, Chapter 12 (p. 86)

Harper & Brothers. New York, New York, USA. 1955

**Hofmann, A. W.**

No biographical data available

...symbolic formulae...would deserve to rank among the chemist's most powerful instruments of research.

*Introduction to Modern Chemistry*

Lecture V (p. 87)

Walton & Maberly. London, England. 1866

**Huxley, Thomas Henry** 1825–95

English biologist

...as the grandest mill in the world will not extract wheat-flour from peascods, so pages of formulae will not get a definite result out of loose data.

*Lay Sermons, Addresses and Reviews*

Chapter XI (p. 249)

D. Appleton & Company. New York, New York, USA. 1871

...there can be little doubt that the further science advances, the more extensively and consistently will all the phenomena of Nature be represented by materialistic formulae and symbols.

*Collected Essays* (Volume 1)

*Method and Result*

On the Physical Basis of Life (p. 164)

Macmillan & Company Ltd. London, England. 1904

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

There is a famous formula — perhaps the most compact and famous of all formulas — developed by Euler from a discovery of the French mathematician De Moivre:  $e^{i\pi} + 1 = 0$ ... It appeals equally to the mystic, the scientist, the philosopher, the mathematician.



*Mathematics and the Imagination*

Transcendental and Imaginary (p. 103)  
Simon & Schuster. New York, New York, USA. 1940

**Kipling, Rudyard** 1865–1936

British writer and poet

No proposition Euclid wrote  
No formulae the text-books know,  
Will turn the bullet from your coat,  
Or ward the tulwar's downward blow.  
Strike hard who cares — shoot straight who can —  
The odds are on the cheaper man.

*Rudyard Kipling's Verse*

Arithmetic on the Frontier (p. 45)  
Hodder & Stroughton. London, England. 1919

**Mitchell, Maria** 1818–89

American astronomer and educator

Every formula which expresses a law of nature is a hymn  
to praise of God.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 185)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

**Planck, Max** 1858–1947

German physicist

Ever since the observation of nature has existed, it has  
held a vague notion of its ultimate goal as the composi-  
tion of the colorful multiplicity of phenomena in a uni-  
form system, where possible, in a single formula.

Translated by Elizabeth Oehlkers

In Ernest Peter Fischer

*Beauty and the Beast*

Chapter 2 (p. 47)

Plenum Trade. New York, New York, USA. 1999

...even if the radiation formula should prove itself to be  
absolutely accurate, it would after all be only an interpo-  
lation...it would still only have, within the significance  
of a happily chosen interpolation formula, a strictly lim-  
ited value. For this reason, I busied myself, from then on,  
that is, from the day of its establishment, with the task of  
elucidating a true physical character for the formula...

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1918

The Genesis and Present State of Development of the Quantum Theory  
(p. 411)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Thanks to the formula, a single algebraic demonstration  
spares us the pains of going over the same ground time  
after time for each new calculation.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 126)

Government Printing Office. Washington, D.C. 1910

**Saint Augustine of Hippo** 354–430

Theologian and doctor of the Church

If I am given a formula, and I am ignorant of its meaning,  
it cannot teach me anything, but if I already know it what  
does the formula teach me?

*De Magistro*

Chapter X, 23

Hackett Publishing Company. Indianapolis, Indiana, USA. 1995

**Stoppard, Tom** 1937–

Czech-born English playwright

THOMASINA: If you could stop every atom in its posi-  
tion and direction, and if your mind could comprehend  
all the actions thus suspended, then if you were really,  
really, good at algebra you could write the formula for all  
the future; and although nobody can be so clever to do it,  
the formula must exist just as if one could.

*Arcadia*

Act I, Scene One (p. 5)

Faber & Faber Ltd. London, England. 1993

**FOSSIL****Author undetermined**

Every little fossil has a meaning all its own —  
Meaning that is clear to me, yes, clear to me alone;  
For every species or variation  
I have found in its own formation —  
Will assist my determination  
Of the stratigraphic zone.

More or Less

*The Pick and Hammer Club*, November 17–18, 1950 (p. 10)

Child of an ancient world! O'er whom the storms  
That shatter'd empires silently have roll'd,  
What awful mysteries could'st thou unfold  
Of Chance and Change in all their various forms!  
Thy frond-like leaves were blooming when in glory,  
Proud Rome and Egypt each beheld its prime,  
And doubtless thou could'st tell us many a story  
Of mighty victors of the olden time.  
Geology, with microscopic eye,  
Regards thee as a phantom metaphoric;  
While Chemistry, whose flight is always high,  
Claims thee as a production meteoric;  
But sister Poesy seems half afraid,  
And wisely keeps her learning in the shade.

*The Museum of Foreign Literature and Science*, Volume 29, 1836  
(p. 572)

**Blumenbach, Johann Friedrich** 1752–1840

German naturalist and anthropologist

If one looks at fossils from the grand viewpoint that they  
are the most infallible documents in Nature's archives,  
demonstrating that our planet has gone through several

upheavals, showing even the manner and to some extent the times of these major changes, thus making it possible to determine the relative ages of the various major formations — it is obvious that their history must be regarded as one of the most important and instructive parts of all natural history, and especially of scientific mineralogy.

In Andrew Cunningham and Nicholas Jardine (ed.)

*Romanticism and the Sciences*

In Nicholas A. Rupke

Caves, Fossils and the History of the Earth (p. 248)

Cambridge University Press. Cambridge, England. 1990

### **Bucher, W. H.**

No biographical data available

Since those who know where to find fossils are unwilling to look, and most of those who look at metamorphic rocks do not know what to look for and where, much valuable material must remain undiscovered.

Fossils in Metamorphic Rocks, A Review

*Bulletin of the Geological Society of America*, Volume 64, Number 3, March 1953 (p. 293)

### **Callaway, Jack M.**

No biographical data available

### **Nicholls, Elizabeth L.**

No biographical data available

Good index fossils have two key distributional attributes — they are widespread (geography) and they represent short-lived taxa (stratigraphy).

*Ancient Marine Reptiles*

Chapter 14 (p. 427)

Academic Press. San Diego, California, USA. 1997

### **Carson, Hampton** 1914–2004

American biologist

The fossil record says eloquently that profuse evolution had indeed occurred over millions of years, but the data just aren't sensitive enough to analyze evolutionary kinetics. This is the province of the evolutionary geneticist who works with descent and change in populations of present-day organisms.

Letters

*Science*, Volume 211, Number 4484, February 20, 1981 (p. 773)

### **Committee on Guidelines for Paleontological Collecting**

...fossils are very different from human artifacts, but past attempts at regulation have tended to confuse the two. This has led to uncritical and often unfortunate transfers of standards and procedures from archaeology to paleontology.

*Paleontological Collecting*

Executive Summary (p. 2)

National Academy Press. Washington, D.C. 1987

### **Conrad, Timothy** 1803–77

American geologist and malacologist

Methinks I see thee gazing from the stone

With those great eyes, and smiling in scorn

Of notions and of systems which have grown

From relics of the time when thou wert born.

Ode to a Trilobite

*Rocks and Minerals*, Volume 8, 1926 (p. 413)

### **Cook, James H.** 1857–1942

No biographical data available

The early fossil hunters surely had to endure hardships in the days when West meant West. I can well remember how most of my western friends regarded the early fossil hunters and naturalists who came to do collecting. They were usually spoken of as bone- or bug-hunting idiots. For anyone to go chasing over the West hunting for petrified bones, or even bugs, was conclusive evidence of his lack of good horse sense, especially in sections of the West where Indians were still wild enough to want to stick their arrows into anything wearing a white skin.

*Fifty Years on the Old Frontier*

Supplementary Chapter, The Agate Springs Fossil Beds (pp. 280–281)

University of Oklahoma Press. Norman, Oklahoma, USA. 1992

### **Cuppy, Will** 1884–1929

American humorist and critic

If this egg is really 100,000,000 years old, that would make it older than the dinosaur eggs found by Roy Chapman Andrews in the Gobi Desert and therefore one of the oldest fossil eggs known to man, but that doesn't matter to me. In order to appeal to me...an egg has to have more than mere age. There is such a thing as sentiment. Some of us feel a real affection for Mr. Andrew's dinosaur eggs, and I, for one, am not going to switch to ophiacodon's eggs all of a sudden.

*How to Get from January to December*

April 6 (p. 75)

Henry Holt & Company. New York, New York, USA. 1951

### **Cuvier, Georges** 1769–1832

French zoologist and statesman

We are ignorant even of the agents which may have held some of these substances in a state of solution; and it is still disputed respecting several of them, whether they have owed their origin to the agency of water or fire. After all, philosophers are only agreed on one point, which is, that the sea has changed its place; and this could have never been certainly known, but for the existence of extraneous fossils. These fossils, then, which have given rise to the theory of the earth, have at the same time furnished its principal illustrations — the only ones, indeed, that have as yet been generally received and acknowledged.

*An Essay on the Theory of the Earth*

Section 23 (pp. 70–71)

Kirk & Mercein. New York, New York, USA. 1818

The importance of investigating the relations of extraneous fossils with the strata in which they are contained is quite obvious. It is to them alone that we owe the commencement even of the Theory of the Earth; as, but for them, we could never have even suspected that there had existed any successive epochs in the formation of our earth, and a series of different and consecutive operations in reducing it to its present state.

*An Essay on the Theory of the Earth*

Section 23 (p. 69)

Kirk & Mercein. New York, New York, USA. 1818

It is also owing to these extraneous fossils, slight as is the knowledge we have hitherto acquired respecting them, that we have yet been enabled to discover the little that we yet know concerning the revolutions of our globe. From them we have learned that the strata, or at least those which contain their remains, have been quietly deposited in a fluid; that the variations of the several strata must have corresponded with the variations in the nature of the fluid; that they have been left bare by the transportation of this fluid to some other place; and that his fact must have happened more than once. Nothing of all this could have been known with certainty, without the aid of extraneous fossils.

*An Essay on the Theory of the Earth*

Section 23 (pp. 69–70)

Kirk & Mercein. New York, New York, USA. 1818

It is my object, in the following work, to travel over ground which has as yet been little explored, and to make my reader acquainted with a species of Remains, which, though absolutely necessary for understanding the history of the globe, have been hitherto almost uniformly neglected.

*An Essay on the Theory of the Earth*

Section 1 (p. 25)

Kirk & Mercein. New York, New York, USA. 1818

### **Darwin, Charles Robert** 1809–82

English naturalist

Now let us turn to our richest geological museums and what a paltry display we behold! That our collections are imperfect is admitted by everyone. Many fossil species are known from single and often broken specimens. Only a small portion of the earth has been geologically explored, and no part with sufficient care. Shells and bones decay and disappear when left of the bottom of the sea where sediment is not accumulating. We err when we assume that sediment is being deposited over the whole bed of the sea sufficiently quickly to embed fossil remains.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter X (p. 55)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The pleasure of the first day's hunting cannot be compared to finding a fine group of fossil bones, which tell their story of former times with almost a living tongue.

*The Correspondence of Charles Darwin* (Volume 1)

Letter to Sister Catherine, April 6, 1834 (p. 379)

Cambridge University Press. Cambridge, England. 1985

### **Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Fifty million years lay under my feet, fifty million years of bellowing monsters moving in a green world now gone so utterly that its very light was traveling on the far edge of space. The chemicals of all that vanished age lay about me in the ground. The iron did not remember the blood it had once moved within, the phosphorus had forgotten the savage brain...

*The Immense Journey* (p. 171)

Victor Gollancz Ltd. London, England. 1958

### **George, T. N.**

No biographical data available

There is no need to apologize any longer for the poverty of the fossil record. In some ways it has become almost unmanageably rich, and discovery is outpacing integration.

Fossils in Evolutionary Perspective

*Science Progress*, Volume 48, 1960 (p. 1)

### **Harte, Francis Bret** 1839–1902

American author and poet

Speak, O man, less recent! Fragmentary fossil!

Primal pioneer of Pliocene formation,

Hid in lowest drifts below the earliest stratum

Of volcanic tufa!

In John Burroughs (ed.)

*Songs of Nature*

To the Pliocene Skull, Stanza I

Doubleday, Page & Company. Garden City, New York, USA. 1912

I'll show thee the sinuous track

By the slow-moving annelid made,

Or the trilobite, that, farther back,

In the old Potsdam sandstone was laid.

Thou shalt see, in his Jurassic tomb,

The plesiosaurus embalmed;

In his oolitic prime and his bloom,

Iguanodon, safe and unharmed!

In John Burroughs (ed.)

*Songs of Nature*

A Geological Madrical, Stanza II

Doubleday, Page & Company. Garden City, New York, USA. 1912

### **Hitchcock, Edward** 1793–1864

American geologist

“Not a track remains,” says Dr Buckland, “or a single hoof, of all the countless millions of men and beasts whose progress spread desolation over the Earth. But

the reptiles that crawled upon the half finished surface of our planet, have left memorials of their passage enduring and indelible.” And we may add, that the proudest monuments of human art will moulder down and disappear; but while there are eyes to behold them, the sandstone of the Connecticut valley will never cease to remind the observer of the gigantic races that passed over it while yet in an incipient state.

Rejoinder to the “Discovery of Fossil Footmarks”  
*American Journal of Science*, Volume 47, 1844 (p. 321)

### Hitching, Francis

English writer

...the curious thing is that there is a consistency about the fossil gaps; the fossils are missing in all the important places.

*The Neck of the Giraffe: Where Darwin Went Wrong*  
Part One, Chapter One (p. 19)  
Ticknor & Fields. New Haven, Connecticut, USA. 1982

### Hugo, Victor 1802–85

French author, lyric poet, and dramatist

Cuvier, with one eye on Genesis and the other on nature, was striving to please the bigoted reaction by placing fossils in harmony with texts, and letting Moses be flattered by the Mastodons.

*Les Miserables*  
Volume I, Book III, Chapter 1 (p. 117)  
The Heritage Press. New York, New York, USA. 1938

### Leakey, Richard Erskine 1944–

Kenyan paleoanthropologist and politician

I just find the fossils. I'll leave it to the experts to name them.

In Donald C. Johanson and Maitland A. Edey  
*Lucy: The Beginnings of Humankind*  
Chapter 6 (p. 136)  
Simon & Schuster. New York, New York, USA. 1981

### Leakey, Richard Erskine 1944–

Kenyan paleoanthropologist and politician

### Lewin, Roger Amos

Anthropologist

When out fossil hunting, it is very easy to forget that rather than telling you how the creatures lived, the remains you find indicate only where they became fossilized.

*Origins: What New Discoveries Reveal About the Emergence of Our Species and Its Possible Future*  
Chapter 5 (p. 96)  
E.P. Dutton. New York, New York, USA. 1977

### Lyell, Sir Charles 1797–1875

English geologist

Then might those genera of animals return, of which the memorials are preserved in the ancient rocks of our continents. The huge iguanodon might reappear in the

woods, and the ichthyosaurs in the sea, while the pterodactyl might flit again through umbrageous groves of tree-ferns.

*Principles of Geology* (Volume 1)  
Chapter VII (p. 123)  
John Murray. London, England. 1830

### Marsh, O. C.

No biographical data available

[Fossils are] the stepping stones by which the evolutionist of today leads the doubting brother across the shallow remnant of the gulf, once thought impassable.

Introduction and Succession of Vertebrate Life in North America  
*Nature*, Volume 16, 1877

### McMenamin, Mark

### McMenamin, Dianna

The worst problem in the search for the oldest animal fossils is mistaken identity.

*The Emergence of Animals: The Cambrian Breakthrough*  
Chapter III (p. 31)  
Columbia University Press. New York, New York, USA. 1990

### Melville, Herman 1819–91

American novelist

“Hold!” cried Media, “yonder is a curious rock. It looks black as a whale’s hump in blue water, when the sun shines.”

“That must be the Isle of Fossils,” said Mohi. “Ay, my lord, it is.”

“Let us land, then,” said Babbalanja.

*Typee, Omoo, Mardi*  
Mardi  
Chapter 132 (p. 1070)  
The Library of America. New York, New York, USA. 1982

### Miller, Hugh 1802–56

Scottish geologist and theologian

There is scarce an architectural ornament of the Gothic or Grecian styles which may not be found existing as fossils in the rocks.

*The Testimony of the Rocks: of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Sixth (p. 255)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

### Morris, Henry 1918–2006

American creationist

Never are fossils of creatures found with incipient eyes, with half-way wings, with half-scales turning into feathers, with partially-evolved forelimbs, or with any other nascent or transitional characters. Yet there must have been innumerable individuals which possessed such features, if the neo-Darwinian model of evolutionary history is correct.

*The Troubled Waters of Evolution*  
Chapter IV (pp. 91–92)  
Creation-Life Publishers. San Diego, California, USA. 1974

**Nicholson, Norman** 1914–87  
English poet

In the bones of the rock  
The fossils are living,  
Crinoid and ammonite;  
In the red of the rock  
(Sandstone and hematite)  
The fossils are moving,  
Coiling, crawling,  
Aching for the sea.

In Neil Curry (ed.)  
*Norman Nicholson Collected Poems*  
Fossils (p. 216)  
Faber & Faber Ltd. London, England. 1994

**Osborn, Henry Fairfield** 1857–1935  
American paleontologist and geologist

The hunter of wild game is always bringing live animals nearer to death and extinction, whereas the fossil hunter is always seeking to bring extinct animals to life.

In Robert West Howard  
*The Dawnseekers: The First History of American Paleontology*  
Chapter 17 (p. 238)  
Harcourt Brace Jovanovich. New York, New York, USA. 1975

**Parkinson, James** 1755–1824  
English physician and paleontologist

The study of fossil organized remains has hitherto been directed too exclusively to the consideration of the specimens themselves; and hence has been considered rather as an appendix to botany and zoology, than as (what it really is) a very important branch of geological inquiry. Observations on Some of the Strata in the Neighborhood of London, and on the Fossil Remains Contained in Them  
*Geological Society of London Transactions*, Volume 1, 1811 (p. 324)

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

The series of changes which fossil bodies are defined to undergo does not cease with their elevation above the level of the sea; it assumes, however, a new direction, and from the moment that they are raised up to the surface, is constantly exerted in reducing them again under the dominion of the ocean. The solidity is now destroyed which was acquired in the bowels of the earth; and as the bottom of the sea is the great laboratory, where loose materials are mineralized and formed into stone, the atmosphere is the region where stones are decomposed, and again resolved into earth.

*Illustrations of the Huttonian Theory of the Earth*  
Section III, 92 (p. 97)  
Dover Publications, Inc. New York, New York, USA. 1964

A very little attention to the phenomena of the mineral kingdom is sufficient to convince us that the conditions of the earth's surface has not been the same at all times that it is at the present moment. When we observe the impressions of plants in the heart of the hardest rocks; when we discover trees converted into flint, and entire beds of limestone or of marble composed of shells and corals; we see the same individual in two states, the most widely different from one another; and, in the latter instance, we have clear proof, that the present land was once deep immersed under the waters of the ocean.

*Illustrations of the Huttonian Theory of the Earth*  
Illustrations, &c. (p. 1)  
Dover Publications, Inc. New York, New York, USA. 1964

**Robertson, Percival**  
No biographical data available

The greatest interest lies in the study of fossils in the field, but even if I were located where it was impossible to study fossils in the field, I still think that fossils should be the central theme of historical geology — not pictures of fossils, not drawings of fossils, not lantern slides of fossils, but the little “bugs” themselves.

Holding Student Interest in Historical Geology  
*Journal of Geological Education*, Volume 1, Number 3, April 1952 (pp. 34–35)

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

DON JUAN: You forget that brainless magnificence of body has been tried. Things immeasurably greater than man in every respect but brains have existed and perished. The megatherium, the ichthyosaurus have paced the earth with seven-league steps and hidden the day with cloud vast wings. Where are they now? Fossils in museums, and so few and imperfect at that, that a knuckle bone or a tooth of one of them is prized beyond the lives of a thousand soldiers.

*Man and Superman: A Comedy and a Philosophy*  
Act III (p. 83)  
The Heritage Press. New York, New York, USA. No date

**Simpson, George Gaylord** 1902–84  
American paleontologist

The history of life ceases to be hypothesis and inference and becomes direct knowledge when fossils are available.

*Life: An Introduction to Biology*  
Chapter 29 (p. 756)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1965

Fossil hunting is by far the most fascinating of all sports. It has some danger, enough to give it zest and probably about as much as in the average modern engineered big-game hunt, and danger is wholly to the hunter. It has uncertainty and excitement and all the thrill of gambling

with not of its vicious features. The hunter never knows what his bag may be, perhaps nothing, perhaps a creature never before seen by human eyes. It requires knowledge, skill, and some degree of hardihood. And its results are so much more important, more worthwhile than those of any other sport! The fossil hunter does not kill, he resurrects. And the result of this sport is to add to the sum of human pleasure and to the treasure of human knowledge.

*Attending Marvels: A Patagonian Journal*

Chapter IV (p. 83)

The Macmillan Company. New York, New York, USA. 1934

### Skwara, T.

No biographical data available

Fossils in isolation are antiquarian objects; in the absence of context and concepts they are mute. But with conceptual models and technical tools at our disposal, a rich and luxuriant tapestry — the history of life on earth — emerges. Fossils, time, and change are the foundations of that history.

*Old Bones and Serpent Stones: A Guide to Interpreted Fossil Localities in Canada and the United States*

Section I (p. 9)

McDonald & Woodward. Blacksburg, Virginia, USA. 1992

### Smith, William

No biographical data available

Rural amusements to those who can enjoy them, are the most healthful; and the search for a fossil may be considered at least as rational as the pursuit of a hare.

*Stratigraphical System of Organized Fossils*

Preface (p. vi)

Printed for E. William. London, England. 1817

Fossils have long been studied as great Curiosities collected with great pains treasured up with great Care and at great Expense and shown and admired with as much pleasure as a Child's rattle or his Hobbyhorse is shown and admired by himself and his playfellows — because it is pretty. And this has been done by Thousands who have never paid the least regard to that wonderful order & regularity with which Nature has disposed of these singular productions and assigned to each Class its peculiar Stratum.

In John G.C.M. Fuller

The Industrial Basis of Stratigraphy: John Strachey and William Smith

*American Association of Petroleum Geologists Bulletin*, Volume 53, 1968

### Spencer, Herbert 1820–1903

English social philosopher

Whoever has not sought for fossils, has little idea of the poetical associations that surround the places where imbedded treasures were found.

*Education: Intellectual, Moral, and Physical*

Chapter I (p. 72)

A.L. Fowle. New York, New York, USA. 1860

### Watson, Lyall

No biographical data available

The fossils that decorate our family tree are so scarce that there are still more scientists than specimens. The remarkable fact is that all the physical evidence we have for human evolution can still be placed, with room to spare, inside a single coffin!

The Water People

*Science Digest*, Volume 90, May 1982 (p. 44)

## FOURTH DIMENSION

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

The material structure of the four-dimensional world is fibrous, with the threads all running along time — like tracks; it is a tangled warp without a woof.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 60)

At The University Press. Cambridge, England. 1921

### Sleator, William

The Fourth Dimension is just a hypothetical math concept. Or else it's time, or something. Just a lot of sci-fi crud.

*The Boy Who Reversed Himself*

Chapter 4 (p. 16)

E.P. Dutton. New York, New York, USA. 1986

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

Here is a portrait of a man at eight years old, another at fifteen, another at seventeen, another at twenty-three, and so on. All these are evidently sections, as it were, Three-Dimensional representations of his Four-Dimensional being, which is a fixed and unalterable thing.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine

Chapter One (p. 450)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

## FRACTAL

### Krantz, Steven 1951–

Mathematician

There is not even a universally accepted definition of the term “fractal.” It seems that if one does not prove theorems (as, evidently, fractal geometers do not), then one does not need definitions. One notable difference between fractal geometry and calculus is that fractal geometry has not solved any problems. It is not even clear that it has created any new ones.

Fractal Geometry

*The Mathematical Intelligencer*, Volume 11, Number 4, Fall 1989 (pp. 13–14)

**Paulos, John Allen** 1945–  
American mathematician

...the simple equations that generate the convoluted Mandelbrot fractal have been called the wittiest remarks ever made.

*Once Upon a Number: The Hidden Mathematical Logic of Stories*  
Appendix: Humor and Computation (pp. 130–131)  
Basic Books. New York, New York, USA. 1998

## FRACTION

**Beckmann, Petr** 1924–93  
Physicist

Continued fractions are part of the “lost mathematics,” the mathematics now considered too advanced for high school and too elementary for college.

*A History of Pi*  
Chapter 12 (p. 129)  
St. Martin’s Press. New York, New York, USA. 1974

**Burr, Lehigh**  
No biographical data available

“My daughter,” and his voice was stern,  
“You must set this matter right;  
What time did the Sophomore leave,  
Who sent in his card last night?”  
“His work was pressing, father dear,  
And his love for it was great;  
He took his leave and went away  
Before a quarter of eight.”  
Then a twinkle came to her bright blue eye,  
And her dimple deeper grew.  
‘Tis surely no sin to tell him that,  
For a quarter of eight is two.

In R.L. Paget  
*Poetry of American Wit and Humor*  
Applied Mathematics (p. 302), I.C.  
Page. Boston, Massachusetts, USA. 1899

## FRACTURE

**Hippocrates** 460 BCE–377 BCE  
Greek physician

In treating fractures and dislocations, the physician must make the extension as straight as possible, for this is the most natural direction. But if it inclines to either side, it should rather turn to that of pronation, for there is thus less harm than if it be towards supination.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
On Fractures, 1 (p. 74)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## FREEDOM

**Hoagland, Hudson** 1899–1982  
American physiologist

All scientists must be heretics and dissenters against accepted views in science if science itself is to advance. Freedom is thus essential to a scientific society, one in evolution. It is merely a nuisance to be discouraged in a static, authoritarian society.

Science and the New Humanism  
*Science*, Volume 143, Number 3062, 10 January 1964 (pp. 112–113)

## FUNCTION

**Agnew, Ralph Palmer**  
American mathematician

Just as a lass may walk through the grass and, seeing no snakes, believe that there are no snakes, so also a student, may pass through elementary calculus and, seeing only elementary functions may for integrals, believe that each elementary function necessarily has an elementary function for an integral.

*Differential Equations*  
Chapter 13 (p. 432)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

One should not forget that the functions, like all mathematical constructions, are only our own creation, and that when the definition with which one begins ceases to make sense, one should not ask, what is, but what is convenient to assume in order that it [remain] significant.

In Bryan H. Bunch  
*Mathematical Fallacies and Paradoxes*  
Chapter 1 (p. 1)  
Van Nostrand Reinhold Company. New York, New York, USA. 1982

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

The connections shown by these particular examples hold in general: given a transformation, you have a function and a relation; given a function, you have a relation and a transformation; given a relation, you have a transformation and a function: one thing — three aspects; and the fact is exceedingly interesting and weighty.

*Mathematical Philosophy: A Study of Fate and Freedom*  
Lecture X (pp. 167–168)  
E.P. Dutton & Company. New York, New York, USA. 1922

Every one is familiar with the ordinary notion of a function — with the notion, that is, of the lawful dependence of one or more variable things upon other variable things, as the area of a rectangle upon the lengths of its sides, as the distance traveled upon the rate of going, as the

volume of a gas upon the temperature and pressure, as the prosperity of a throat specialist upon the moisture of the climate, as the attraction of material particles upon the distance asunder, as the rate of chemical change upon the amount or the mass of the substance involved, as the turbulence of labor upon the lust of capital, and so on and on without end.

*Mathematical Philosophy: A Study of Fate and Freedom*

Lecture III (pp. 49–50)

E.P. Dutton & Company. New York, New York, USA. 1922

### McCormack, Thomas J.

No biographical data available

That flower of modern mathematical thought — the notion of a function.

On the Nature of Scientific Law and Scientific Explanation

*Monist*, Volume 10, 1899–1900 (p. 555)

### Rankine, William John Macquorn 1820–72

Scottish engineer and physicist

Let x denote beauty, y manners well-bred,  
z fortune (this last is essential),

Let L stand for love — our philosopher said —

Then L is a function of x, y and z

Of the kind that is known as potential.

*Songs and Fables*

The Mathematician in Love, Verse 6

J. Maclehose, Glasgow, Scotland. 1874

### Roe, Jr., E. D.

No biographical data available

The continuous function is the only workable and usable function. It alone is subject to law and the laws of calculation. It is a loyal subject of the mathematical kingdom. Other so-called or miscalled functions are freaks, anarchists, disturbers of the peace, malformed curiosities which one and all are of no use to anyone, least of all to the loyal and burden-bearing subjects who by keeping the laws maintain the kingdom and make its advance possible...scholarship lies in the direction of paying deference to the loyal continuous function rather than to the outlaws of mathematical society.

A Generalized Definition of Limit

*The Mathematics Teacher*, Volume III, Number 1, September 1910 (p. 4)

## FUNDING

### Dunlap, Knight

No biographical data available

It is easier for a man to get funds for what he proposes to do than for what he is doing.

The Outlook for Psychology

*Science*, Volume 69, Number 1782, February 22, 1929 (p. 206)

### Loehle, Craig

Mathematical ecologist

What would have happened if Darwin and Einstein as young men had needed to apply for government support? Their probability of getting past the grant reviewers would be similar to a snowball surviving in Hell.

A Guide to Increased Creativity in Research – Inspiration or Perspiration? *BioScience*, Volume 40, Number 2, February 1990 (p. 125)

## FUNGI

### Ajello, Libero 1916–

Some fungi produce a mycosis

Like blaster or histoplasmosis

But for musical sake

The one I will take

Is coccidioidomycosis.

In George W. Hudler

*Magical Mushrooms, Mischievous Molds*

Coccidioidomycosis (p. 109)

Princeton University Press. Princeton, New Jersey, USA. 1998

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

There's a thing that grows by the fainting flower,  
And springs in the shade of the lady's bower;  
The lily shrinks, and the rose turns pale,  
When they feel its breath in the summer gale,  
And the tulip curls its leaves in pride,  
And the blue-eyed violet starts aside:

But the lily may flaunt, and the tulip stare,

For what does the honest toadstool care?

*The Complete Poetical Works of Oliver Wendell Holmes*

The Toadstool, Stanza 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

### Nicholson, Norman 1914–87

English poet

The toadstool towers infest the shore:

Stink-horns that propagate and spore

Wherever the wind blows.

*A Local Habitation*

Windscale (p. 282)

Faber & Faber Ltd. London, England. 1994

### Peattie, Donald Culrose 1896–1964

American botanist, naturalist, and author

The fungi are the underworld of plant life, that lives clandestinely, by its unconscious wits, taking to cover in unfavorable times, rioting at another.

*Flowering Earth*

Chapter 18 (p. 234)

G.P. Putnam's Sons. New York, New York, USA. 1939

## FUSION

### Macaulay, Robert B.

No biographical data available



Fission is like kissing your wife. Fusion is like kissing your mistress.

*Globe and Mail*, Toronto, June 8, 1983

**Pauli, Wolfgang** 1900–58

Austrian-born physicist

Let no man join together what God hath put asunder.

In Robert P. Crease and Charles C. Mann

How the Universe Works

*The Atlantic Monthly*, August 1984 (p. 68)

**Winsor, Frederick**

No biographical data available

The Hydrogen Dog and the Cobalt Cat

Side by side in the Armory sat.

Nobody thought about fusion or fission,

Everyone spoke of their peacetime mission,

Till somebody came and opened the door,

There they were, in a neutron fog,

The Codrogen Cat and the Hybalt Dog;

They mushroomed up with a terrible roar —

And Nobody Never was there — No more.

*The Space Child's Mother Goose*

Simon & Schuster. New York, New York, USA. 1958

## FUTURE

**Boulding, Kenneth E.** 1910–93

English economist and social scientist

There are only two things we know about the future. One is where and when eclipses will take place and the other is that a kitten will never grow up into a rhinoceros.

The Dodo Didn't Make It: Survival and Betterment

*Bulletin of the Atomic Scientists*, Volume XXVIII, Number 5, May 1971

(p. 20)

**Davy, Sir Humphry** 1778–1829

English chemist

The future is composed merely of images of the past, connected in new arrangements by analogy, and modified by the circumstances and feelings of the moment...

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 18)

Press of the Royal Institution of Great Britain. London. 1802

**Einstein, Albert** 1879–1955

German-born physicist

The scientist is possessed by the sense of universal causation. The future, to him, is every whit as necessary and determined as the past.

*Ideas and Opinions*

The Religious Spirit of Science (p. 40)

Crown Publishers, Inc. New York, New York, USA. 1954

**Hilbert, David** 1862–1943

German mathematician

Who of us would not be glad to lift the veil behind which the future lies hidden; to cast a glance at the next advances of our science and at the secrets of its development during future centuries?

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902

(p. 437)

**Kapitza, Pyetr Leonidovich** 1894–1984

Russian physicist

...only by having a clear perspective of the future can we rightly direct our work in the present.

*The Collected Papers of P.L. Kapitza* (Volume 3)

Chapter 26 (p. 190)

Pergamon Press. Oxford, England. 1967

**Lawrence Ernest O.** 1901–58

American physicist

In a discussion bearing on the future, the scientist is always in something of a dilemma. On the one hand, he is cautioned to make only very limited prognostications, for he has learned the limited region of applicability of existing knowledge and the likelihood of error in speculation. On the other hand, he faces the future with eager excitement and curiosity about what is beyond the present frontiers of knowledge, and he is naturally tempted to speculate and indeed to indulge in day dreams.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1941

The New Frontiers in the Atom (p. 163)

Government Printing Office. Washington, D.C. 1942

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

When the time is run, and that future become history, it will be clear how little of it we today foresaw or could foresee.

*The Open Mind*

Chapter III (p. 53)

Simon & Schuster. New York, New York, USA. 1955

**Poincaré, Lucien** 1862–1920

French physicist

It would doubtless be exceedingly rash, and certainly very presumptuous, to seek to predict the future which may be reserved for physics. The role of prophet is not a scientific one, and the most firmly established precisions of to-day may be overthrown by the reality of to-morrow.

*The New Physics and Its Evolution*

Chapter XI (p. 322)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

**Tennyson, Alfred (Lord)** 1809–92

English poet

When I dipt into the Future, far as human eye could see;  
Saw the vision of the world, and all the wonder that  
would be.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 8

Oxford University Press, Inc. London, England. 1953

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The man of science comes to believe at last that the events of the year A.D. 4000 are as fixed, settled, and unchangeable as the events of the year 1600. Only about the latter he has some material for belief and about the former practically none.

*The Discovery of the Future* (pp. 23–24)

B.W. Huebsch. New York, New York, USA. 1913

On the whole there is something sympathetic for the dupe of the fortune-teller in the spirit of modern science; it is one of the persuasions that come into one's mind, as one assimilates the broad conception of science, that the adequacy of causation is universal; that in absolute fact — if not in that little bubble of relative fact which constitutes the individual life — in absolute fact the future is just as fixed and determinate, just as settled and inevitable, just as possible a matter of knowledge as the past.

*The Discovery of the Future* (pp. 22–23)

B.W. Huebsch. New York, New York, USA. 1913

Man has acquired the habit of going to the past because it was the line of least resistance for his mind. While a certain variable portion of the past is serviceable matter for knowledge in the case of everyone, the future is, to a mind without an imagination trained in scientific habits of thought, non-existent.

*The Discovery of the Future* (p. 21)

B.W. Huebsch. New York, New York, USA. 1913

All this world is heavy with the promise of greater things, and a day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool, and shall laugh and reach out their hands amidst the stars.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

*The Discovery of the Future* (p. 392)

Government Printing Office. Washington, D.C. 1903

**Wiener, Norbert** 1894–1964

American mathematician

The future offers very little hope for those who expect that our new mechanical slaves will offer us a world in which we may rest from thinking. Help us they may, but at the cost of supreme demands upon our honesty and intelligence. The world of the future will be an ever more demanding struggle against the limitations of our intelligence, not a comfortable hammock in which we can lay down to be waited upon by our robot slaves.

*God and Golem, Inc.: A Comment on Certain Points Where Cybernetics*

*Impinges on Religion*

Chapter V (p. 69)

The MIT Press. Cambridge, Massachusetts, USA. 1964

**Whyte, A. Gowans**

Scottish writer

Knowledge is advancing in geometrical progression, and with each new conquest we gain more mastery over the problems that confront us. More assuredly than ever before, the future rests with science.

*The Triumph of Physics*

*The Rationalist Annual*, 1931 (p. 34)

## G

### GAIA

#### Joseph, Lawrence E.

No biographical data available

The Gaia hypothesis is the first comprehensive scientific expression of the profoundly ancient belief that the planet Earth is a living creature.

*GALA, the Growth of an Idea*

Introduction (p. 1)

St. Martin's Press. New York, New York, USA. 1990

#### Lovelock, James Ephraim 1919–

English scientist

When I first introduced Gaia [an ecological theory], I had vague hopes that it might be denounced from the pulpit and thus made acceptable to my scientific colleagues. As it was, Gaia was embraced by theologians and by a wide range of New Age writers and thinkers but denounced by biologists.

*Earthwatch*

Rethinking Life on Earth: The Sum: Gaia Takes Flight

September/October 1992

The Gaia hypothesis is for those who like to walk or simply stand and stare, to wonder about the Earth and the life it bears, and to speculate about the consequences of our own presence here.

*Gaia: A New Look at Life on Earth*

Introductory (p. 11)

Oxford University Press, Inc. Oxford, England. 2000

The clues to Gaia's existence are as transient as our sand-castle. If her partners in life were not there, continually repairing and recreating, as children build fresh castles on the beach, all Gaia's traces would soon vanish....

*Gaia: A New Look at Life on Earth*

Chapter 3 (p. 31)

Oxford University Press, Inc. Oxford, England. 2000

#### Murchie, Guy 1907–97

American biologist

If a germ cannot be presumed aware of the living state of the body it dwells in, how can man's somewhat similarly circumscribed view afford him much more comprehension of the total aliveness of his planet today....

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*

Part Three, Chapter 14 (p. 389)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

...the physical essence of Earth life may be termed a spherical biofilm rotating in gravitational, electromagnetic, and nuclear fields — a sort of gyrating bubble of evolving potency, a cosmic node of ferment.

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*

Part One, Chapter 1 (p. 15)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

### GALAPAGOS

#### Darwin, Charles Robert 1809–82

English naturalist

Considering the small size of these islands, we feel the more astonished at the number of their aboriginal beings and at their confined range. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period, geologically recent, the unbroken ocean was here spread out. Hence, both in space and time, we seem to be brought somewhat near to that great fact — that mystery of mysteries — the first appearance of new beings on this earth....

*The Voyage of The Beagle*

Chapter XVII (pp. 377–378)

Heron Books. Sheridan, Oregon, USA. 1968

### GALAXY

#### Chaisson, Eric J. 1946–

Astrophysicist

Silently and majestically, galaxies twirl in the faraway tracts of the Universe — vast pinwheels of energy, matter, and perhaps life — imparting a feeling simultaneously for the immensity of the Universe and for the mediocrity of our position in it.

*The Life Era: Cosmic Selection and Conscious Evolution*

Chapter 1 (p. 18)

The Atlantic Monthly Press. New York, New York, USA. 1987

#### Denton, Michael J. 1943–

British-Australian molecular biologist

Ironically, our relatively peripheral position on the spiral arm of a rather ordinary galaxy is indeed rather fortunate. If we had been stationed in a more central position — say, near the galactic hub — it is likely that our knowledge of the universe of other galaxies, for example, might not have been as extensive. Perhaps in such a position the light from surrounding stars could well have blocked our view of intergalactic space. Perhaps astronomy and cosmology as we know these subjects would never have developed.

*Nature's Destiny: How the Laws of Biology Reveal Purpose in the Universe*

Conclusion (p. 372)

The Free Press, New York, New York, USA. 1998

#### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

The running away of the galaxies does not mean that they have a kind of aversion from us.

*New Pathways in Science*

Chapter X, Section II (p. 210)

The Macmillan Company. New York, New York, USA. 1935

Let us first understand what a galaxy is. The following is a recipe for making galaxies: Take about ten thousand million stars. Spread them so that on the average light takes three or four years to pass from one to the next. Add about the same amount of matter in the form of diffuse gas between the stars. Roll it all out flat. Set it spinning in its own plane. Then you will obtain an object which, viewed from a sufficient distance, will probably look more or less like a spiral nebula.

*New Pathways in Science*

Chapter X, Section I (p. 206)

The Macmillan Company. New York, New York, USA. 1935

**Ferris, Timothy** 1944–

American science writer

Galaxies are so big that once you get up to their scale, the universe starts to take on an almost country-cottage intimacy.

*Seeing In the Dark*

Chapter 17 (p. 253)

Simon & Schuster. New York, New York, USA. 2002

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Think of the stars as ordinary household specks of dust. Then we must think of a galaxy as a collection of specks a few miles apart from each other, the whole distribution filling a volume about equal to the Earth. Evidently one such collection of specks could pass almost freely through another.

*Frontiers of Astronomy*

Chapter Sixteen (p. 278)

Harper & Row, Publishers. New York, New York, USA. 1955

**Jeffers, Robinson** 1887–1962

American poet

Galaxy on galaxy, innumerable swirls of innumerable stars, endured as it were forever and humanity Came into being, its two or three million years are a moment, in a moment it will certainly cease out from being.

*The Selected Poetry of Robinson Jeffers*

Margrave

Random House, Inc. New York, New York, USA. 1938

**Keel, William C.**

No biographical data available

Galaxies are rightly called the “atoms of astronomy,” for they are the fundamental building blocks of matter on a cosmic scale.

Crashing Galaxies, Cosmic Fireworks

*Sky and Telescope*, Volume 77, Number 1, January 1989 (p. 18)

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

We find that the galaxy has a much larger mass than the sum of all the stars, dust, and other things we “see.” The shortfall is not just a few percentage points, but most of the mass of our galaxy seems to have been left unaccounted.

*Blind Watchers of the Sky*

Chapter Eleven (pp. 292–293)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

...I leave it undecided whether the Milky Way visible to us still belongs to uncounted others and forms with these a whole system. Perhaps the light of this so immeasurably distant Milky Way is so weak that we are unable to see it.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Tenth Letter (p. 111)

Science History Publications. New York, New York, USA. 1976

**Sagan, Carl** 1934–96

American astronomer and science writer

The study of the galaxies reveals a universal order and beauty. It also shows us chaotic violence on a scale hitherto undreamed of. That we live in a universe which permits life is remarkable. That we live in one which destroys galaxies and stars and worlds is also remarkable. The universe seems neither benign nor hostile, merely indifferent to the concerns of such puny creatures as we.

*Cosmos*

Chapter X (p. 250)

Random House, Inc. New York, New York, USA. 1980

**Sandage, Allan** 1926–

American astronomer

They are to astronomy what atoms are to physics. Each galaxy is a stellar system somewhat like our Milky Way, and isolated from its neighbors by nearly empty space. In popular terms, each galaxy is a separate universe unto itself.

*The Hubble Atlas of Galaxies* (p. 1)

Carnegie Institution of Washington. Washington, D. C. 1961

**Saslaw, William C.**

Astronomer

If galaxies did not exist we would have no difficulty in explaining the fact.

*Gravitational Physics of Stellar and Galactic Systems*

Chapter 21 (p. 157)

Cambridge University Press. London, England. 1985

**Tennyson, Alfred (Lord)** 1809–92

English poet

The fires that arch this dusty dot —  
 Yon myriad worlded-ways —  
 “The vast sun-cluster” gathered blaze,  
 World-isles in lonely skies,  
 Whole heavens within themselves amaze  
 Our brief Humanities.

*Alfred Tennyson's Poetical Works*

Epilogue, l. 51–56

Oxford University Press, Inc. London, England. 1953

**Updike, John** 1932–

American novelist, short story writer, and poet

And beyond our galaxy are other galaxies, in the universe all told at least a hundred billion, each containing a hundred billion stars. Do these figures mean anything to you?

*The Centaur*

Chapter I (p. 37)

Alfred A. Knopf. New York, New York, USA. 1995

**Wolf, Fred Alan** 1934–

American theoretical physicist, writer, and lecturer

Stars, like little lost children seeking shelter on a cold night, tend to cluster, via gravitationally induced starlight, into galaxies.

*Parallel Universes*

Chapter 6 (p. 71)

Simon & Schuster. New York, New York, USA. 1988

**Wright, Thomas** 1711–86

English cosmologist

Since as the Creation is, so is the Creator also magnified, we may conclude in consequence of an infinity, and an infinite all-active power, that as the visible creation is supposed to be full of sidereal systems and planetary worlds, so on, in like similar manner, the endless immensity is an unlimited plenum of creations not unlike the known. . . . That this in all probability may be the real case, is in some degree made evident by the many cloudy spots, just perceivable by us, as far without our starry Regions, in which tho' visibly luminous spaces, no one star or particular constituent body can possibly be distinguished; those in all likelihood may be external creation, bordering upon the known one, too remote for even our telescopes to reach.

*An Original Theory or New Hypothesis of the Universe*

Letter the Ninth (p. 83)

Printed for the Author. London, England. 1750

**GALL BLADDER**

**Rogers, Will** 1879–1935

American actor and humorist

Then he turned and exclaimed with a practiced and well-subdued enthusiasm, “It’s the Gall-Bladder — just what

I was afraid of.” Now you all know what the word “afraid of,” when spoken by a doctor, leads to. It leads to more calls.

*The Autobiography of Will Rogers*

Chapter Twelve (p. 153)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

**GAMBLING**

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

In moderation, gambling possesses undeniable virtues. Yet it presents a curious spectacle replete with contradictions. While indulgence in its pleasures has always lain beyond the pale of fear of Hell’s fires, the great laboratories and respectable insurance palaces stand as monuments to a science originally born of the dice cup.

*Mathematics and the Imagination*

Chance and Chanceability (p. 239)

Simon & Schuster. New York, New York, USA. 1940

**Pompidou, Georges** 1911–1974

19<sup>th</sup> president and longest serving prime minister of France

There are three roads to ruin; women, gambling and technicians. The most pleasant is with women, the quickest is with gambling, but the surest is with technicians.

*Sunday Telegraph*, 26 May 1968

**Puzo, Mario** 1920–99

American novelist and screenwriter

He felt the table was having a run of bad luck, but he knew. Gronevelt would never accept that explanation. Gronevelt believed that the house could not lose over the long run, that the laws of percentage were not subject to chance. As gamblers believed mystically in their luck so Gronevelt believed in percentages.

*Fools Die: A Novel*

Chapter 17 (pp. 187–188)

G.P. Putnam’s Sons. New York, New York, USA. 1978

**GARDEN**

**Armstrong, Martin D.** 1882–1974

No biographical data available

A garden is the attempt of Man and Nature to materialize their dreams of the original Paradise. Man is its father and Nature its mother, so that all gardens which deserve the name are half-human, can appeal to us with a personality of their own.

Two Italian Gardens

*The Atlantic Monthly*, Volume cx, September 1912 (p. 360)

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

God Almighty first planted a garden.

*The Essays or Counsels Civil of Francis Bacon*  
Of Gardens (p. 195)

J.M. Dent &amp; Sons Ltd. London, England. 1900

**GAS****Author undetermined**

Sir James Dewar

Is cleverer than you are

None of you asses

Can condense gases.

In Abraham Pais

*Inward Bound*

Chapter 7 (p. 137)

Clarendon Press. Oxford, England. 1986

Sulfurated hydrogen is a gas of pugnacious odor.

Classroom Emanations, Volume 2, Number 7, July 1925 (p. 611)

A gas is a dry liquid.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

In my opinion it would be a great tragedy for science if the theory of gases were temporarily thrown into oblivion because of a momentary hostile attitude toward it, as for example was the wave theory because of Newton's authority.

I am conscious of being only one individual struggling weakly against the stream of time. But it still remains in my power to contribute in such a way that, when the theory of gases is again revived, not too much will have to be rediscovered.

Translated by Stephen G. Brush

*Lectures on Gas Theory*

Part II, Forward to Part II (p. 216)

University of California Press. Berkeley, California, USA. 1964

**Dalton, John** 1766–1844

English chemist and physicist

At the time I formed the theory of mixed gases I had a confused idea, as many have, I suppose, at this time, that the particles of elastic fluids are all of the same size; that a given volume of oxygenous gas contains just as many particles as the same volume of hydrogenous.... But...I became convinced that different gases have not their particles of the same size: and that the following may be adopted as a maxim, till some reason appears to the contrary: namely — [t]hat every species of pure elastic fluid has its particles globular and all of a size; but that no two species agree in the size of their particles, the pressure and temperature being the same.

*A New System of Chemical Philosophy*

John Day. New York, New York, USA. 1966

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

...chemistry, which is the analysis of matter, has taught us that we eat gas, drink gas, tread on gas, and are gas.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Lectures and Biographical Sketches

Chapter XII (p. 329)

Houghton, Mifflin and Company. Boston, Massachusetts, USA. 1904

**Maxwell, James Clerk** 1831–79

Scottish physicist

So many of the properties of matter, especially when in the gaseous form, can be deduced from the hypothesis that their minute parts are in rapid motion, the velocity increasing with the temperature, that the precise nature of this motion becomes a subject of rational curiosity. Daniel Bernoulli, Herapath, Joule, Krönig, Clausius, etc. have shewn that the relations between pressure, temperature, and density in a perfect gas can be explained by supposing the particles to move with uniform velocity in straight lines, striking against the sides of the containing vessel and thus producing pressure.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 1)

Illustrations of the Dynamical Theory of Gases (p. 377)

At The University Press. Cambridge, England. 1890

**Silver, Brian L.**

Israeli professor of physical chemistry

In general, chemical experience suggests that each gas is unique, which is true, and has very little, if anything, in common with most other gases, which is not true. That which is common to all gases is the way in which their molecules move.

*The Ascent of Science*

Part I, Chapter 1 (p. 5)

Solomon Press Book. New York, New York, USA. 1998

**The X-Files**

SCULLY: And you know, there's a marsh over there. The lights the driver saw may have been swamp gas.

MULDER: Swamp gas?

SCULLY: It's a natural phenomenon in which phosphine and methane rising from decaying organic matter ignite, creating globes of blue flame.

*E.B.E.*

Television program

Season 1 (1993)

**GASTRULATION****Wolpert, Lewis** 1929–

American biologist

It is not birth, marriage, or death, but gastrulation which is truly the most important time in your life.

In J.M.W. Slack (ed.)

*From Egg to Embryo: Determinative Events in Early Development*  
(p. 1)

Cambridge University Press. Cambridge, England. 1991

## GENE

**Beadle, George Wells** 1903–89

American geneticist

**Tatum, Edward** 1909–75

American biochemist

One gene — one enzyme.

In Francis Crick

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 13 (p. 33)

Basic Books, Inc. New York, New York, USA. 1988

**Benzer, Seymour** 1921–

American molecular biologist

The genes are the atoms of heredity...

*The Harvey Lectures*

Genetic Fine Structure, Series 56, (p. 1)

Academic Press. New York, New York, USA. 1960–61

**Boulding, Kenneth E.** 1910–93

English economist and social scientist

The gene is a wonderful teacher. It is, however, a very poor learner.

*The Image*

Chapter 3 (p. 37)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1956

**Danforth, Charles Haskell** 1883–1969

American anatomist

One might say that the gene is to some of the biological sciences what the atom is to the physical sciences...

Genetics and Anthropology

*Science*, Volume 79, Number 2045, Friday March 9, 1934 (p. 216)

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

We are survival machines — robot vehicles blindly programmed to preserve the selfish molecules known as genes...They swarm in huge colonies, safe inside gigantic lumbering robots...they are in you and me; they created us, body and mind; and their preservation is the ultimate rationale for our existence.

*The Selfish Gene*

Preface to the 1976 Edition (p. ix)

Oxford University Press, Inc. Oxford, England. 1976

The genes are master programmers, and they are programming for their lives.

*The Selfish Gene*

Chapter 4 (pp. 66–67)

Oxford University Press, Inc. Oxford, England. 1976

**Heinlein, Robert A.** 1907–88

American science fiction writer

No man owns his genes; he's merely their custodian. They are passed to him willy-nilly in the meiotic dance; he passes them along to others through the same blind chances.

*Time Enough for Love*

Chapter X (p. 253)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Lote, Christopher J.**

No biographical data available

The human genome project will sooner or later identify the gene or genes responsible for religious belief. Perhaps we can contemplate (with tongue only slightly in cheek!) a brave new world in which genetic engineering can free humanity from the scourge of religion and allow us to look forward to a bright rationalist future.

Correspondence

*Nature*, Volume 363, Number 6428, 3 June 1993 (p. 390)

**Midgley, Mary** 1919–

English philosopher

Genes cannot be selfish or unselfish, any more than atoms can be jealous, elephants abstract or biscuits teleological.

Gene-juggling

*Philosophy*, Volume 54, Number 210, 1979 (p. 439)

**Murchie, Guy** 1907–97

American biologist

A gene is one step in the secret recipe for growing up, for living. It is a wave of the unseen wand that turns a tadpole into a frog, a caterpillar into a butterfly. It is a basic unit of heredity.

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*

Part One, Chapter 6 (p. 152)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

**Sagan, Carl** 1934–96

American astronomer and science writer

...organisms die but their genes pass on — often mutated and redistributed, it is true, but genes nevertheless; and it is difficult, therefore, to escape the conclusion that the design of the organism is merely to provide for gene multiplication and survival...

Radiation and the Origin of the Gene

*Evolution*, January 1957

**Watson, James D.** 1928–

American geneticist and biophysicist

We used to think our fate was in our stars. Now we know, in large measure, our fate is in our genes.

In L. Jaroff

The Gene Hunt

*Time*, March 20, 1989(p. 67)

**GENE POOL**

**Mayr, Ernst** 1904–2005  
German-born American biologist

The genes within a gene pool form a harmonious whole which can evolve only as a whole. The first step, then, in the multiplication of species, is a physical separation of a portion of the species, permitting it to go its own way genetically. What happens after this isolation depends on the genetic contents of the isolated population, on the totality of selection forces working on it and on numerous chance phenomena (mutation, recombination, etc).

Isolation as an Evolutionary Factor

*Proceedings of the American Philosophical Society*, Volume 103, 1959 (p. 226)

**GENERA**

**Darwin, Charles Robert** 1809–82  
English naturalist

Please observe the question is not whether there are more or fewer varieties in larger or smaller genera, but whether there is a stronger or weaker tendency in the minds of botanists to record such in large or small genera.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to Asa Gray, February 21, 1859 (p. 464)

D. Appleton & Company. New York, New York, USA. 1896

**Linnaeus, Carl (von Linné)** 1707–78  
Swedish botanist and explorer

By a botanist I mean one who understands how to observe the genera of Nature. I judge unworthy of the name of botanist the meddlesome person who is indifferent to genera.

*Critica Botanica*

Generic Names (p. 3)

The Ray Society. London, England. 1938

**GENERAL PRACTICE**

**Bashford, Sir Henry Howarth**

General practice is at least as difficult, if it is to be carried on well and successfully, as any special practice can be, and probably more so; for the G.P. has to live continually, as it were, with the results of his handiwork.

*The Corner of Harley Street*

Chapter 26 (p. 233)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**GENERAL PRACTITIONER**

**Hubbard, Kin** 1868–1930  
American Democratic newspaper editor

Th' thing I like about general practitioners is that you don't have t' let 'em know a week ahead when you're goin' t' be sick.

*Abe Martin: Hoss Sense and Nonsense* (p. 94)

The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1926

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

For the general practitioner a well-used library is one of the few correctives of the premature senility which is so apt to overtake him. Self-centered, self-taught, he leads a solitary life, and unless his every-day experience is controlled by careful reading or by the attrition of a medical society it soon ceases to be of the slightest value and becomes a mere accretion of isolated facts, without correlation. It is astonishing with how little reading a doctor can practise medicine, but it is not astonishing how badly he may do it.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Books and Men (pp. 210–211)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**GENERAL RELATIVITY**

**Besso, Michele** 1873–1955  
Physicist

...the devil has gotten into my friends in the Physical Society and they want a talk from me on your [Einstein's] latest papers: even though there are at least three people here — Abraham, Grossmann, and Weyl — who know a hundred times more about the topic than I do. I feel like someone for whom Beethoven has whistled his symphony and who now on the basis of that has to whistle after him — someone with the score in front of his eyes, but only being able to read it the way I read sheet music...

*Collected Papers of Albert Einstein* (Volume 8)

Letter, Besso to Einstein (Document 229)

June 28, 1916

Princeton University Press. Princeton, New Jersey, USA. 1987

**Einstein, Albert** 1879–1955  
German-born physicist

My faith in the reliability of the theory still fluctuates... Thus, if not all systems of equations of the theory... admit transformations other than linear ones, then the theory contradicts its own starting point and all is up in the air.

*Collected Papers of Albert Einstein* (Volume 5)

Letter, Einstein to Lorentz (Document 467)

August 14, 1913

Princeton University Press. Princeton, New Jersey, USA. 1987

**GENERALITY**

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist



Generalization is always a new influx of divinity into the mind. Hence the thrill that attends it.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Circles (p. 407)

The Library of America. New York, New York, USA. 1983

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

In the natural sciences, and particularly in chemistry, generalities must come after the detailed knowledge of each fact and not before it. It is really only after having acquired this knowledge that one may see if the facts have anything in common...and only after that is it permissible to consider them in a general manner.

*Annales de Chimie et de Physique*, Volume 11, 1819 (p. 297)

**Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

Science is nothing without generalisations.... The suggestion of a new idea, or the detection of a law, supersedes much that had previously been a burden upon the memory, and by introducing order and coherence facilitates the retention of the remainder in an available form.

In William C. McC. Lewis

*A System of Physical Chemistry* (Volume 1) (p. iv)

Longmans, Green and Company. London, England. 1918

## GENERALIZATION

**Bloom, Orly Castel** 1960–

Israeli writer

What is a generalization? Who said that one should not generalize?...To say that one should not generalize is not a generalization?

*Human Parts* (p. 150)

Kinneret. Tel Aviv, Israel. 2002

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

It is well to be explicit when a positive generalization is made from negative experimental evidence.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter IV (p. 76)

At The University Press. Cambridge, England. 1921

**Michener, James A.** 1907?–97

American Pulitzer Prize novelist

When a man has studied the heavens for ten thousand nights, he is entitled to make certain generalizations. Space is without limit or definition. There is no east or west, no north or south, no down or up, no in or out. It is truly boundless and must be respected as such. It cannot

be measured or comprehended. All we can do is behave in accordance with its laws as we dimly perceive them.

*Space*

Chapter VI (p. 333)

Random House, Inc. New York, New York, USA. 1982

## GENETIC

**Callahan, Daniel**

No biographical data available

That the emphasis has so far fallen most heavily on ridding mankind of genetic disease should not obscure the fact that the vision of genetic improvement has a lively life just below the surface, in the stirrings of a new eugenics movement.

*The Tyranny of Survival; and Other Pathologies of Civilized Life*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1973

**Campbell, J. H.**

No biographical data available

This new era of genetics is disclosing a remarkable new type of biological function. Some genetic structures do not adapt the organism to its environment. Instead, they have evolved to promote and direct the process of evolution. They function to enhance the capacity of the species to evolve.

In D.J. Depew and B.H. Weaver (eds.)

*Evolution at a Crossroads: The New Biology and the New Philosophy of Science*

An Organizational Interpretation of Evolution (p. 137)

MIT Press. Cambridge, Massachusetts, USA. 1985

**Dobzhansky, Theodosius** 1900–75

Russian American scientist

Genetics is the first biological science which got in the position in which physics has been in for many years. One can justifiably speak about such a thing as theoretical mathematical genetics, and experimental genetics, just as in physics. There are some mathematical geniuses who work out what to an ordinary person seems a fantastic kind of theory. This fantastic kind of theory nevertheless leads to experimentally verifiable prediction, which an experimental physicist has to test the validity of. Since the times of Wright, Haldane, and Fisher, evolutionary genetics has been in a similar position.

In William B. Provine

*Sewall Wright and Evolutionary Biology*

Chapter 9 (p. 277)

Genetics, an important branch of biological science, has grown out of the humble peas planted by Mendel in a monastery garden.

The Mendel Centennial

*The Rockefeller Institute Review*, Volume 2, 1964

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

In the 50 years since Mendel's Laws were so dramatically rediscovered, genetics has been transformed from a groping incertitude to a rigorous and many-sided discipline, the only branch of biology in which induction and deduction, theory and experiment, observation and comparison have come to interlock, in the same sort of way that they have for many years done in physics.  
In L.C. Dunn (ed.)

*Genetics in the 20th Century: Essays on the Progress of Genetics during the First 50 Years*  
Genetics, Evolution and Human Destiny (p. 591)  
The Macmillan Company. New York, New York, USA. 1951

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

...the genetic code [is] written in the four-letter alphabet, "A", "G", "C", "T." Here, then, floating in the nuclear sap, is the code which governs the skill of creating a six-foot drum major with a slight squint and dimpled cheeks out of an egg with a diameter of a few microns.  
*The Act of Creation*  
Book Two, Chapter I (p. 417)  
The Macmillan Company. New York, New York, USA. 1964

**Sturtevant, A. H.**  
No biographical data available

Man is one of the most unsatisfactory of all organisms for genetic study.  
Social Implications of the Genetics of Man  
*Science*, Volume 120, Number 3115, September 10, 1954 (p. 405)

**Thomas, Lewis** 1913–93  
American physician and biologist

It is the very strangeness of nature that makes science engrossing. That ought to be at the center of science teaching. There are more than seven-times-seven types of ambiguity in science, awaiting analysis. The poetry of Wallace Stevens is crystal-clear alongside the genetic code.  
*Late Night Thoughts on Listening to Mahler's Ninth Symphony*  
Humanities and Science (p. 150)  
Viking Press. New York, New York, USA. 1983

## GENETIC THEORY

**Jeffers, Robinson** 1887–1962  
American poet

He smiled in himself  
Thinking about the scrap of Mendelian theory  
Picked up in high-school: blue eyes recessive, brown dominant:  
Therefore blue-eyed parents cannot produce  
A dark-eyed child, the dark-eyed-producing element

Is lacking in them. If it were present in either,  
That one would be dark-eyed, for dark eyes are dominant.  
In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 2)  
Such Counsels You Gave to Me (p. 568)  
Stanford University Press. Stanford, California, USA. 1988

## GENETICS

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

I believe that no one who is familiar, either with mathematical advances in other fields, or with the range of special biological conditions to be considered, would ever conceive that everything could be summed up in a single mathematical formula, however complex.  
The Evolutionary Modification of Genetic Phenomena  
*Proceedings of the 6th International Congress of Genetics*, Volume 1, 1932

**Shakespeare, William** 1564–1616  
English poet, dramatist, and actor

But where the bull and cow are both milk-white,  
They never do beget a coal-black calf.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
Titus Andronicus  
Act V, Scene i, l. 31–32  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sturtevant, A. H.**  
No biographical data available

The possibilities of the genetic study of *Drosophila* were then just beginning to be apparent; we were at the right place at the right time.  
*American Scientist*, Volume 53, Number 303, 1965

**Virchow, Rudolf Ludwig Karl** 1821–1902  
German pathologist and archaeologist

Where a cell arises, there a cell must have previously existed (*omnis cellula e cellula*), just as an animal can spring only from an animal, a plant only from a plant.  
Translated by Framl Chase  
*Cellular Pathology: As Based Upon Physiological and Pathological History*  
Lecture II (p. 54)  
Dover Publications, Inc. New York, New York, USA. 1971

## GENIUS

**Amiel, Henri-Frédéric** 1821–81  
Swiss philosopher, poet, and critic

To do easily what is difficult for others is the mark of talent. To do what is impossible for talent is the mark of genius.  
Translated by Mrs. Humphrey Ward

*Amiel's Journal*

December 17, 1856 (p. 76)

A.L. Burt Company, Publishers. New York, New York, USA. 189?

**Bartol, C. A.** 1813–1900

No biographical data available

As diamond cuts diamond, and one hone smoothes a second, all the parts of intellect are whetstones to each other; and genius which is but the result of their mutual sharpening is character too.

*Radical Problems*

Individualism (p. 43)

Robert Brothers. Boston, Massachusetts, USA. 1872

**Bester, Alfred** 1913–87

Science fiction author

A genius is someone who travels to truth by an unexpected path.

*Starlight: The Great Short Fiction of Alfred Bester*

The Man Who Murdered Mohammed (p. 90)

Nelson Doubleday, Inc. Garden City, New York, USA. 1976

**Bromberger, Sylvain**

No biographical data available

A clear mark of scientific genius is the ability to see certain well-known facts as departures from general rules... and the germane ability to ask why-questions that occur to no one else.

In Robert G. Colodny (ed.)

*Mind and Cosmos*

Why-Questions (p. 103)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1966

**Carlyle, Thomas** 1795–1881

English historian and essayist

...genius is ever a secret to itself...

*Characteristics, by Thomas Carlyle; Favorite Poems, by Percy Bysshe*

*Shelley; the Eve of St. Agnes, and Other Poems, by John Keats*

Paragraph 6 (p. 11)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1882

**Ceild, J. M.**

No biographical data available

That man is well on the way to becoming a genius who can take a second man's subject, apply to it a third man's method, and get more out of either than the originators.

In W.J. Greenstreet

*Isaac Newton*

Newton and the Art of Discovery (p. 129)

G. Bell & Sons Ltd. London, England. 1927

**Diderot, Denis** 1713–84

French encyclopedist and philosopher of materialism

We have three principal means: observation of nature, reflection, and experiment. Observation gathers the facts reflection combines them, experiment verifies the result of the combination. It is essential that the observation

of nature be assiduous, that reflection be profound, and that experimentation be exact. Rarely does one see these abilities in combination. And so, creative geniuses are not common.

*Thoughts on the Interpretation of Nature*

Chapter XV

Clinamen Press Ltd. Manchester, England. 2000

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

They say that genius is an infinite capacity for taking pains, he remarked with a smile. It's a very bad definition, but it does apply to detective work.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 3 (p. 171)

Wings Books. New York, New York, USA. 1967

**Edison, Thomas Alva** 1847–1931

American inventor

Genius is 1 per cent inspiration and 99 per cent perspiration.

In Frank Lewis Dyer

*Edison His Life and Inventions* (Volume 2)

Chapter XXIV (p. 607)

Harper & Brothers. New York, New York, USA. 1929

**Egler, Frank E.** 1911–96

Ecologist

Genius knows no method, tho it leaves a spoor-method for drones to follow.

*The Way of Science*

Methodology and Logic (p. 44)

Hafner Publishing Company. New York, New York, USA. 1970

**Fitzgerald, F. Scott** 1896–1940

American novelist and short story writer

Genius is the ability to put into effect what is in your mind. There's no other definition of it.

*The Crack-Up*

The Note-Books, E (p. 123)

New Directions. New York, New York, USA. 1945

**Hazlitt, William Carew** 1834–1913

English bibliographer

Genius is a native to the soil where it grows — is fed by the air, and warmed by the sun; and is not a hothouse plant or an exotic.

In W. Carew Hazlitt (ed.)

*The Round Table; Northcotes Conversations; Characteristics*

Commonplaces, XXVII (p. 534)

George Bell & Sons. London, England. 1884

**Joyce, James** 1882–1941

Expatriate Irish writer and poet

A man of genius makes no mistakes. His errors are volitional and are the portals of discovery.

*Ulysses* (p. 188)

Random House, Inc. New York, New York, USA. 1946

### Phillips, Wendell

No biographical data available

We measure genius by quality, not by quantity.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter VIII (p. 82)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

### Priestley, Joseph 1733–1804

English theologian and scientist

It sometimes happens to men whose genius far transcends the level of their day, to be from that very circumstance neither understood nor believed by their contemporaries.

*Memoirs of Dr. Joseph Priestley* (Volume 1)

Appendix Number 1 (p. 225 fn)

J. Binns. Northumberland, Pennsylvania, USA. 1806

### Swann, William Francis Gray 1884–1962

English physicist

When an outstanding genius causes science to take a leap forward beyond the vision of his contemporaries, there usually follows a period of depression in which it seems that all that is worth doing has been done, and that the universe has not already revealed must forever defy the power of man to fathom.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

Three Centuries of Natural Philosophy (p. 237)

Government Printing Office. Washington, D.C. 1929

### Westfall, Richard S. 1924–96

Science historian

...geniuses...are more apt to indicate the line of march into the future than to reflect the consensus accepted in their own time.

In David C. Lindberg and Ronald L. Numbers

*God and Nature: Historical Essays on the Encounter Between Christianity and Science*

The Rise of Science and the Decline of Orthodox Christianity (p. 219)

University of California Press. Berkeley, California, USA. 1986

### Whipple, E. P.

No biographical data available

Talent repeats; Genius creates. Talent is a cistern; Genius is a fountain. Talent deals with the actual, with discovered and realized truths, analyzing, arranging, combining, applying positive knowledge, and in action looking to precedents; Genius deals with the possible, creates new combinations, discovers new laws, and acts from an insight into principles. Talent jogs to conclusions to which Genius takes giant leaps. Talent accumulates knowledge, and has it packed up in the memory; Genius assimilates it with its own substance, grows with every

new accession, and converts knowledge into power. Talent gives out what it has taken in; Genius what has risen from its unsounded wells of living thought. Talent, in difficult situations, strives to untie knots, which Genius instantly cuts with one swift decision. Talent is full of thoughts, Genius [is] of thought; one has definite acquisitions, the other indefinite power.

*Literature and Life*

Genius (p. 162)

Ticknor, Reed and, Fields. Boston, Massachusetts, USA. 1850

### Wittgenstein, Ludwig Josef Johann 1889–1951

Austrian-born English philosopher

There are no more lights in a genius than in any other honest man — but he has a particular kind of lens to concentrate this light into a burning point.

Translated by Peter Winch

*Culture and Value* (p. 35e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

## GENOME

### Ridley, Matt 1958–

English science writer

This is the reality of genes for behavior. Do you see now how unthreatening it is to talk of genetic influences over behavior? How ridiculous to get carried away by one “personality gene” among 500? How absurd to think that, even in a future brave new world, some-body might abort a foetus because one of its personality genes is not up to scratch — and take the risk that on the next conception she would produce a foetus in which two or three other genes were of a kind she does not desire? Do you see now how futile it would be to practise eugenic selection for certain genetic personalities, even if somebody had the power to do so? You would have to check each of 500 genes one by one, deciding in each case to reject those with the “wrong” gene. At the end you would be left with nobody, not even if you started with a million candidates. We are all of us mutants. The best defense against designer babies is to find more genes and swamp people in too much knowledge.

*Genome: The Autobiography of a Species in 23 Chapters*

Chapter 11 (p. 165)

HarperCollins Publishers. New York, New York, USA. 2000

The truth is that nobody is in charge. It is the hardest thing for human beings to get used to, but the world is full of intricate, cleverly designed and interconnected systems that do not have control centers. The economy is such a system. The illusion that economies run better if somebody is put in charge of them — and decides what gets manufactured where and by whom — has done devastating harm to the wealth and health of people all over the world, not just in the former Soviet Union, but in the

west as well.... It is the same with the body. You are not a brain running a body by switching on hormones. Nor are you a body running a genome by switching on hormone receptors. Nor are you a genome running a brain by switching on genes that switch on hormones. You are all of these at once.

*Genome: The Autobiography of a Species in 23 Chapters*  
Chapter 10 (p. 151)  
HarperCollins Publishers. New York, New York, USA. 2000

## GENUS

### Wiley, E. O.

No biographical data available

The genus is a mandatory category to which every species must belong if binomial nomenclature is to be preserved.

*Phylogenetics: The Theory and Practice of Phylogenetic Systematics*  
(p. 205)  
John Wiley & Sons, Inc. New York, New York, USA. 1981

## GEOLOGY

### Adams, Henry Brooks 1838–1918

American man of letters

...the easier study of geology...suited idle minds as well as though it were history.

In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
Chapter XV (p. 225)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

### Barrett-Browning, Elizabeth 1806–61

English poet

Geology, ethnology, what not? —  
(Greek endings, each the little passing bell  
That signifies some faith's about to die.)

*The Poetical Works of Robert Browning*  
Bishop Blougram's Apology  
Smith, Elder & Co. London, England. 1886

### Berlinski, David 1942–

Mathematician

To geology go the Rock and Riffs; entomology gets the bugs.

Review of the Pleasures of Counting  
*The Sciences*, Volume 37, Number 4, Jul/Aug 1997 (p. 37)

### Bice, James

No biographical data available

The vital elements which make geology interesting eludes us: The grandeur of scenes cannot be brought indoors and the imposing vistas of time and change are beyond our powers to exhibit. The rocks and minerals, torn from their native habitat, lie naked and nearly

meaningless on the laboratory tables, and the topographic map does not convey to the beginner an impression of the scenery it represents.

Courses: An Observer Report  
*Geology in General Education*, Volume 1, 1952 (p. 23)

### Bierce, Ambrose 1842–1914

American newspaperman, wit, and satirist

GEOLOGY, n. The science of the earth's crust — to which, doubtless, will be added that of its interior whenever a man shall come up garrulous out of a well. The geological formations of the globe already noted are catalogued thus: the Primary, or lower one, consists of rocks, bones or mired mules, gas pipes, miner's tools, antique statues minus the nose, Spanish doubloons and ancestors. The Secondary is largely made up of red worms and moles. The Tertiary comprises railway tracks, patent pavements, grass, snakes, moldy boots, beer bottles, tomato cans, intoxicated citizens, garbage, anarchists, snap-dogs and fools.

*The Enlarged Devil's Dictionary* (p. 112)  
Doubleday. Garden City, New York, USA. 1967

### Blackie, John Stuart 1809–95

Scottish scholar

I'll sing you a ditty that needs no apology —  
Attend, and keep watch in the gates of your ears! —  
Of the famous new science which men call Geology,  
And gods call the story of millions of years.

*Lays and Legends of Ancient Greece: With Other Poems*  
A Song of Geology (p. 20)  
Sutherland and Knox. Edinburgh, Scotland. 1857

### Bretz, J Harlen 1882–1981

American geologist

Geology does have a first authoritative book of facts — but it is not in the library! It is in the rocks of the lithosphere. No author's personal equation need be allowed for when you read it; no emotional reactions warped the original historian's selection of facts. Yet this unbiased book is exceedingly difficult to read, for it is written in hieroglyphs and it is very fragmentary. Its deciphering is far from complete, and many fragments previously unknown are constantly being collected and pieced together.

In H.H. Newman (ed.)  
*The Nature of the World and of Man*  
Geological Processes and Earth's History (p. 70)  
The University of Chicago Press. Chicago, Illinois, USA. 1927

### Brewster, Edwin Tenney 1866–1960

Educator

Geology is always the science of such rocks as the way-faring man can look at for himself and understand.

*This Puzzling Planet*  
Chapter XIX (p. 307)  
The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1928

**Büchner, Georg** 1813–37  
German dramatist

1st GENTLEMAN: You were afraid?!

2nd GENTLEMAN: Indeed I was. The crust of the earth is exceedingly thin: when I see such a hole I'm always afraid I might fall right through. We must tread very carefully, it could give way beneath us.

Translated by John Reddick  
*Complete Plays, Lenz and Other Writings*  
Danton's Death  
Act II, Scene II (p. 33)  
Penguin Books. London, England. 1993

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

The father of [geology] was he who seeing fossil shells on a mountain conceived the theory of the deluge.

*The Note-Books of Samuel Butler* (Volume 1)  
1874–1883 (p. 89)  
University Press of America, Inc. Lanham, Maryland, USA. 1984

**Chamberlin, T. C.** 1843–1928  
Geologist

In pioneer days, when the sciences were struggling for a place in the sun, it fell to geology to pull up and set back the stakes that man had struck to mark the beginning of the earth. This seemed to many a moving of sacred landmarks; to others it seemed a wanton use of the secrets of the cemetery of nature's dead.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1922*  
The Age of the Earth (p. 241)  
Government Printing Office. Washington, D.C. 1924

**Cloos, Hans** 1885–1951  
German geologist

...it was during my enchanted days of travel that the idea came to me which, through the years, has come into my thoughts again and again and again and always happily — the idea that geology is the music of the earth.

*Conversation with the Earth*  
Prologue (p. 3)  
Alfred A. Knopf. New York, New York, USA. 1953

**Cowper, William** 1731–1800  
English poet

...some drill and bore  
The solid earth, and from the strata there  
Extract a register, by which we learn  
That he who made it, and revel'd its date  
To Moses, was mistaken in its age.

*The Poetical Works of William Cowper*  
The Task  
Book iii, The Garden  
John W. Lovell Company. New York, New York, USA. n.d.

**Dana, James Dwight** 1813–95  
American geologist

Geology may seem to be audacious in its attempts to unveil the mysteries of creation. Yet what it reveals are only some of the methods by which the Creator has performed his will; and many deeper mysteries it leaves untouched.

*New Textbook of Geology Designed for Schools and Academies*  
Concluding Remarks (p. 394)  
Iverson, Blakeman, Taylor & Co. New York, New York, USA. 1888

**Darwin, Charles Robert** 1809–82  
English naturalist

I am quite charmed with Geology, but like the wise animal between two bundles of hay, I do not know which to like the best; the old crystalline group of rocks, or the softer and fossiliferous beds.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter VI (p. 221)  
D. Appleton & Company. New York, New York, USA. 1896

We continually overrate the perfection of the geological record and falsely infer, because certain genre or families have not been found below a certain stage, that they did not exist before that stage.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter X (p. 162)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...I look at the natural geological record as a history of the world imperfectly kept, and written in changing dialect; of this history we possess the last volume alone, relating to only two or three countries. Of this volume, only here and there a short chapter has been preserved; and of each page, only here and there a few lines.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter X (p. 166)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Davis, William Morris** 1850–1934  
American geomorphologist

The movement of land waste is generally so slow that it is not noticed. But when one has learned that many land forms result from the removal of more or less rock waste, the reality and the importance of the movement are better understood. It is then possible to picture in the imagination a slow washing and creeping of the waste down the land slopes; not bodily or hastily, but grain by grain, inch by inch, yet so patiently that in the course of ages even mountains may be laid low.

*Physical Geography*  
Chapter X (p. 263)  
Ginn & Company. Boston, Massachusetts, USA. 1898

The more clearly the immensely speculative nature of geological science is recognized, the easier it becomes

to remodel our concepts of any inferred terrestrial conditions and processes in order to make outrages upon them not outrageous.

The Value of Outrageous Geological Hypotheses

*Science*, Volume 63, Number 1636, May 7, 1926 (p. 466)

**Davy, Sir Humphry** 1778–1829

English chemist

Geology, perhaps more than any other department of natural philosophy, is a science of contemplation. It requires no experience or complicated apparatus, no minute processes upon the unknown properties of matter. It demands only an enquiring mind and senses alive to the facts almost everywhere presented in nature. And as it may be acquired without much difficulty, so it may be improved without much painful exertion.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Lecture One (p. 13)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

**Dawkins, Boyd** 1837–1929

English geologist

Geology stands to engineering in the same relation as faith to works.... The success or failure of an undertaking depends largely upon the physical conditions which fall within the province of geology, and the “works” of the engineer should be based on the “faith” of the geologist.

On the Relation of Geology to Civil Engineering

*Institution of Civil Engineers, Minutes of Proceedings*, Volume 134, 1898 (pp. 254–255)

**Dawson, Sir John William** 1820–99

Canadian geologist and educator

The old rocks and the ancient lines of folding and the perished forms of life are not merely a scaffolding set up to be thrown down, but the foundation stones of a great and symmetrical structure.

*Some Salient Points in the Science of the Earth*

Chapter II (p. 35)

Hodder & Stroughton. London, England. 1893

Geological reading, especially when of a strictly uniformitarian character and in warm weather, sometimes becomes monotonous...

*Some Salient Points in the Science of the Earth*

Chapter II (p. 9)

Hodder & Stroughton. London, England. 1893

**de Lunay, L.**

No biographical data available

Geology was made by the waters; it was made by the seas.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1914*

The Geology of the Bottom of the Seas (p. 330)

Government Printing Office. Washington, D.C. 1915

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Knowledge of Geology — Practical, but limited. Tells at a glance different soils from each other. After walks has shown me splashes upon his trousers, and told me by their colour and consistence in what part of London he had received them.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 2 (p. 156)

Wings Books. New York, New York, USA. 1967

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Geology, a science of forty or fifty summers, has had the effect to throw an air of novelty and mushroom speed over entire history.

...Geology itself is only chemistry with the element of time added...

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Chapter VII (p. 212)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Astronomy...compelled a certain extension and uplifting of our views of the Deity and his Providence. This correction of our superstitions was confirmed by the new science of Geology...

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Lectures and Biographical Sketches

Chapter XII (p. 336)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Esar, Evan** 1899–1995

American humorist

[Geology] The subject that brings a student down to earth.

*Esar's Comic Dictionary*

Geology

Doubleday. Garden City, New York, USA. 1983

**Faul, Henry** 1920–

Geochronologist

**Faul, Carol**

No biographical data available

Geology began when early man first picked up a stone, considered its quantities, and decided that it was better than the stone he already had. Good stones were useful and they were collected, mined, and traded.

*It Began with a Stone*

Chapter One (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1983

**Garrels, Robert M.** 1916–88

American geochemist

The greatest problem encountered by students in geology is the necessity for a complete reorganization of their concepts of space and time.

*A Textbook of Geology*

Chapter I (p. 1)

Harper Publishers. New York, New York, USA. 1951

**Gerould, Katherine Fullerton** 1879–1944

American writer

The geologic ages are dealt with by pick and hammer and reduced to slides and the lore of the stars has become a pure matter of mathematical formulae.

The Extirpation of Culture

*The Atlantic Monthly*, October 1915 (pp. 454–455)

**Gibson, William Sidney**

No biographical data available

The subjects of Geological inquiry are among the most magnificent that science has opened to the contemplation of the human mind, and their importance is admitted by all persons who are acquainted with their nature and results, and is sufficiently attested by the very exalted rank which Geology has attained in the circle of inductive science...

*The Certainties of Geology*

Chapter I (p. 1)

Smith, Elder & Company. London, England. 1840

**Good, John Mason** 1764–1827

English physician and author

The direct object of geology is, to unfold the solid substance of the earth — to discover by what causes its several parts have been either arranged or disorganized — and from what operations have originated the general stratification of its materials, the inequalities of its surface, and the vast variety of bodies that enter into its make.

*The Book of Nature*

Series I, Lecture VI (p. 65)

Belknap and Hamersley. Hartford, Connecticut, USA. 1844

**Granville, Peter**

No biographical data available

...if you call botany beautiful, and astronomy sublime... call Geology romantic, because it not only leads us to travel among the wildest scenery of nature, but carries the imagination back to the birth and infancy of our little planet...

*Conversations on Geology*

Conversation First (p. 7)

Printed for Samuel Maunder. London, England. 1828

**Gray, Asa** 1810–88

American botanist

Among the questions which disquieted pious souls in my younger days, but which have ceased to disquiet any

of us, are those respecting the age and gradual development of the earth and of the solar system, which came in with geology and modern astronomy. I remember the time when it was a mooted question whether geology and orthodox Christianity were compatible...

*Natural Science and Religion*

Two Lectures Delivered to the Theological School of Yale University (p. 6)

Charles Scribner's Sons. New York, New York, USA. 1880

**Gregory, J. W.**

No biographical data available

A new geology was developing, and the Geological Society of London ushered in its birth. No more should observations be made through the distorting medium of preconceived fancies! No more should geology be inspired by that heedless spirit which cares not to distinguish between fancy and fact! With youthful vigor the new geology would have nothing to do with the search for cosmogonies and such like fancy foods, and the Geological Society of London should be nourished on unadulterated facts.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Geology of the Inner Earth — Igneous Ores (pp. 311–312)

Government Printing Office. Washington, D.C. 1908

**Grinnell, George Bird** 1849–1938

American anthropologist

At the end of a long day's march, one of the soldiers, hot, thirsty and utterly weary, was heard to exclaim: "What did God Almighty make such a country for?" To which one of his companions made the reply that "God Almighty made the country good enough, but it's this infernal geology that the professor talks about that has spoiled it all."

An Old Time Bone Hunt

*Natural History*, Volume 23, Number 4, July–August 1923 (p. 332)

**Hall, J.**

No biographical data available

To some minds geology scarcely assumes the rank of a science, except where treated from a physical point of view. They consider the simplest physical law adequate to the explanation of the most stupendous phenomena. To them, mountain chains rise and are abraded, and the entire crust of the earth is folded and plicated in obedience to certain laws. They see no difficulty in the way of imagining torrents of water moving onward and upward, carrying masses of rocks over heights far above their origin by some simply gyratory force. The entire earth becomes with equal ease to them, either a pliable, elastic, or compressible mass, or a non-elastic body; sudden cataclysms, according to the fancy of the expounder. No wizard's wand ever played so many pranks as the poor earth in the hands of these theorizing geologists.



*Contributions to the Geological History of the American Continent* (p. 34)  
Printed at the Salem Press. Salem, Massachusetts. 1882

Geology, if we would let alone grand theorizing, is a simple and beautiful study, in which we see everything evolved naturally and harmoniously, without at any time great and sudden changes. We remark those changes as one who having viewed a city in its progress, should fall asleep for a century and afterwards behold the difference. But to one who could have seen stone laid upon stone, and each edifice completed singly, it would have had but the aspect of natural and quiet progress.

*Contributions to the Geological History of the American Continent* (p. 63)  
Printed at the Salem Press. Salem, Massachusetts. 1882

### Harris, Anita

No biographical data available

Not by accident is geology called geology. It's named for Gaea, the daughter of Chaos.

In John McPhee

*Annals of the Former World*

Book 2, In Suspect Terrain (p. 213)

Farrar, Straus & Giroux. New York, New York, USA. 1998

### Herschel, Sir John Frederick William 1792–1871

English astronomer and chemist

Geology, in the magnificence and sublimity of the objects of which it treats, undoubtedly ranks next [to astronomy] in the scale of the sciences.

In William Sidney Gibson

*The Certainties of Geology*

Chapter II (p. 21)

Smith, Elder & Company. London, England. 1840

Geology...in the magnitude and sublimity of the objects of which it treats, undoubtedly ranks in the scale of sciences, next to astronomy.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part III, Chapter V, Section 323 (p. 287)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

### Hewitt, Philip C.

No biographical data available

...don't believe that geology is only for geologists. It is, or should be for everyone.

Why Study Geology?

*Journal of Geological Education*, Volume XV, Number 1, February 1969 (p. 10)

### Hillaby, John 1917–96

Journalist

Fortunately for poets and those who like to walk about in the open air, the beauty of landscape is not something that can be reduced easily to basic geology or a few ready-wrapped phrases about what places are used for. Preference and prejudice creep in.

*A Walk Through Britain*

The Striding Dales (p. 163)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1969

### Huxley, Thomas Henry 1825–95

English biologist

Once more, an invariably-recurring lesson of geological history, at whatever point its study is taken up: the lesson of the almost infinite slowness of the modification of living forms. The lines of the pedigrees of living things break off almost before they begin to converge.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On the Formation of Coal (p. 158)

Macmillan & Company Ltd. London, England. 1904

### James, William 1842–1910

American philosopher and psychologist

Geology, economics, mechanics are humanities when taught with reference to the successive achievements of the geniuses to which these sciences owe their being. Not taught thus, literature remains grammar, art a catalogue, history a list of dates, and natural science a sheet of formulas and weights and measures.

*Memories and Studies*

The College-Bred (p. 313)

Longmans, Green & Company. New York, New York, USA. 1917

### Kingsley, Charles 1819–75

English clergyman and author

Be sure, that wherever there is a river, or even a drain; and a stone quarry, or even a roadside bank; much more where there is a sea, or a tidal estuary, there is geology enough to be learnt, to explain the greater part of the making of all the continents on the globe.

*Town Geology*

Chapter I (p. 35)

D. Appleton and Company. New York, New York, USA. 1873

### Knopf, Alfred A. 1892–1984

American publisher

An urgent task for geology is to determine, in years, the length of the eras, periods, and "ages" (time spans of the stages) and, eventually of the zones. Not a single one of them — eras, periods, and ages, let alone zones — has yet been reliably determined. This statement is possibly surprising in view of the fact that almost any modern writer can produce a geologic timetable that gives precise datings and lengths of eras and systems and even of some of the smaller subdivisions....All other absolute ages have been derived from the three radioactive tie points by interpolation based on thickness of strata or by "reasoned guesses"...

Measuring Geologic Time

*Scientific Monthly*, Volume 85, 1957 (p. 227)

**Knopoff, L.**

No biographical data available

A century ago geology — under the impact of the theory of evolution, the statement of the principles of stratigraphy and widespread exploration — was perhaps the most exciting area of science. With passing years, geological activities were overshadowed by dramatic discoveries in chemistry, physics, biology, and astronomy. The recent new discoveries relating to the solid earth: i) put earth sciences once again in the forefront; ii) unified previously diverse fields of geology and geophysics; and iii) greatly enhanced the morale of geologists and geophysicists. The new excitement in the earth sciences is attracting many talented young people into this complex but highly important area of science.

Significance and Achievement of the Upper Mantle Project  
*ICSU Bulletin*, Volume 27, September 1972 (pp. 4–5)

**Lapworth, Charles** 1842–1920

English geologist

Astronomy concerns itself with the whole of the visible universe, of which our earth forms but a relatively insignificant part; while Geology deals with that earth regarded as an individual. Astronomy is the oldest of the sciences, while Geology is one of the newest. But the two sciences have this in common, that to both are granted a magnificence of outlook, and an immensity of grasp denied to all the rest.

*Proceedings of the Geological Society of London*, Volume 59, 1903 (p. lxxviii)

**Louderback, G. D.**

American mineralogist

Geology needs an independent time clock that runs at a uniform rate, just as we need it in our daily life, and the physicist needs it in his laboratory.

The Age of the Earth from Sedimentation  
*Scientific Monthly*, Volume 42, 1936 (p. 245)

**Lyell, Sir Charles** 1797–1875

English geologist

To assume that the evidence of the beginning or end of so vast a scheme lies within the reach of our philosophical inquiries, or even of our speculations, appears to us inconsistent with a just estimate of the relations which subsist between the finite powers of man and the attributes of an Infinite and Eternal Being.

*Principles of Geology* (Volume 3)

Concluding Remarks (p. 385)

John Murray. London, England. 1830

The discovery of other systems in the boundless regions of space was the triumph of astronomy — to trace the same system through various transformations — to behold it at successive eras adorned with different hills and

valleys, lakes and seas, and peopled with new inhabitants, was the delightful need of geological research.

*Principles of Geology*

Chapter IV

John Murray. London, England. 1830

Geology is the science which investigates the successive changes that have taken place in the organic and inorganic kingdom of nature...

*Principles of Geology* (Volume 1)

Chapter I (p. 1)

John Murray. London, England. 1830

Geology is intimately related to almost all the physical sciences...a geologist should be well-versed in...every science relating to organic and inorganic nature.

*Principles of Geology* (Volume 1)

Chapter I (p. 2)

John Murray. London, England. 1830

...we are apprehensive lest zoological periods in geology, like artificial divisions in other branches of natural history, should acquire too much importance, from being supposed to be founded on some great interruptions in the regular series of events in the organic world, whereas...we ought to regard them as invented for the convenience of systematic arrangement, always expecting to discover intermediate gradations between the boundary lines we have first drawn.

*Principles of Geology* (Volume 3)

Chapter V (p. 57)

John Murray. London, England. 1830

**Merrill, William**

No biographical data available

Whither goest we?

Whither goes geology?

The crystal ball

That tell us all

A little fuzzy be.

Purposes of Undergraduate Degree Programs in Geology

*Journal of Geological Education*, Volume XIII, Number 3, June 1965 (p. 67)

**Miller, Hugh** 1802–56

Scottish geologist and theologian

All geologic history is full of the beginning and the ends of species, — of their first and last days, but it exhibits no genealogies of development.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two*

*Theologies, Natural and Revealed* (p. 183)

Gold and Lincoln. Boston, Massachusetts, USA. 1857

Nor can I doubt that [the Earth's] history throughout the long geologic age — its strange story of successive creations, each placed in advance of that which had gone before, and its succeeding organisms, vegetable and animal, ranged according to their appearance in time, on principles which our profounder students of

natural science have but of late determined — will be found in an equal degree more worthy of its Divine Author than that which would huddle the whole into a few literal days, and convert the incalculably ancient universe which we inhabit into a hastily run-up erection of yesterday.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
1857

Geology is the most poetical of all sciences; and its various facts, as they present themselves to the human mind, possess a more overpowering immensity than even those of Astronomy itself. For while the Astronomer can carry about with him in his imagination a little portable Orrery of the whole solar system, the Geologist is oppressed by a weight of rocks and mountains, and of strata piled over strata which all his diligence in forming theories has not yet enabled him completely to arrange. He is no mere intellectual mechanic, who calculates and reasons on the movements of a piece of natural clockwork; the objects with which he is chiefly conversant have no ascertained forms, or known proportions, that he may conceive of them as abstract figures, or substitute a set of models in their places; his province, in at least all its outer skirts, is still a terra incognita, which he cannot conceive of as a whole; and the walks which intersect it are so involved and irregular that, like those of an artificial wilderness, they seem to double its extent. The operations of his latest eras, as his science exists in time, terminate long before history begins; while, as it exists in space, he has to grapple with the immense globe itself, with all its oceans, and all its continents.

*Scenes and Legends of the North of Scotland* (1<sup>st</sup> edition) (p. 48)  
Adam and Charles Black. Edinburgh, Scotland. 1835

Geology, of all the sciences, addresses itself most powerfully to the imagination; and hence one main cause of the interest which it excites.

*The Old Red Sandstone*  
Chapter II (p. 57)  
J.M. Dent & Sons Ltd. London, England. 1922

The science of the geologist seems destined to exert a marked influence on that of the natural theologian. For not only does it greatly add to the materials on which the natural theologian founds his deductions, by adding to the organisms, plant and animal, of the present creation the extinct organisms of the creations of the past, with all their extraordinary display of adaptation and design; but it affords him, besides, materials peculiar to itself, in the history which it furnishes both of the appearance of these organisms in time, and of the wonderful order in which they were chronologically arranged.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Fifth (p. 211)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

Nature is a vast tablet, inscribed with signs, each of which has its own significance, and becomes poetry in the mind when read; and geology is simply the key by which myriads of these signs, hitherto indecipherable, can be unlocked and perused, and thus a new province added to the poetical domain.

*Sketch-Book of Popular Geology*  
Lecture Third (p. 87)  
William P. Nimmo & Co. Edinburgh, Scotland. 1880

He will find sermons in stones, and more of the suggestive and the sublime in a few broken scours of clay, a few fragmentary shell, and a few green reaches of the old coast line...

*Sketch-Book of Popular Geology*  
Lecture Second (p. 80)  
William P. Nimmo & Co. Edinburgh, Scotland. 1880

It is one of the great marvels of our day, that through the key furnished by geologic science we can now pursue the history of past creations more clearly, and arrive at a more thorough and certain knowledge of at least the structural peculiarities of the organisms, than we can read the early histories of the old dynasties of our own species, that flourished and decayed on the banks of the Euphrates or of the Nile, or ascertain the true character of the half-forgotten tyrants with whom they terminated, or from whom they began.

*The Old Red Sandstone*  
Geological Evidences in Favour of Revealed Religion (pp. 275–276)  
J.M. Dent & Sons Ltd. London, England. 1922

...poets need be in no degree jealous of the geologists. The stoney science, with buried creations for its domains, and half an eternity charged with its annals, possesses it realms of dim and shadowy fields, in which troops of fancies already walk like dismembered ghosts in the old fields of Elysium, and which bid fair to be quite dark and uncertain enough for all the purposes of poesy for centuries to come.

*Sketch-Book of Popular Geology*  
Lecture Third (pp. 82–83)  
William P. Nimmo & Co. Edinburgh, Scotland. 1880

**Montgomery, Arthur** 1909–99  
American geologist

More than any other science, except perhaps astronomy, geology has inherent in it the capacity for capturing the quick interest of those who live upon the surface of the earth.

Popular Geology  
*Journal of Geological Education*, Volume 1, Number 2, October 1951  
(p. 9)

**More, Louis Trenchard** 1870–1944  
English physicist and biographer of Issac Newton

We can then be certain that geology cannot, and never will be able to, translate the thickness of any one stratum

into an equivalent length of time and that it cannot, and never will be able to, establish real contemporaneousness of time in different parts of the world.

*The Dogma of Evolution*

Chapter Four (p. 151)

Princeton University Press. Princeton, New Jersey, USA. 1925

**Muir, John** 1838–1914

American naturalist

...see how God writes history [in the earth]. No technical knowledge is required; only a calm day and a calm mind.

*Our National Parks*

Chapter II (p. 59)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Newman, Joseph S.**

Poet

For several thousand endless ages  
It [earth] muddled thru its early stages  
Of heat, eruptions, floods, and quakes  
And other infant belly-aches.  
Surviving all such pains and notions  
It settled down to land and oceans.  
In eras which are known as “glacials”  
The planet then got several facials.  
Four geological massages  
In four successive Ice barrages  
Which filled its unbecoming dimples  
And leveled off some rocky pimples.

*Poems for Penguins and Other Lyrical Lapses*

Geology

Greenburg. New York, New York, USA. 1941

**Nye, Bill** 1850–96

American journalist

Geology is that branch of natural science which treats of the structures of the earth's crust and the mode of formation of its rocks. It is a pleasant and profitable study, and to the man who has married rich and does not need to work, the amusement of busting geology with the Bible, or busting the Bible with geology is indeed a great boon.

*Remarks*

About Geology (p. 201)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Palissy, Bernard** 1510–90

French Huguenot potter and writer

I have had no other book than the sky and the earth, which is known to all, and it is given to all to know and read in this beautiful book.... That is why a man who works in the art of the earth is always learning because of unknown natures, and diversity of earths.

Translated by Auréle La Rocque

*Admirable Discourses of Bernard Palissy* (p. 148, 186)

University of Illinois Press. Urbana, Illinois, USA. 1957

**Penn, Granville** 1761–1844

English scriptural geologist

EDWARD: Sea-shells, did you say, mother, in the heart of solid rocks, and far inland? There must surely be some mistake in this; at least it appears to me incredible.

MRS.R.: The history of the shells, my dear, and many other things no less wonderful, is contained in the science called geology, which treats of the first appearance of rocks, mountains, valleys, lakes, and rivers; and the changes they have undergone, from the Creation and the Deluge, till the present time.

*Conversations on Geology*

Conversation First (p. 1, 3)

Printed for Samuel Maunders. London, England. 1828

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

It is admitted, on all hands, that the Scriptures are not intended to resolve physical questions, or to explain matters in no way related to the morality of human actions; and if, in consequence of this principle, a considerable latitude of interpretation were not allowed, we should continue at this moment to believe that the earth is flat; that the sun moves around the earth; and that the circumference of a circle is not more than three times its diameter. It is but reasonable, therefore, that we should extend to the geologist the same liberty of speculation, which the astronomer and mathematicians are already in possession of; and this may be done, by supposing that the chronology of Moses relates only to the human race.

*Illustrations of the Huttonian Theory of the Earth*

Section 125 (pp. 126–127)

Dover Publications, Inc. New York, New York, USA. 1964

**Proctor, Richard A.** 1837–88

English astronomer

Astronomy and Geology owe much of their charm to the fact that they suggest thoughts of other forms of life than those with which we are familiar. Geology teaches us of days when this earth was peopled with strange creatures such as now are found upon its surface. We turn our thoughts to the epochs when those monsters throve and multiplied, and picture to ourselves the appearance which our earth then presented.

*Other Worlds Than Ours*

Introduction (p. 17)

H.L. Fowle. New York, New York, USA. 1870

**Robertson, Percival**

...teachers of geology have a great privilege in opening the pages of the earth's own autobiography and helping the student to interpret its inspiring pages.

Holding Student Interest in Historical Geology

*Journal of Geological Education*, Volume 1, Number 3, April 1952 (p. 40)

**Rudwick, Martin J. S.**

Science historian

The emergence of a visual language for geological science...helps in a small way to counter the common but intellectually arrogant assumption that visual modes of communication are either a sop to the less intelligent or a way of pandering to a generation soaked in television.

*History of Science*, Volume 14, 1976

**Scrope, George Poulett** 1797–1876

English geologist and political economist

Geology has for its business a knowledge of the processes which are in continual or occasional operation within the limits of our planet, and the application of these laws to explain the appearances discovered by our Geognostical researches, so as from these materials to deduce conclusions as to the past history of the globe.

*Considerations on Volcanoes*

Preface (p. iv)

W. Phillips & George Yarp. London, England. 1825

If the business of Geology is the study of the structure of the accessible portion of the Earth, and of the changes it has undergone, there can be no more important branch of the science than that which examines the nature and mode of operation of the subterranean forces which have everywhere more or less broken up, disturbed, and altered the level of the superficial rocks, modified their internal texture and composition, and brought fresh material upon or towards the exterior of the globe.

*Volcanoes* (2<sup>nd</sup> edition)

Chapter I (p. 1)

Longman, Green, Longmans & Roberts. London, England. 1862

**Sedgwick, Adam** 1785–1873

English geologist

I cannot promise to teach you all geology, I can only fire your imaginations.

In J. W. Clark and T. McHughes

*The Life and Letters of Adam Sedgwick* (Volume 2) (p. 489)

At the University Press. Cambridge, England. 1890

Geology, like every other science when well interpreted, lends its aid to natural religion. It tells us, out of its own records, that man has been but a few years a dweller on the earth; for traces of himself and his works are confined to the last monuments of its history. Independently of every written testimony, we therefore believe that man with all his powers and appetencies, his marvelous structure and fitness for the world was called into being a few thousand years of the days in which we live.

*Discourse on the Studies of the University of Cambridge* (pp. 22–23)

John W. Parker. London, England. 1850

But let us for a moment, suppose that there are some religious difficulties in the conclusions of Geology. How are we then to solve them? Not by making a world after

a pattern of our own — not by shifting and shuffling the solid strata of the earth, or dealing them out in such a way as to play the game of an ignorant and dishonest hypothesis — not by shutting our eyes to the facts, or denying the evidence of our senses: but by patient investigation carried on in the sincere love of truth and by learning to reject every consequence not warranted by direct physical evidence.

*Discourse on the Studies of the University of Cambridge*

Appendix (p. 105)

John W. Parker. London, England. 1850

We might expect...that as we come close upon living nature, the characters of our old records would grow legible and clear. But just where we begin to enter on the history of the physical changes going on before our eyes, and in which we ourselves bear a part, our chronicle seems to fail us; a leaf has been torn out from Nature's book, and the succession of events is almost hidden from our eyes.

*Sketch-Book of Popular Geology*

Lecture First (p. 43)

William P. Nimmo & Co. Edinburgh, Scotland. 1880

**Smith, Goldwin** 1823–1910

English-Canadian historian

In my youth, geology was nervously striving to accommodate itself to Genesis. Now it is Genesis that is striving to accommodate itself to geology.

In Robert M. Hamilton

*Canadian Quotations and Phrases*

Lines of Religious Inquiry, Address, Toronto (p. 5)

McClelland and Stewart. Toronto, Ontario, Canada. 1952

**Smith, John Pye** 1774–1851

English Congregational theologian

If from the discoveries of Astronomy and Geology we infer that the created universe, including our own globe, has existed through an unknown but unspeakably long period of time past; and IF, from the records of revelation, we draw the conclusion that the work of creation, or at least so far as respects our planet, took place not quite six thousand years ago; it is evident that the two positions cannot stand: one destroys the other. One of them must be an error; both may be wrong; only one can be right.

*The Relation Between the Holy Scriptures and Some Parts of Geological Science* (p. 15)

H. G. Bohn. London, England. 1854

**Sollas, William Johnson** 1849–1936

Geologist

The close of one century, the dawn of another, may naturally suggest some brief retrospective glance over the path along which our science has advanced, and some general survey of its present position from which we may gather hope of its future progress; but other connexion with geology the beginnings and endings of centuries

have none. The great periods of movement have hitherto begun, as it were, in the early twilight hours, long before the dawn.

*The Age of the Earth and Other Geological Studies*  
Chapter I (p. 2)

T. Fisher Unwin. London, England. 1905

Our science [geology] has become evolutionary, and in the transformation has grown more comprehensive: her petty parochial days are done, she is drawing her provinces closer around her, and is fusing them together into a united and single commonwealth — the science of the earth.

*The Age of the Earth and Other Geological Studies*  
Chapter I (p. 4)

T. Fisher Unwin. London, England. 1905

### Toepffer, Rodolphe

But that is exactly what I like about this science of geology. It is infinite, ambiguous, like all poetry; like all poetry it has secrets, is permeated by them, lives within them, without being destroyed by them. It does not lift the veil, but only moves it, and through tiny holes in the fabric a few rays escape, which dazzle the eye.

In Ronald B. Parker

*The Tenth Muse: The Pursuit of Earth Science* (p. xiii)

Charles Scribner's Sons. New York, New York, USA. 1986

### Townsend, Joseph 1739–1816

No biographical data available

The science of geology becomes of infinite importance when we consider it as connected with our immortal hopes. These depend on the truth of revelation, and the whole system of revealed religion is ultimately connected with the veracity of Moses. The divine legation of Christ and of the Jewish lawgiver must stand or fall together. If the Mosaic account of the creation and of the deluge is true, and consequently the promises recorded by him well founded, we may retain our hopes; but, should the former be given up as false, we must renounce the latter.

*The Character of Moses Established for Veracity as an Historian:*

*Recording Events from the Creation to the Deluge* (p. 430)

Printed by M.Gye. Bath, England. 1813

### Trefethen, Joseph M.

No biographical data available

The relationship between civil engineering and geology is as old as the hills, manmade hills that is.

Geology for Civil Engineers

*Journal of Engineering Education*, Volume 39, Number 7, March 1949  
(p. 383)

### Twain, Mark (Samuel Langhorne

**Clemens) 1835–1910**

American author and humorist

Geology has revealed the fact that the crust of the earth is composed of five layers or strata. We exist on the surface of the fifth. Geology teaches, with scientific accuracy, that each of these layers was from ten thousand to two million years forming or cooling. (A disagreement as to a few hundred thousand years is a matter of little consequence to science.)

*Collected Tales, Sketches, Speeches, & Essays 1852–1890* (Volume 1)

A Brace of Brief Lectures on Science (p. 529)

The Library of America. New York, New York, USA. 1992

We now come to the geological part [of history]. This is the one where the evidence is not all in, yet. It is coming in, hourly, daily, coming in all the time, but naturally it comes with geological carefulness and deliberation, and we must not be impatient, we must not get excited, we must be calm, and wait. To lose our tranquility will not hurry geology; nothing hurries geology.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Was the World Made for Man? (p. 572)

The Library of America. New York, New York, USA. 1992

### Tyndall, John 1820–93

Irish-born English physicist

Time and intensity are the main factors in geologic change, and they are in a certain sense the convertible. A feeble force acting through long periods, and an intense force acting through short ones, may produce approximately the same results.

*Fragments of Science*

Niagara, Section 6 (p. 192)

D. Appleton. New York, New York, USA. 1898

### Umbgrove, J. H. F.

No biographical data available

Geology, the science of the history of the Earth and Life, reaches back into the infinitely remote ages and depths of the Universe and extends its speculations to the origin and meaning of all organisms and inorganic matter.

*The Pulse of the Earth*

Chapter I (p. 1)

Martinus Nijhoff. The Hague, Netherlands. 1947

### van Hise, Charles R. 1857–1918

American academic

It may be said that the history of events, as shown by the rocks and fossils, does not necessarily require physical or chemical treatment. There is some truth in these statements, but on the other side it may be held that the facts are the results accomplished by physical and chemical works. These facts become important and significant mainly as they are interpreted in physical and chemical terms. The objects of the earth, — the complex results of chemical and physical work — if described without reference to the manner in which the results came about, have comparatively little interest.

The Problems of Geology  
*Journal of Geology*, Volume 12, 1904 (pp. 590–591)

Those geologists who have made the attempt to combine mathematical with their geological reasoning usually have shown marked deficiency in their mathematics. Upon the other hand, those mathematicians who have attempted to handle the problems of geology mathematically have usually been so deficient in a knowledge of geology that their work has been of comparatively little value.... [T]he time has come for co-operation between geologists and mathematicians in the advancement of the science of geology to a quantitative basis.

The Problems of Geology  
*Journal of Geology*, Volume 12, 1904 (p. 603)

**Verne, Jules** 1828–1905  
French novelist

His imagination is a perfect volcano, and to make discoveries in the interest of geology he would sacrifice his life.

*A Journey to the Center of the Earth*  
Chapter 3 (pp. 18–19)  
The Limited Editions Club. New York, New York, USA. 1966

**von Zittel, Karl Alfred** 1839–1904  
German palaeontologist

It does not come within the domain of geology to investigate the origin of the universe and of solar and planetary systems. Yet such investigations are so closely associated with the origin and earliest history of the earth that the results attained by astronomical researches have at all times exerted an influence upon the views of geologists.

Translated by Maria M. Ogilvie-Gordon  
*History of Geology and Paleontology*  
Chapter I (p. 153)  
W. Scott. London, England. 1901

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

...but geology alone can tell us nothing of lands which have disappeared beneath the ocean.

*The Malay Archipelago*  
Chapter XXXIII (p. 291)  
Macmillan & Company Ltd. London, England. 1869

**Whewell, William** 1794–1866  
English philosopher and historian

Have the changes which lead us from one geological state to another been, on a long average, uniform in their intensity, or have they consisted of epochs of paroxysmal and catastrophic action, interposed between periods of comparative tranquility. These two opinions will probably for some time divide the geological world into two sects, which may perhaps be designated as the Uniformitarians and the Catastrophists.

Review of Lyell's Principles of Geology  
*Quarterly Review*, 1832

**Williams, G. H.**  
No biographical data available

Geology has, for the earliest times, claimed the serious attention of mankind, by appealing to two entirely different sides of human character. In the first place, reverence for the mysterious in nature, which in untutored men amounts to worship, has always been excited by the secrets of the earth; while, in the second place, the cupidity of man has always led him to explore the rocks in quest of the mineral treasures which they contain.

Some Modern Aspects of Geology  
*Popular Science Monthly*, Volume 35, 1889

**Winchell, Alexander** 1824–91  
American geologist

The study of science is a virtue. Attention to geology is a human duty.

*Walks and Talks in the Geological Field*  
Part I, Chapter VI (p. 36)  
Chautauqua Press. New York, New York, USA. 1890

**Woodward, Robert Simpson** 1849–1924  
American scientist and teacher

Geology illustrates better than any other science, probably, the wide ramifications and the close inter-relations of physical phenomena. There is scarcely a process, a product, or a principle in the whole range of physical science, from physics and chemistry up to astronomy and astrophysics, which is not fully illustrated in its uniqueness and in its diversity by actual operations still in progress on the earth, or by actual records preserved in her crust. The earth is thus at once the grandest of laboratories and the grandest of museums available to man.

In J.A. Thomson  
*Introduction to Science*  
Chapter IV (pp. 109–110)  
Williams & Norgate Ltd. London, England. 1916

## GEOLOGICAL TIME

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

I have devoted my whole life to the study of Nature, and yet a single sentence may express all that I have done. I have shown that there is a correspondence between the succession of Fishes in geological time and the different stages of their growth in the egg — that is all.

*Methods of Study In Natural History*  
Chapter II (p. 23)  
Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Burroughs, John** 1837–1921  
American naturalist and writer

Time, geologic time, looks out at us from the rocks as from no other objects in the landscape. Geologic time! How the striking of the great clock, whose hours are millions of years, reverberates out of the abyss of the past!

*Under the Apple-Trees*

Chapter II (p. 40)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

Geologic time is the most potent of the gods of change. He wields an invisible hammer beside which the hammer of Thor is a child's toy. Its slow, silent blows break in through granite rocks as big as a house.

...

How geologic time looks out from the ledges and walls of gray rocks unmindful of us human ephemera that pass! It has seen the mountains decay and the hills grow old. The huge drift boulders rest on the margin of meadows and fields, or stand sentry to the woods, and through races and kingdoms pass, scarcely the change of a wrinkle disturbs their calm stone faces. Yet time gets the better of them also. The frowning ledge melts as inevitably as a snow bank.

*Under the Apple-Trees*

Chapter II (p. 58)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

**Coman, Dale Rex** 1906–

Writer and naturalist

The rule is that no species prevails for long as measured in the units of eras by which our planet conducts its affairs.

*The Endless Adventure*

Once There Was a Planet (p. 181)

Henry Regnery Company. Chicago, Illinois, USA. 1972

A planet has no need to rush in the conduct of its affairs; its major schemes are plotted on a chart of eons.

*The Endless Adventure*

Along the Coast in April (p. 135)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

As a microscope helps our minds to burrow through alien galleries of cell membranes, and as a telescope lifts us to far galaxies, another way of coming out of the anesthetic is to return, in our imaginations, through geological time.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*

Chapter I (p. 9)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Forbes, Edward** 1815–54

English naturalist

Palaeontological research exhibits, beyond question, the phenomenon of provinces in time, as well as provinces in

space. Moreover, all our knowledge of organic remains teaches us that species have a definite existence, and a centralization in geological time as well as in geographical space, and that no species is repeated in time.

*The Natural History of the European Seas*

Chapter I (p. 10)

John Van Voorst. London, England. 1859

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

We see, in the vastness of geologic time, events that bear superficial similarity to phenomena of local populations — and we assign a similar cause [to these events] without realizing that the extended time itself precludes such an application.

*The Promise of Paleobiology as a Nomothetic, Evolutionary Discipline*

*Paleobiology*, Volume 5, 1980

The geologic time scale is a layer cake of odd names, learned by generations of grumbling students with mnemonics either too insipid or too salacious for publication: Cambrian, Ordovician, Silurian, Devonian.... Their ubiquity in all geological writing has led students to suspect that these names, like the rocks they represent, have been present from time immemorial (*et nunc, et semper, et in saecula saeculorum, amen*).

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 5 (p. 76)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

**Hurley, Patrick M.**

No biographical data available

...each grain of sand, each minute crystal in the rocks about us is a tiny clock, ticking off the years since it was formed. It is not always easy to read them, and we need complex instruments to do it, but they are true clocks or chronometers. The story they tell numbers the pages of earth history.

*How Old Is the Earth?*

Introduction (p. 14)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1959

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

...if the succession of worlds is established in the system of nature, it is in vain to look for anything in the origin of the earth. The result, therefore, of our present enquiry is, that we find no vestige of a beginning, — no prospect of an end.

*The Theory of the Earth* (Volume 1)

Part I, Chapter I, Section IV (p. 200)

Messrs. Cadwell, Junior, and Davies. London, England. 1795

**Knopf, Alfred A.** 1892–1984

American publisher

If I were asked as a geologist what is the single greatest contribution of the science of geology to modern



civilized thought, the answer would be the realization of the immense length of time. So vast is the span of time recorded in the history of the earth that it is generally distinguished from the more modest kinds of time by being called “geologic time.”

*Time and Its Mysteries*

Series 3 (p. 33)

New York University Press. New York, New York, USA. 1936

**Lambert, Johann Heinrich** 1728–77

Swiss German mathematician and astronomer

Happy intelligences, how excellent must be the frame of your nature! Myriads of ages pass away with you, like so many days with the inhabitants of the Earth. Our largest measurements are your infinitely small quantities; our millions the elements of your arithmetic; we breathe but a moment; our lot is error and death; yours science and immortality.

Translated by James Jacque

*The System of the World*

Part I, Chapter IX (p. 58)

Printed for Vernor and Hood. London, England. 1800

**McPhee, John** 1931–

American journalist and nonfiction writer

With your arms spread wide...to represent all time on earth, look at one hand with its line of life. The Cambrian begins in the wrists, and the Permian extinction is at the outer end of the palm. All of the Cenozoic is in a fingerprint, and in a single stroke with a medium-grained nail file you could eradicate human history.

*Basin and Range* (p. 126)

Farrar, Straus & Giroux. New York, New York, USA. 1981

**Morris, Henry**

Creationist

The only way we can determine the true age of the earth is for God to tell us what it is. And since He has told us, very plainly, in the Holy Scriptures that it is several thousand years in age, and no more, that ought to settle all basic questions of terrestrial chronology.

*The Remarkable Birth of Planet Earth*

Chapter VIII (p. 94)

Creation-Life Publishers. San Diego, California, USA. 1972

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Geological time is not money. A pity too; for it would have abolished poverty from the earth.

In Albert Bigelow Paine (ed.)

*Mark Twain's Notebook*

Chapter XXXV (p. 393)

Harper & Brothers. New York, New York, USA. 1899

**Walcott, Charles D.** 1850–1927

Geologist

Few of us have a clear realization of the age of the earth. Under many deceptive aspects she carries with her the secret of a long and busy life, one of such fascinating activity that it is not surprising that students are ever seeking to unravel the mysteries of the past. With all the evidences of youth there is to be felt, especially among the mountains, a sense of age and infinite power, and we are inspired with awe as we trace the base of worn-down rocks, miles in thickness, that formed the mountain ranges far back in geologic time.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1915*

Evidences of Primitive Life (p. 235)

Government Printing Office. Washington, D.C. 1916

**Wald, George** 1906–97

American biologist and biochemist

Time is in fact the hero of the plot. The time with which we have to deal is of the order of two billion years. What we regard as impossible on the basis of human experience is meaningless here. Given so much time, the “impossible” becomes possible, the possible probable, and the probable virtually certain. One has only to wait: time itself performs the miracles.

*The Physics and Chemistry of Life*

The Origin of Life (p. 12)

Simon & Schuster. New York, New York, USA. 1955

**GEOLOGIST**

**Author undetermined**

Over the ground

Passes a sound;

It is the pit-a-pat of footsteps in the sand.

See them advance,

Thicker than ants;

Survey geologists are swarming through the land!

Quo Vadose?

*The Pick and Hammer Club*, March 16, 1948 (p. 12)

**Bates, R. L.**

No biographical data available

I wonder who was the very first geologist to get it into his noodle

That an educated guess about something would sound better if he called it a model?

Petulant Questions

*Geotimes*, Volume 22, Number 6, 1977 (p. 46)

**Bradley, W. H.**

No biographical data available

Again, because a geologist can see only parts of the features he studies and must forever deal with partial information (he constructs geologic maps primarily to bring large features down to a comprehensive scale at which he

can integrate the parts and visualize the whole), it is most essential that he be able to visualize, in three dimensions and with perspective, processes that may have gone on that will help to reconstruct events of the past.

In Claude C. Albritton

*The Fabric of Geology*

Geologic Laws (p. 16)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1963

### **Brown, H.**

No biographical data available

### **Monnett, J.**

No biographical data available

Whatever his method of approach, the geologist must take cognizance of the following facts...There is no place on the earth where a complete record of the rocks is present...To reconstruct the history of the earth, scattered bits of information from thousands of locations all over the world must be pieced together. The results will be at best only a very incomplete record. If the complete story of the earth is compared to an encyclopedia of thirty volumes, then we can seldom hope to find even one complete volume in a given area. Sometimes only a few chapters, perhaps only a paragraph or two, will be the total geological contribution of a region; indeed, we are often reduced to studying scattered bits of information more nearly comparable to a few words or characters.

*Introduction to Geology* (p. 11)

Ginn. Boston, Massachusetts, USA. 1958

### **Chalmers, Thomas**

There are prejudices...against the speculations of the geologist, which I am anxious to remove. It has been said that they nurture infidel propensities. It has been alleged that geology, by referring the origin of the globe to a higher antiquity than is assigned to it by the writings of Moses, undermines our faith in the inspiration of the Bible, and in all the animating prospects of the immortality which it unfolds. This is a false alarm. The writings of Moses do not fix the antiquity of the globe.

Quoted in Hugh Miller

*The Testimony of the Rocks: of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Third (p. 141)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

### **Chamberlin, T. C.** 1843–1928

Geologist

The studies of the geologist are peculiarly complex. It is rare that his problem is a simple unitary phenomenon explicable by a single simple cause. Even when it happens to be so in a given instance, or at a given stage of work, the subject is quite sure, if pursued broadly, to grade into some complications or undergo some transition. He must

therefore ever be on the alert for mutations and for the insidious entrance of new factors. If, therefore, there are any advantages in any field in being armed with a full panoply of working hypotheses and in habitually employing them, it is doubtless the field of the geologist.

The Method of Multiple Working Hypotheses

*Journal of Geology*, Volume 5, Number viii, November–December, 1897 (p. 848)

### **Chapman, Clark R.**

Astronomer and asteroid researcher

The geologist in the wilderness epitomizes man against nature. A tiny, transitory creature, whose life will be over in a mere second of geologic time, attempts to discern the life processes of Earth. Hammering at the rocks pregnant with data, the geologist is in physical contact and combat with the Earth, like a mosquito attacking Goliath. Ever so grudgingly, the Earth yields its life history.

*The Inner Planets: New Light on the Rocky Worlds of Mercury, Venus,*

*Earth, the Moon, Mars, and the Asteroids*

Chapter 1 (p. 10)

Charles Scribner's Sons. New York, New York, USA. 1977

### **Darwin, Charles Robert** 1809–82

English naturalist

I have long discovered that geologists never read each other's works, and that the only object in writing a book is a proof of earnestness, and that you do not form your opinions without undergoing labour of some kind.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter IX (p. 303)

D. Appleton & Company. New York, New York, USA. 1896

About thirty years ago there was much talk that geologists ought only to observe and not theorize; and I well remember someone saying that at this rate a man might as well go into a gravel-pit and count the pebbles and describe the colours. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 1)

Letter 133, Darwin to Fawcett, 18 September, 1861 (p. 195)

D. Appleton & Company. New York, New York, USA. 1903

### **Dawson, Sir John William** 1820–99

Canadian geologist and educator

The geologist, ascending from the oldest and lowest portions of the earth's crust, and dealing for millions of years with physical forces and the instinctive powers of animals alone, at length as he approaches the surface finds himself in contact with an entirely new agency, the free-will and conscious action of man.

*The Meeting-Place of Geology and History*

Chapter I (p. 12)

Fleming H. Revell Company. New York, New York, USA. 1894

**Dexter, William A.**

No biographical data available

For every fossil or old rock the geologist can unearth, the astronomer can point his telescope toward an object whose light left the object when either the rock was formed or the fossil was alive.

The Bigness and the Smallness of Time

*Journal of Geological Education*, Volume XV, Number 4, October 1967 (p. 162)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The time has gone by when the physicists prescribed dictatorially what theories the geologist might be permitted to consider.

The Borderland of Astronomy and Geology

*Nature*, Volume 111, Number 2775, January 6, 1923 (p. 21)

**Esar, Evan** 1899–1995

American humorist

[Geologist] A scientist whose life is less sedentary than sedimentary.

*Esar's Comic Dictionary*

Geologist

Doubleday, Garden City, New York, USA. 1983

[Geologist]. A faultfinder.

*Esar's Comic Dictionary*

Geologist

Doubleday, Garden City, New York, USA. 1983

**Gilbert, G. K.** 1843–1918

American geologist

It is the natural and legitimate ambition of a properly constituted geologist to see a glacier, witness an eruption and feel an earthquake.

The Investigation of the San Francisco Earthquake

*Popular Science Monthly*, Volume 69, 1906 (p. 97)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

No Geologist worth anything is permanently bound to a desk or laboratory, but the charming notion that true science can only be based on unbiased observation of nature in the raw is mythology.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 6 (p. 98)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

**Harrington, John W.**

No biographical data available

Creative scientists work in an open-ended world of splendid uncertainty. Geologists are sometimes pitied, for their world is the most uncertain of all. Theirs is a historical science, rooted in a past that defies experimental research methods.

*Dance of the Continents*

Chapter Two (p. 41)

J.P. Tarcher. Los Angeles, California, USA. 1983

**Langley, Samuel Pierpoint** 1834–1906

American astronomer and aviation pioneer

We approach now the only planet in which man is certainly known to exist, and which ought to have an interest for us superior to any which we have yet seen, for it is our own. We are voyagers on it through space, it has been said, as passengers on a ship, and many of us have never thought of any part of the vessel but the cabin where we are quartered. Some curious passengers (these are the geographers) have visited the steerage, and some (the geologists) have looked under the hatches, and yet it remains true that those in one part of our vessel know little, even now, of their fellow-voyagers in another. How much less, then, do most of us know of the ship itself, for we were all born on it, and have never once been off it to view it from the outside!

*The New Astronomy*

**Lawson, Andrew C.**

By thought and dint of hammering

Is the good work done whereof I sing,

And a jollier crowd you'll rarely find,

Than the men who chip at earth's old rind,

And often wear a patched behind,

By thought and dint of hammering.

*Mente et Malleo*

December 7, 1877

**Macaulay, Thomas Babington** 1800–59

English historian and author

Bishop Watson compares a geologist to a gnat mounted on an elephant, and laying down theories as to the whole internal structure of the vast animal from the phenomena of the hide. The comparison is unjust to the geologist.

On History

*Edinburgh Review*, May 1828

**McPhee, John** 1931–

American journalist and nonfiction writer

Geologists, in their all but closed conversation, inhabit scenes that no one ever saw, scenes of global sweep, gone and gone again, including seas, mountains, rivers, forests, and archipelagoes of aching beauty rising in volcanic violence to settle down quietly and then forever disappear — almost disappear.

*Basin and Range* (p. 82)

Farrar, Straus & Giroux. New York, New York, USA. 1981

I used to sit in class and listen to the terms come floating down the room like paper airplanes. Geology was called a descriptive science, and with its pitted outwash plains and drowned rivers, its nothing if not descriptive. It was

a fountain of metaphors.... Geologists communicated in English; and they could name things in a manner that sent shivers through the bones.

*Basin and Range* (pp. 24, 25)

Farrar, Straus & Giroux. New York, New York, USA. 1981

A roadcut is to a geologist as a stethoscope is to a doctor.

*Basin and Range* (p. 11)

Farrar, Straus & Giroux. New York, New York, USA. 1981

**Miller, Hugh** 1802–56

Scottish geologist and theologian

There are few theologians worthy of the name who now hold that the deductions of the geologists regarding the earth's antiquity are at variance with the statements of Scripture respecting its first creation, and subsequent preparation for man.

*Sketch-Book of Popular Geology*

Lecture Second (p. 53)

William P. Nimmo & Co. Edinburgh, Scotland. 1880

The fact of the existence, throughout all the geological ages, of the great law of death, is a fact which must often press upon the geologist.

*Sketch-Book of Popular Geology*

Lecture Fifth (p. 158)

William P. Nimmo & Co. Edinburgh, Scotland. 1880

The geologist, as certainly as the theologian, has a province exclusively his own; and were the theologian ever to remember that the Scriptures could not possibly have been given to us as revelations of scientific truth, seeing that a single scientific truth they never yet revealed, and the geologist that it must be in vain to seek in science those truths which lead to salvation, seeing that in science these truths were never yet found, there would be little danger even of difference among them, and none of collision.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Sixth (pp. 280–281)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

The natural boundaries of the geographer are rarely described by right lines. Whenever these occur, however, the geologist may look for something remarkable.

*The Old Red Sandstone*

Chapter VI (p. 121)

J.M. Dent & Sons Ltd. London, England. 1922

**Nye, Bill** 1850–96

American journalist

Geologists ascertain the age of the earth by looking at its teeth and counting the wrinkles on its horns. They have learned that the earth is not only of great age, but that it is still adding to its age from year to year.

*Remarks*

About Geology (p. 201)

G.P. Brown Publishing Company. Chicago, Illinois, USA. 1888

**Pallister, William Hales** 1877–1946

Canadian physician

A torrid, turning sphere, cooling with crack and crash,  
Thick crust of lava-rock, and deep volcanic ash,  
Whose stratified formations now compose the book  
Of broken records where geologists may look.  
They classify the layers, by antiquity,  
In five sections: Achaean, long o'er life could be;  
The Paleozoic, site of life, the primary;  
Then Mesozoic, where the sequent life we see;  
Next comes the tertiary with creatures such as we,  
And, last of all, the recent-laid quaternary.

*Poems of Science*

Other Worlds and Ours, The Earth (p. 208)

Playford Press. New York, New York, USA. 1931

**Playfair, John** 1748–1819

Scottish geologist, physicist and mathematician

The geologist sadly mistakes both the object of his science and the limits of his understanding who thinks it his business to explain the means employed by INFINITE WISDOM for establishing the laws which now govern the world.

*Illustrations of the Huttonian Theory of the Earth*

Section 119 (p. 121)

Dover Publications, Inc. New York, New York, USA. 1964

The geologist must not content himself with examining the insulated specimens of his cabinet, or with pursuing the nice subtleties of mineralogical arrangement; he must study the relations of fossils, as they actually exist; he must follow nature into her wildest and most inaccessible abodes; and must select, for the places of his observations, those points, from which the variety and gradation of her works can be most extensively and accurately explored.

*Illustrations of the Huttonian Theory of the Earth*

Section 133 (p. 138)

Dover Publications, Inc. New York, New York, USA. 1964

...the outlines, at least, of geology have now been traced with tolerable truth, and are not susceptible of great variation...The mass of knowledge is in that state of termination from which the true theory may be expected to emerge.

*Illustrations of the Huttonian Theory of the Earth*

Section 449, 451 (pp. 515, 516)

Dover Publications, Inc. New York, New York, USA. 1964

**Prestwich, Joseph** 1812–96

English geologist and archaeologist

The geologist commences where the astronomer ends.  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1875*

The Past and Future of Geology (p. 177)

Government Printing Office. Washington, D.C. 1876

**Pretorius, D. A.**

No biographical data available

It is the nature of the history of the earth that a geologist has available to him only partial information. Occasional lines from disconnected paragraphs in obscurantist chapters are what can be read. Violence in the handling of the book through time has caused many of these chapters to be ripped and reassembled out of context. That the gist of the early chapters can be deciphered at all is a credit to the perseverance and imagination not always associated with other sciences. The geologist operates at all times in an environment characterized by a high degree of uncertainty and ornamented with end-products which are the outcomes of the interactions of many complex variables. He sees only the end, and has to induce the processes and the responses that filled the time since the beginning.

In Stanley A. Schumm

*To Interpret the Earth*

Chapter 1 (p. 5)

Cambridge University Press, Cambridge, England, 1991

**Read, Herbert Harold** 1889–1970

Geologist

In these hurried days, geologists will take no harm from a quiet contemplation of the history of even this small part of their science.

*The Granite Controversy: Geological Addresses Illustrating the Evolution of a Disputant* (p. xiii)

Interscience Publishers, New York, New York, USA, 1957

**Redfern, Martin**

No biographical data available

Rocks and stones are not the most forthcoming storytellers. They have a tendency to sit there gathering moss, only rolling when pushed. But geologists have ways of making them talk. They can hit them and slice them; squeeze them, squash them, strain and stress them until they crack — sometimes quite literally. If you know how to look at them, rocks can tell you their history.

*The Earth: A Very Short Introduction*

Chapter 1 (p. 3)

Oxford University Press, Inc. Oxford, England, 2003

**Scott, Sir Walter** 1771–1832

Scottish novelist and poet

[geologists]...rin uphill and down dale, knapping the chucky stanes to pieces wi' hammers, like sae mony road-makers run daft, to see how the world was made.

*Saint Ronan's Well*

Section 3 (p. 30)

Maarcus Ward & Co. London, England, 1879

**Sollas, William Johnson** 1849–1936

Geologist

A physicist studying geology is by definition a geologist.

*The Age of the Earth and Other Studies*

Chapter I (p. 4)

T. Fisher Unwin, London, England, 1905

**van Hise, Charles R.** 1857–1918

American academic

No man has ever stated more than a small part of the facts with reference to any area. The geologist must select facts which he regards of sufficient note to record and describe. But such selection implies theories of their importance and significance. In a given case the problem is therefore reduced to selecting facts for record, with a broad and deep comprehension of the principles involved, a definite understanding of the rules of the game...

*The Problems of Geology*

*Journal of Geology*, Volume 12, Number 7, 1904 (p. 612)

**Wordsworth, William** 1770–1850

English poet

He who with pocket-hammer smites the edge  
Of luckless rock or prominent stone disfigured  
In weather-stain or crusted o'er by Nature  
With her first growths, detaching by the stroke  
A chip or splinter — to resolve his doubts;  
And, with that ready answer satisfied,  
The substance classes by some barbarous name,  
And hurries on; on from the fragments picks  
His specimen, if but haply intervened  
With sparkling mineral, or should crystal cube  
Lurk in its cells — and thinks himself enriched,  
Wealthier, and doubtless wiser than before.

*The Complete Poetical Works of William Wordsworth*

The Excursion

Crowell, New York, New York, USA, 1888

**GEOMETER****du Hamel, Joannes Baptiste**

No biographical data available

I do not find that geometers are mighty solicitous, whether their arguments be, in formula, compounded according to logical prescription; and yet there are none who demonstrate wither more precisely or with greater conviction. For they usually follow the guidance of nature; descending step by step, from the simpler and more general to the more complex, and defining every term, they leave no ambiguity in their language. Hence it is that they cannot err in the form of their syllogisms — for we seldom deviate from logical rules, except when we abuse the ambiguity of words, or attribute a different meaning to the middle term in the major and in the minor proposition. It is also the custom of geometers to prefix certain self-evident axioms or principles from which all that they are subsequently to demonstrate flow. Finally, their conclusions are deduced, either from definitions which cannot

be called in question, or from those principles and propositions known by the light of nature, which are styled axioms, or from other already established conclusions, which now obtain the cogency of principles. They make not troublesome inquiry into the mood or figure of a syllogism, nor lavish attention on the rules of logic; for such attention, by averting their mind from more necessary objects, would be detrimental rather than advantageous.

*Edinburgh Review*, Volume 52, January 1836 (p. 228)

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The geometer shows us the true order in figures...

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Lectures and Biographical Sketches

Chapter III (p. 80)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Huxley, Aldous** 1894–1963

English writer and critic

How orderly philosophical is the landscape, are all the inhabitants of this World! It is the creation of a god who “ever plays the geometer.”

*Music at Night and Other Essays*

Music At Night (p. 45)

Doubleday Doran & Company, Inc. Garden City, New York, USA. 1931

### **Scaliger, Joseph**

No biographical data available

A dull and patient intellect such should be your geometers. A great genius cannot be a great mathematician.

*Edinburgh Review*, Volume 52, January 1836 (p. 229)

## **GEOMETRY**

### **Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

This would appear to put at least part of the Theory of Demonstration in a category with the efforts of beginners in Geometry: To prove that A equals B: let A equal B; therefore A equals B.

*Debunking Science*

University of Washington Book Store. Seattle, Washington, USA. 1930

The cowboys have a way of trussing up a steer or a pugnacious bronco which fixes the brute so that it can neither move nor think. This is the hog-tie, and it is what Euclid (B.C. 330–275) did to geometry.

*The Search for Truth*

Chapter VII, Section 4 (p. 117)

George Allen & Unwin Ltd. London, England. 1935

...the only royal road to elementary geometry is ingenuity.

*The Development of Mathematics* (p. 322)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

With a literature much vaster than those of algebra and arithmetic combined, and as least as extensive as that of analysis, geometry is a richer treasure house of more interesting and half-forgotten things, which a hurried generation has no leisure to enjoy, than any other division of mathematics

*The Development of Mathematics* (p. 320)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

### **Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

The method of Fluxions [the calculus] is the general key by help whereof the modern mathematicians unlock the secrets of Geometry, and consequently of Nature.

In E.T. Bell

*Men of Mathematics* (p. 90)

Simon & Schuster. New York, New York, USA. 1937

### **Bôcher, Maxime** 1867–1918

Mathematician

We must, then, admit...that there is an independent science of geometry just as there is an independent science of physics, and that either of these may be treated by mathematical methods. Thus geometry becomes the simplest of the natural sciences, and its axioms are of the nature of physical laws, to be tested by experience and to be regarded as true only within the limits of the errors of observation.

The Fundamental Conceptions and Methods in Mathematics

*Bulletin of the American Mathematical Society, 2nd Series*, Volume 11, 1904 (p. 124)

### **Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

The goal of geometry is to study those properties of bodies which can be considered independent of their matter, but only with respect to their dimensions and their forms. Geometry measures the surface of a field without bothering to find out whether the soil is good or bad.

Source undetermined

### **Brown, Fredric** 1906–72

Writer

“I’ve always been poor at geometry,” he began....

“You’re telling me,” said the demon gleefully.

Smiling flames, it came for him across the chalk lines of the useless hexagram Henry had drawn by mistake instead of the protecting pentagram.

*And the Gods Laughed: A Collection of Science Fiction and Fantasy*

Naturally

Phantasia Press. Bloomfield, Michigan, USA. 1987

### **Cedering, Siv** 1939–

Poet, painter, author, and sculptor

As I picture each planet

floating within the geometric perfections

of space, I think geometry was implanted in man along with the image of God.

Geometry indeed is God.

*Letters from the Floating World*

Letters from the Astronomers, II. Johannes Kepler (p. 114)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1984

### Charlie Chan

Fictional character

In phraseology of Euclid, X over Y equal proposition still unsolved.

*Dangerous Money*

Film (1946)

### Chasles, Michel 1793–1880

French mathematician

The doctrines of pure geometry often, and in many questions, give a simple and natural way to penetrate to the origin of truths, to lay bare the mysterious chain which unites them, and to make them known individually, luminously and completely.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 834)

Oxford University Press, Inc. New York, New York, USA. 1972

### Chern, Shiing-Shen 1911–2004

Chinese-American differential geometer

Physics and geometry are one family.

Together and holding hands they roam to the limits of outer space...

Surprisingly, Math has earned its rightful place for man and in the sky;

Fondling flowers with a smile — just wish nothing is said!

Interview with Shiing Shen Chern

*Notices of the American Mathematical Society*, Volume 45, Number 7, August 1998 (p. 865)

### Clifford, William Kingdon 1845–79

English philosopher and mathematician

...for geometry, you know, is the gate of science, and the gate is so low and small that we can only enter it as a little child.

In Stephen F. Gull, Anthony N. Lasenby and Chris J.L. Doran

Imaginary Numbers Are Not Real — The Geometric Algebra of Spacetime

*Foundations of Physics USA*, Volume 23, Number 9, September 1993 (p. 1175)

### Comte, Auguste 1798–1857

French philosopher

...GEOMETRY is a true natural science; — only more simple, and therefore more perfect than any other. We must not suppose that, because it admits the application of mathematical analysis, it is therefore a purely logical science, independent of observation. Every body

studied by geometers presents some primitive phenomena which, not being discoverable by reasoning, must be due to observation alone.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter III (p. 86)

John Chapman. London, England. 1853

### Coolidge, Julian L. 1873–1954

American professor of mathematics

The present author humbly confesses that, to him, geometry is nothing at all, if not a branch of art...

*A Treatise on Algebraic Plane Curves*

Preface (p. x)

Dover Publications. New York, New York, USA. 1959

### Davies, Paul Charles William 1946–

Mathematical physicist

Geometry was the mid wife of science.

*Superforce: The Search for a Grand Unified Theory of Nature*

Chapter 10 (p. 165)

Simon & Schuster. New York, New York, USA. 1984

### de Morgan, Augustus 1806–71

English mathematician and logician

Geometry, then, is the application of strict logic to those properties of space and figure which are self-evident, and which therefore cannot be disputed. But the rigor of this science is carried one step further; for no property, however evident it may be, is allowed to pass without demonstration, if that can be given. The question is therefore to demonstrate all geometrical truths with the smallest possible number of assumptions.

*On the Study and Difficulties of Mathematics*

Chapter XV (p. 231)

The Open Court Publishing Company. La Salle, Illinois, USA. 1943

### Dee, John 1527–1609

English mathematician and occultist

There is (gentle reader) nothing (the works of God only set apart) which so much beautifies and adorns the soul and mind of man as does knowledge of the good arts and sciences.... Many...arts there are which beautify the mind of man; but of all none do more garnish and beautify it than those arts which are called mathematical, unto the knowledge of which no man can attain, without perfect knowledge and instruction of the principles, grounds, and Elements of Geometry.

*Euclid*

Preface (p. 1)

Printed by Robert and William Leybourn. London, England. 1651

### Descartes, René 1596–1650

French philosopher, scientist, and mathematician

...we have sufficient evidence that the ancient Geometricians made use of a certain analysis which they extended

to the resolution of all problems, though they grudged the secret to posterity.

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule IV (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Dieudonné, Jean** 1906–92

French mathematician and educator

...it has been said that the art of geometry is to reason well from false diagrams.

*Mathematics — The Music of Reason*

Chapter III, Section 4 (p. 37)

Springer-Verlag. Berlin, Germany. 1992

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

We may climb into the thin and cold realm of pure geometry and lifeless science...

*The Complete Works of Ralph Waldo Emerson* (Volume 3)

Essays: Second Series

Chapter II (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The astronomer discovers that geometry, a pure abstraction of the human mind, is the measure of planetary motion.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

The American Scholar

The Library of America. New York, New York, USA. 1983

Moon, planet, gas, crystal, are concrete geometry and numbers.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

Nature (p. 548)

The Library of America. New York, New York, USA. 1983

### **Euripides** c. 480 BC–406 BC

Greek playwright

Mighty is geometry; joined with art, resistless.

In Stanley Gudder

*A Mathematical Journey* (p. 67)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

### **Fabre, Jean-Henri** 1823–1915

French entomologist and author

Geometry, that is to say, the science of harmony in space, presides over everything. We find it in the arrangement of the scales of a fir-cone, as in the arrangement of an Epeira's limy web; we find it in the spiral of a Snail-shell, in the chaplet of a Spider's thread, as in the orbit of a planet; it is everywhere, as perfect in the world of atoms as in the world of immensities.

Translated by Alexander Teixeira de Mattos

*The Life of the Spider*

Appendix: The Geometry of the Eperia's Web (p. 399)

Dodd, Mead & Company. New York, New York, USA. 1913

### **Fontenelle, Bernard Le Bovier**

A work of morality, politics, criticism will be more elegant, other things being equal, if it is shaped by the hand of geometry.

*l'Utilité des Mathématiques et de la Physique*

Preface

Publisher undetermined

### **Galilei, Galileo** 1564–1642

Italian physicist and astronomer

SIMPLICIO: Indeed, I begin to understand that while logic is an excellent guide in discourse, it does not, as regards stimulation to discovery, compare with the power of sharp distinction which belongs to geometry.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

Second Day (p. 190)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Gauss, Johann Carl Friedrich** 1777–1855

German mathematician

I am coming more and more to the conviction that the necessity of our geometry cannot be demonstrated, at least neither by, nor for, the human intellect. Perhaps in some other life we may arrive at other insights into the nature of space that are at present inaccessible to us. Until such time geometry should be ranked, not with arithmetic, which is purely aprioristic, but with mechanics.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part II, Chapter I (p. 133)

Princeton University Press. Princeton, New Jersey, USA. 1949

### **Halsted, George Bruce** 1853–1922

American mathematician

No mathematical exactness without explicit proof from assumed principles — such is the motto of the modern geometer.

In Henri Poincaré

*The Foundations of Science*

The Value of Science, Translator's Introduction (p. 202)

The Science Press. New York, New York, USA. 1913

### **Hamilton, Sir William Rowan** 1805–65

Irish mathematician

The mathematical process in the symbolical method (i.e., the algebraical) is like running a railroad through a tunneled mountain, ...in the ostensive (i.e., the geometrical) like crossing the mountain on foot. The former causes us, by a short and easy transit, to our destined point, but in miasma, darkness and torpidity, whereas the latter allows us to reach it only after time and trouble, but feasting us at each turn with glances of the earth and of the heavens, while we inhale the pleasant breeze, and gather new strength at every effort we put forth.



In Richard Olson  
*Scottish Philosophy and British Physics: 1750–1880*  
 Chapter 1 (p. 22)  
 Princeton University Press. Princeton, New Jersey, USA. 1975

**Hermite, Charles** 1822–1901  
 French mathematician

I cannot tell you the efforts to which I was condemned to understand something of the diagrams of Descriptive Geometry, which I detest.

In E.T. Bell  
*Men of Mathematics* (p. 183)  
 Simon & Schuster. New York, New York, USA. 1937

**Herodotus** 484 BC–432 BC  
 Greek historian

Sesostris also...made a division of the soil of Egypt among the inhabitants, assigning square plots of ground of equal size to all.... If the river carried away any portion of a man's lot, he appeared before the king, and related what has happened; upon which the king sent persons to examine, and determine by measurement the exact extent of the loss.... From this practice, I think, geometry first came to be known.

In *Great Books of the Western World* (Volume 6)  
*The History of Herodotus*  
 The Second Book, Section 109 (p. 70)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hilbert, David** 1862–1943  
 German mathematician

Three-dimensional geometry becomes a chapter in four-dimensional physics.

In Constance Reid  
*Hilbert — Courant*  
 Hilbert  
 Chapter XIV (p. 112)  
 Springer-Verlag. New York, New York, USA. 1986

**Hobbes, Thomas** 1588–1679  
 English philosopher and political theorist

Geometry...the only Science that it hath pleased God hitherto to bestow on mankind....

In *Great Books of the Western World* (Volume 23)  
*Leviathan*  
 Part I, Chapter 4 (p. 56)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...Geometry...is the Mother of all Natural Science...

In *Great Books of the Western World* (Volume 23)  
*Leviathan*  
 Part IV, Chapter 46 (p. 268)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hugo, Victor** 1802–85  
 French author, lyric poet, and dramatist

Geometry itself is one kind of harmony.  
*Notre-Dame de Paris*

Book III, Chapter 2 (p. 117)  
 J.M. Dent & Sons Ltd. London, England. 1910

**Huxley, Aldous** 1894–1963  
 English writer and critic

...a world where beauty and logic, painting and analytic geometry, had become one.

*After Many a Summer Dies the Swan*  
 Part I, Chapter III (p. 44)  
 Ivan R. Dee, Publisher. Chicago, Illinois, USA. 1993

**Huygens, Christiaan** 1629–95  
 Dutch mathematician, astronomer, and physicist

As happens in all the sciences in which geometry is applied to matter, the demonstrations concerning Optics are founded on truths drawn from experience.

In *Great Books of the Western World* (Volume 34)  
*Treatise on Light*  
 Chapter One, On Rays Propagated in Straight Lines (p. 553)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ibn Khaldun** 1332–1406  
 Historiographer and historian

Geometry enlightens the intellect and sets one's mind right. All of its proofs are very clear and orderly. It is hardly possible for errors to enter into geometrical reasoning, because it is well arranged and orderly. Thus, the mind that constantly applies itself to geometry is not likely to fall into error. In this convenient way, the person who knows geometry acquires intelligence.

*The Muqaddimah: An Introduction to History*  
 The Various Kinds of Sciences, section 20  
 Pantheon Books. New York, New York, USA. 1958

**Keller, Helen** 1880–1968  
 American author and lecturer

I am sure the daisies and buttercups have as little use for the science of Geometry as I, in spite of the fact that they so beautifully illustrate its principles.

*The Story of My Life*  
 Letter to Charles Dudley Warner  
 June 7, 1898 (p. 243)  
 Grosset & Dunlap, Publishers. New York, New York, USA. 1905

**Kepler, Johannes** 1571–1630  
 German astronomer

Why waste words? Geometry existed before the Creation, is co-eternal with the mind of God, is God himself (what exists in God that is not God himself?): geometry provided God with a model for the Creation and was implanted into man, together with God's own likeness — and not merely conveyed to his mind through the eyes.

In Arthur Koestler  
*The Sleepwalkers*  
 Part Four, Chapter II, Section 3 (p. 262)  
 The Macmillan Company. New York, New York, USA. 1966

Geometry has two great treasures: one is the Theorem of Pythagoras; the other, the division of a line into extreme and mean ratio. The first we may compare to a measure of gold; the second we may name a precious jewel.

In Carl B. Boyer

*A History of Mathematics* (p. 55)

John Wiley & Sons, Inc. New York, New York, USA. 1968

### **Klein, Felix** 1849–1925

German mathematician

Projective geometry has opened up for us with the greatest facility new territories in our science, and has rightly been called the royal road to its own particular field of knowledge.

In E.T. Bell

*Men of Mathematics* (p. 206)

Simon & Schuster. New York, New York, USA. 1937

### **Kline, Morris** 1908–92

American mathematics professor and writer

In the house of mathematics there are many mansions and of these the most elegant is projective geometry.

Projective Geometry

*Scientific American*, Volume 192, Number 1, January 1955 (p. 80)

...no branch of mathematics competes with projective geometry in originality of ideas, coordination of intuition in discovery and rigor in proof, purity of thought, logical finish, elegance of proofs and comprehensiveness of concepts. The science born of art proved to be an art.

Projective Geometry

*Scientific America*, Volume 192, Number 1, 1955 (p. 86)

### **Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

Those few things having been considered, the whole matter is reduced to pure geometry, which is the one aim of physics and mechanics.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 391)

Oxford University Press, Inc. New York, New York, USA. 1972

### **Manning, Henry Parker** 1859–1956

American mathematician

Suspended o'er geometry,  
I am a fish-worm dangling —

A creature too obtuse to see

What is acute in angling.

In Francis A. Litz (ed.)

*The Poetry of Father Tabb*

Humorous Verse, A Problem in Mathematics

Dodd, Mead. New York, New York, USA. 1928

...the greatest advantage to be derived from the study of geometry of more than three dimensions is a real understanding of the great science of geometry. Our plane and solid geometries are but the beginning of this science.

The four-dimensional geometry is far more extensive than the three-dimensional, and all the higher geometries are more extensive than the lower.

*Geometry of Four Dimensions*

Introduction (p. 13)

Dover Publication, Inc. New York, New York, USA. 1914

### **Marvell, Andrew** 1621–78

English metaphysical poet

As lines, so loves oblique may well

Themselves in every angle greet

But ours, so truly parallel,

Though infinite can never meet.

*The Poetical Works of Andrew Marvell*

Definition of Love, Verse VII

A. Murray. London, England. 1870

### **Morgan, Frank**

No biographical data available

We are just beginning to understand how geometry rules the universe.

Review: The Parsimonious Universe

*The American Mathematical Monthly*, Volume 104, Number 4, April,

1997 (p. 376)

### **Newton, Sir Isaac** 1642–1727

English physicist and mathematician

...it is the glory of geometry that from so few principles, fetched from without, it is able to produce so many things.

*Mathematical Principles of Natural Philosophy*

Preface to the First Edition

E.P. Dutton & Company. New York, New York, USA. 1922

### **O'Brien, Katharine**

Mathematician

Now Einstein's Glee was plain to see at the sight of a cone with a sphere on top...

Einstein and the Ice-Cream Cone

*The Mathematics Teacher*, April 1968 (p. 404)

### **Philips, J. D.**

No biographical data available

When school children study analytic geometry, they should be made aware that his seemingly trivial and esoteric subject exists to us only because of the heroic efforts of a succession of brilliant minds, culminating in the work of Descartes. Its depth, originality, and profundity are lost on students. It has been carefully polished and refined so exquisitely, presented so elegantly and simply, that students myopically receive it as a trifle.

The Humanistic Mathematics Network Journal

*Mathematics as an Aesthetic Discipline*, Number 12, October 1995

### **Pirsig, Robert M.** 1928–

American writer

One geometry cannot be more true than another; it can only be more convenient. Geometry is not true, it is advantageous.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part III, Chapter 22 (p. 264)  
William Morrow & Company, Inc. New York, New York, USA. 1974

**Plato** 428 BC–347 BC

Greek philosopher

...we are concerned with that part of geometry which relates to war; for in pitching a camp, or taking up a position, or closing or extending the lines of an army, or any other maneuver, whether in actual battle or on a march, it will make all the difference whether a general is or is not a geometrician.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 526 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the knowledge at which geometry aims is knowledge of the eternal, and [naught of] perishing and transient.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 527 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...geometry will draw the soul towards truth, and create the spirit of philosophy, and raise up that which is now unhappily allowed to fall down.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 527 (p. 394)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Plotinus** 205–70

Egyptian-Roman philosopher

Geometry [is] the science of the Intellectual entities...

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Fifth Ennead IX.11 (p. 250)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

That being so what ought one to think of this question: Is the Euclidean Geometry true? The question is nonsense. One might as well ask whether the metric system is true and the old measures false; whether Cartesian co-ordinates are true and polar co-ordinates false.

Non-Euclidean Geometry

*Nature*, Volume 45, Number 1165, February 25, 1892 (p. 407)

Common geometry has a great advantage in that the senses may come to the help of our reason and aid it in finding what path to follow, and many minds prefer to put their problems of analytical geometry in the ordinary geometrical form. Unfortunately our senses can not lead

us so very far, and they fail us when we try to escape from the classical three dimensions.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 138)

Government Printing Office. Washington, D.C. 1910

...if there were no solid bodies in nature, there would be no geometry.

*The Foundations of Science*

Science and Hypothesis, Part II

Chapter IV (p. 73)

The Science Press. New York, New York, USA. 1913

...geometry is not true, it is advantageous.

*The Foundations of Science*

Science and Hypothesis, Part II

Chapter V (p. 91)

The Science Press. New York, New York, USA. 1913

...the facts of geometry are naught else than the facts of algebra and analytical geometry expressed in another language.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

1909

The Future of Mathematics (p. 138)

Government Printing Office. Washington, D.C. 1910

**Pólya, George** 1887–1985

Hungarian mathematician

Geometry is the art of correct reasoning on incorrect figures.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The traditional mathematics professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Geometry, throughout the 17th and 18th centuries, remained, in the war against empiricism, an impregnable fortress of the idealists. Those who held — as was generally held on the Continent — that certain knowledge, independent of experience, was possible about the real world, had only to point to Geometry: none but a madman, they said, would throw doubt on its validity, and none but a fool would deny its objective reference.

*An Essay on the Foundations of Geometry*

Introduction (p. 1)

Dover Publications, Inc. New York, New York, USA. 1956

...Geometry has been, throughout, of supreme importance in the theory of knowledge.

*An Essay on the Foundations of Geometry*

Chapter Bisection 51 (p. 54)

Dover Publications, Inc. New York, New York, USA. 1956

All geometrical reasoning is, in the last resort, circular: if we start by assuming points, they can only be defined by the lines or planes which relate them; and if we start by assuming lines or planes, they can only be defined by the points through which they pass.

*An Essay on the Foundations of Geometry*

Chapter III, Section 108 (p. 120)

Dover Publications, Inc. New York, New York, USA. 1956

There is no logical implication of other entities in space. It does not follow, merely because there is space, that therefore there are things in it. If we are to believe this, we must believe it on new grounds, or rather on what is called the evidence of the senses. Thus we are taking an entirely new step.

*Principles of Mathematics* (2<sup>nd</sup> edition)

Chapter 53 (p. 465)

W.W. Norton & Company, Inc. New York, New York, USA. 1938

How can a certain line, or a certain surface, form an impassable barrier to space, or have any mobility different in kind from that of all other lines or surfaces? The notion cannot, in philosophy, be permitted for a moment, since it destroys that most fundamental of all the axioms, the homogeneity of space.

*An Essay on the Foundations of Geometry*

Chapter I, Section 45 (p. 49)

Dover Publications, Inc. New York, New York, USA. 1956

All points are qualitatively similar, and distinguished by the mere fact that they lie outside one another.

*An Essay on the Foundations of Geometry* (p. 52)

Dover Publications, Inc. New York, New York, USA. 1956

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

A layer cake is geometry and layer cake.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #374 (p. 148)

Definition Press. New York, New York, USA. 1972

**Smith, Henry J. S.** 1826–83

Irish mathematician

One thing at least they have not forgotten, that geometry is nothing if it be not rigorous, and that the whole educational value of the study is lost, if strictness of demonstration be trifled with. The methods of Euclid are, by almost universal consent, unexceptionable in point of rigor.

Opening Address by the President, Section A

*Nature*, Volume 8, Number 204, September 25, 1873 (p. 450)

**Sylvester, James Joseph** 1814–97

English mathematician

Geometry may sometimes appear to take the lead over analysis but in fact precedes it only as a servant goes before the master to clear the path and light him on his way.

*Philosophic Magazine*, Volume 31, 1866 (p. 521)

He who would know what geometry is must venture boldly into its depths and learn to think and feel as a geometer. I believe that it is impossible to do this, and to study geometry as it admits of being studied and am

conscious it can be taught, without finding the reason invigorated, the invention quickened, the sentiment of the orderly and beautiful awakened and enhanced, and reverence for truth, the foundation of all integrity of character, converted into a fixed principle of the mental and moral constitution, according to the old and expressive adage “*abeunt studia*” in mores.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

A Probationary Lecture on Geometry, Delivered before the Gresham Committee and the Members of the Common Council of the City of London, 4 December, 1854 (p. 9)

University Press. Cambridge, England. 1904–1912

**Thom, René** 1923–2002

French mathematician

...the spirit of geometry circulates almost everywhere in the immense body of mathematics, and it is a major pedagogical error to seek to eliminate it.

In A.G. Howson (ed.)

*Developments in Mathematical Education: Proceedings of the Second International Congress on Mathematical Education*

Modern Mathematics: Does It Exist (p. 208)

At the University Press. Cambridge, England. 1973

**Veblen, Oswald** 1880–1960

American mathematician

The branch of physics which is called Elementary Geometry was long ago delivered into the hands of mathematicians for the purposes of instruction. But, while mathematicians are often quite competent in their knowledge of the abstract structure of the subject, they are rarely so in their grasp of its physical meaning.

Geometry and Physics

*Science*, Volume 57, Number 1466, February 2, 1923 (p. 131)

At the same time it will not be forgotten that the physical reality of geometry can not be put in evidence with full clarity unless there is an abstract theory also.... Thus, for example, while the term electron may have more than one physical meaning, it is by no means such a protean object as a point or a triangle.

Geometry and Physics

*Science*, Volume 57, Number 1466, February 2, 1923 (p. 131)

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

Geometry, if we consider it in its true light, is a mere jest, and nothing more.

*The Best Known Works of Voltaire*

Jeannot and Colin (p. 281)

Blue Ribbon Books. New York, New York, USA. 1940

Did anyone ever so much as think of talking geometry in good company?

*The Best Known Works of Voltaire*

Jeannot and Colin (p. 281)

Blue Ribbon Books. New York, New York, USA. 1940

...the geometrician makes a hundred thousand curved lines pass between a circle and a right line that touches it, when, in reality, there is not room for a straw to pass there.

*The Best Known Works of Voltaire*

Jeannot and Colin (p. 281)

Blue Ribbon Books. New York, New York, USA. 1940

...but of all the sciences, the most absurd, and that which in my opinion, is most calculated to stifle genius of every kind, is geometry. The objects about which this ridiculous science is conversant are surfaces, lines, and points, that have no existence in nature.

*The Best Known Works of Voltaire*

Jeannot and Colin (p. 281)

Blue Ribbon Books. New York, New York, USA. 1940

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

Geometry would be best to begin with plain plane geometry, immutably plane. Surely if anything could minister to the mind diseased it would be the steadfast contemplation of a right angle, an existence that no mist of human tears could blur, no blow of fate deflect.

*Mr. Fortune's Maggot*

Mr. Fortune's Maggot (p. 107)

New York Review of Books. New York, New York, USA. 1927

**Warrain, Francis**

No biographical data available

Music is to time what geometry is to space.

In Matila Ghyka

*The Geometry of Art and Life*

Chapter I (p. 6, fn)

Dover Publications Inc. New York, New York, USA. 1977

**Weyl, Hermann** 1885–1955

German mathematician

Geometry became one of the most powerful expressions of that sovereignty of the intellect that inspired the thought of those times. At a later epoch, when the intellectual despotism of the church, which had been maintained through the middle ages, had crumbled, and a wave of skepticism threatened to sweep away all that had seemed most fixed, those who believed in truth clung to Geometry as to a rock, and it was the highest ideal of every scientist to carry on his science "more geometrico."

Translated by Henry L. Brose

*Space — Time — Matter*

Introduction (p. 1)

Dover Publications, Inc. New York, New York, USA. 1922

**Wharton, William** 1925–

American author

In Plane Geometry that afternoon, I got into an argument with Mr. Shull, the teacher, about parallel lines. I say they have to meet. I'm beginning to think everything comes

together somewhere.

*Birdy* (p. 231)

Avon Books. New York, New York, USA. 1980

**Whewell, William** 1794–1866

English philosopher and historian

This science is one of indispensable use and constant reference, for every student of the laws of nature; for the relations of space and number are the alphabet in which those laws are written. But besides the interest and importance of this kind which geometry possesses, it has a great and peculiar value for all who wish to understand the foundations of human knowledge, and the methods by which it is acquired.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 1)

Part I, Book 2, Chapter 4, article 8 (pp. 99–100)

John W. Parker. London, England. 1847

**Wordsworth, William** 1770–1850

English poet

But who shall parcel out

His intellect by geometric rules,

Split like a province into round and square?

*The Complete Poetical Works of William Wordsworth*

The Prelude

School-Time (continued) (p. 41)

Crowell. New York, New York, USA. 1888

## GEOMORPHOLOGY

**Robinson, Geoffrey**

No biographical data available

Geomorphology, the study of earth sculpture, may be engaged in as a science of its own right.

A Consideration of the Relations of Geomorphology and Geography

*Professional Geographer*, Volume 15, 1963 (p. 13)

**Russell, Richard Joel**

No biographical data available

The distinction between geological and geographical geomorphology lies chiefly in a contrast between conclusions of vertical and horizontal significance.

Geographical Geomorphology

*Annals of the Association of American Geographers*, Volume 39, 1949

(p. 4)

**Tinkler, Keith J.**

No biographical data available

Geomorphology is, and always has been, the most accessible earth science to the ordinary person: we see scenery as we sit, walk, ride or fly. It is a part of our daily visual imagery, and we do not even have to stop or stoop to examine it, although our perceptions are usually better if we do.

*A Short History of Geomorphology*

Chapter Twelve (p. 239)  
Barnes and Noble Books. Totowa, New Jersey, USA. 1985

## GEOPHYSICS

**Wegener, Alfred** 1880–1930  
German climatologist and geophysicist

It is a strange fact, characteristic of the incomplete state of our present knowledge, that totally opposing conclusions are drawn about prehistoric conditions on our planet, depending on whether the problem is approached from the biological or geophysical viewpoint.

*The Origin of Continents and Oceans*

Chapter 2 (p. 5)

Dover Publications, Inc. New York, New York, USA. 1966

## GERM PLASM

**Hirsch, Nathaniel David**

The germ cells are like immortal princes confined in isolated castles that they themselves have built; in other castles princesses are confined and they no more than the princes are satisfied with their sister cells. So both princes and princesses ignite their castles by the flame of love; which although ultimately destructive of the existing castle, builds mightier and higher ones from their very flames and ashes.

*Genius and Creative Intelligence* (p. 60)

Sci-Art Publishers. Cambridge, Massachusetts, USA. 1931

The germ plasm has lived millions of years at least; it is perpetually experiencing, for all life, as distinguished from inorganic matter, endures — lives with and through the past. In our own lives we are the total of all our past experiences...we are ever growing older like the universe of the immortal Bergson. So too the germ-plasm; it is literally the heir of all the ages of germ-plasm experience, and the germ plasm is living, is experiencing as much as we and in like manner. The germ cells have sexual yearnings, pugnacious tendencies, and they create; mutations are their darlings...

*Genius and Creative Intelligence* (p. 61)

Sci-Art Publishers. Cambridge, Massachusetts, USA. 1931

**Pauling, Linus** 1901–94  
American chemist

I like people. I like animals, too — Whales and quail, dinosaurs and dodos. But I like human beings especially, and I am unhappy that the pool of human germ plasm, which determines the nature of the human race, is deteriorating.

*New York Times*, October 13, 1963

## GEYSER

**Esar, Evan** 1899–1995  
American humorist

[Geysers] A well with the hiccups.

*Esar's Comic Dictionary*

Geysers

Doubleday. Garden City, New York, USA. 1983

**Muir, John** 1838–1914  
American naturalist

In the solemn gloom, the geysers, dimly visible, look like monstrous dancing ghosts, and their wild songs and the earthquake thunder replying to the storms overhead seem doubly terrible, as if divine government were at an end.

*Our National Parks*

Chapter II (p. 45)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...Nature seems to have gathered them from all the world as specimens of her rarest fountains, to show in one place what she can do.

*Our National Parks*

Chapter II (p. 43)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## GLACIAL DEBRIS

**Burns, Robert** 1759–96  
English author

Hillocks dropt in Nature's careless haste...

*The Complete Poetical Works of Robert Burns*

Verses Written with a Pencil at the Inn at Kenmore

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

## GLACIER

**Adams, Henry Brooks** 1838–1918  
American man of letters

If the glacial period were uniformity, what was catastrophe?

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter XV (p. 227)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Bradley, Jr., John Hodgdon** 1898–1962  
Geologist

Like a scavenging beast the ice on the lower face of the crevasse swallows both the rocky products of disintegration and the ice that enters from the snowfield above.

*Autobiography of Earth*

Chapter V (p. 151)

Coward-McCann, Inc. New York, New York, USA. 1935

**Daumal, Rene** 1908–44  
French surrealist writer

The glacier is an organized being, with a head or névé through which it gulps snow and rock debris, a head well separated from the rest of its body by the rimaye; then an enormous stomach in which snow is transformed into ice, a stomach riddled with crevasses and internal passages for expelling excess water; and in its lower portions it secretes its wastes in the form of moraine. Its life follows the cycle of the seasons. It sleeps in winter and comes to life in the spring with deep creakings and boomings. Certain glaciers even reproduce themselves, by means that are little more rudimentary than those of unicellular beings — either by conjunction and fusion or by division, which gives birth to what are called re-generate glaciers.

*Mount Analogue*

Which Is That of the Crossing (pp. 73–74)  
Shambhala. Boston, Massachusetts, USA. 1986

**de Saussure, Horace-Bénédict** 1740–99  
Swiss physicist and geologist

Its surface resembled that of a sea which has become suddenly frozen — not during a tempest, but at the instant when the wind has subsided, and the waves, although very high, have become blunted and rounded.

In Alexander Winchell

*Walks and Talks in the Geological Field*

Chapter IV (pp. 27–28)

Chautauqua Press. New York, New York, USA. 1890

**Harrison, Will**

No biographical data available

Glaciers are delicate and individual things, like humans. Instability is built into them.

*Time*, 1 September 1986

**Keeler, Charles**

No biographical data available

Out of the cloud-world sweeps thy awful form,  
Vast frozen river, fostered by the storm  
Up on the dear peak's snow-encumbered crest,  
Thy sides deep grinding in the mountain's breast  
As down its slopes thou ploughest to the sea  
To leap into thy mother's arms, and be  
Cradled into nothingness.

In John Burroughs

*Songs of Nature*

To an Alaskan Glacier

Doubleday, Page & Company. Garden City, New York, USA. 1912

**Levinson, Leonard Louis**

GLACIER. Frozen geography.

*The Left Handed Dictionary*

Collier Books. New York, New York, USA. 1963

**Muir, John** 1838–1914

American naturalist

Not a peak, ridge, dome, canyon, lake basin, garden, forest, or stream but in some way explains the past existence and modes of action of flowing, grinding, sculpturing, soil making, scenery making ice.

*Our National Parks*

Chapter III (p. 84)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Pallister, William Hales** 1877–1946

Canadian physician

The story of earth's evolution, told  
In rocks which held the pages stratified:  
In granites torn by glacier and tide,  
In limestone, coal-bed, river-clay and mould;  
The story of the past, now blurred, now bold,  
Which nature tells in signs on every side,  
The story of the species, all allied.

*Poems of Science*

Geology (p. 83)

Playford Press. New York, New York, USA. 1931

**Playfair, John** 1748–1819

Scottish geologist, physicist and mathematician

For the moving of large masses of rock, the most powerful engines without doubt which nature employs are the glaciers, those lakes or rivers of ice which are formed in the highest valleys of the Alps, and other mountains of the first order.

*Illustrations of the Huttonian Theory of the Earth*

Section 348 (p. 388)

Dover Publications, Inc. New York, New York, USA. 1964

**Shelley, Percy Bysshe** 1792–1822

English poet

The glaciers creep

Like snakes that watch their prey, from their far fountains.

*The Complete Poetical Works of Percy Bysshe Shelley*

Mont Blanc

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

...a man who keeps company with glaciers comes to feel tolerably insignificant by and by. The Alps and the glaciers together are able to take every bit of conceit out of a man and reduce his self-importance to zero if he will only remain within the influence of their sublime presence long enough to give it a fair and reasonable chance to do its work.

*A Tramp Abroad*

Chapter XL (p. 298)

Penguin Books. New York, New York, USA. 1997

**GLAND**

**Carrel, Alexis** 1873–1944

French surgeon and biologist

For the noblest aspirations of the soul to vanish it is sufficient that the blood plasma be deprived of certain chemical substances. When the thyroid gland, for example, ceases to secrete thyranin into the blood stream there is no longer either intelligence, sense of evil, sense of beauty or religious sense.

Furthermore, the pituitary, the thyroid, the sexual glands, the supparrenal gland, make possible love, hatred, enthusiasm and faith. The Christian virtues are more difficult to practice when our endocrine glands are deficient.

In Jean Rostand Larousse and Andrée Tétzy

Translated by Delano Ames

*Larousse Science of Life: A Study of Biology, Sex, Genetics, Heredity and Evolution* (p. 19)

Hamlyn. London, England. 1971

## GLASSWARE

### Cullinane, N. M.

No biographical data available

My sweet pipet,

Can I forget

The day we met — Pipet?

The day was drear and wet, how wet!

Your price was half a dollar net,

But shall I ever repay the debt, Pipet?

I think of what you held for me,

E'en though 'twas only 10 cc.,

(or 20 as the case may be),

And how in vain I tried to check

The water running down your neck — pipet.

Ode to a Pipet

*Industrial and Engineering Chemistry: News Edition*, Volume 13, Number 19, 10 October 1935 (p. 394)

### Glaser, Christophe 1615–78

Swiss chemist

The shape and form of Chymical Vessels is almost infinite...

*The Compleat Chymist, or a New Treatise of Chymistry*

Chapter VII (p. 20)

Printed for John Starkey. London, England. 1677

### Smith, Miles

No biographical data available

### Boudy, Cather

No biographical data available

Now if by chance we are missing a flask

We go to our neighbor, and timidly ask,

“Can you give us the low down — who stole our glass?”

With innocent surprise or utter dismay

He tell us that he has not seen it today.

So we give up our search, but the suspicion is strong

That our chemical neighbor has done us the wrong.

Our Poetic Corner, A Wail of Analytiker Men

*Industrial and Engineering Chemistry: News Edition*, Volume 8, Number 2, 20 January 1930

## GLUONS

### Feynman, Richard P. 1918–88

American theoretical physicist

We call these quanta gluons, and say that besides quarks there must be gluons to hold the quarks together.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II, Chapter 6 (p. 251)

Simon & Schuster. New York, New York, USA. 1982

## GOAL

### Browne, Sir Thomas 1605–82

English author and physician

In this virtuous Voyage of thy Life, hull not about like the Ark without the use of Rudder, Mast, or Sail, and bound for no Port. Let not Disappointment cause Despondency, nor difficulty despair.

*The Prose of Sir Thomas Browne*

Christian Morals

Part I, Section 1 (p. 371)

### Farber, Eric A.

No biographical data available

Everything worthwhile which has been achieved by an individual, a group, or humanity as a whole was done by striving toward a definite, clearly defined — although sometimes unattainable — goal.

The Teaching and Learning of Engineering

*Journal of Engineering Education*, Volume 45, Number 10, June 1955 (p. 784)

### Fredrickson, A. G. 1932–

No biographical data available

We must try to set up some definite goals that have the benefit of all mankind as their objective.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 148)

Only by setting up defined goals will it be possible to develop priorities and institutions that can guide the innovative genius of men onto paths that will be truly, as opposed to superficially, beneficial.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 148)

### Grew, Nehemiah 1641–1712

Scientific writer and journalist

... If but little thought be effected, yet to design more, can do us no harm: For although a Man shall never be able to hit Stars by shooting at them; yet he shall come



much nearer to them than another that throws at Apples.

*The Anatomy of Plants*

An Idea of A Philosophical History of Plants (p. 24)

Printed by W. Rawlins. London, England. 1682

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

When schemes are laid in advance, it is surprising how often the circumstances fit in with them.

*Aequanimitas, With Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Internal Medicine as a Vocation (p. 138)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

## GOD

**Adams, George** 1750–95

English instrument maker

God pervades infinity, and sees through eternity...

*Lectures on Natural and Experimental Philosophy* (Volume 4)

Chapter XXVII (p. 4)

Printed by R. Hindmarsh. London, England. 1794

**Allen, Dave** 1936–2005

Irish comic and satirist

If man has a sense of humor about God then surely God must have a sense of humor about man.

*Dave Allen at Large, BBC*

Aired on Miami Channel 2, WPBT, October 18, 1984

**Allen, Ethan** 1738–89

Hero of the American Revolution

As far as we understand nature, we are become acquainted with the character of God; for the knowledge of nature is the revelation of God.

*Reason the Only Oracle of Man*

Chapter I, Section II (p. 30)

Scholar's Facsimiles and Reprints. New York, New York, USA. 1940

**Aristotle** 384 BC–322 BC

Greek philosopher

... God and nature create nothing that has not its use.

In *Great Books of the Western World* (Volume 8)

*On the Heavens*

Book I, Chapter 4 (p. 362)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Asimov, Isaac** 1920–92

American author and biochemist

If we assume the existence of an omniscient and omnipotent being, one that knows and can do absolutely everything, then to my own very limited self, it would seem that existence for it would be unbearable. Nothing to wonder about? Nothing to ponder over? Nothing to discover? Eternity in such a heaven would surely be indistinguishable from hell.

"X" Stands for Unknown

Introduction (p. 11)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Bentley, Richard** 1662–1742

English clergyman

The Atoms or Particles, which now constitute Heaven and Earth, being once separate and diffused in the Mundane Space, like the supposed Chaos, could never without a God by their Mechanical affections have convened into the present Frame of Things or any other like it.

*A Confutation of Atheism from The Origin and Frame of the World* Part II

A Sermon Preached at St Martin's in the Fields

November the 7th, 1692 (p. 7)

**Blackie, John Stuart** 1809–95

Scottish scholar

God hath made three beautiful things,  
Birds, and women, and flowers;  
And he on earth who happy would be  
Must look with love on all the three;  
But chiefly, in bright summer hours,  
He is wise who loves the flowers,  
And roams the fields with me.

*Musa Burschicosa: A Book of Songs for Students and University Men*

The Botanist's Song, First stanza

Edmonston and Douglas. Edinburgh, Scotland. 1869

**Bohm, David** 1917–92

American physicist

I would put it another way: people had insight in the past about a form of intelligence that had organized the universe and they personalized it and called it "God."

Quoted by Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 21)

Routledge & Kegan Paul. London, England. 1986

**Bonnor, William Bowen** 1920–

English physicist

It seems to me highly improper to introduce God to solve our scientific problems.

In Charles-Albert Reichen

*A History of Astronomy* (p. 100)

Hawthorn Books. New York, New York, USA. 1963

**Born, Max** 1882–1970

German-born English physicist

If God has made the world a perfect mechanism, He has at least conceded so much to our imperfect intellects that in order to predict little parts of it, we need not solve innumerable differential equations, but can use dice with fair success.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part I, Chapter 4 (p. 73)

Simon & Schuster. New York, New York, USA. 1982

**Brecht, Bertolt** 1898–1956

German writer

BELLARMIN: Wouldn't you also think it possible that the Creator had a better idea of what he was making than those he has created?

Translated by John Willett

*Life of Galileo*

Scene 7 (p. 19)

Arcade Publishing. New York, New York, USA. 1994

**Buber, Martin** 1878–1965

Austrian-Jewish philosopher

Nature is full of God's utterance, if one but hears it...

*At the Turning: Three Addresses on Judaism*

Third Address, Chapter IV (p. 57)

Farrar, Straus &amp; Young. New York, New York, USA. 1952

**Butler, Joseph** 1692–1752

English bishop and exponent of natural theology

...the Author of Nature appears deliberate throughout His operations, accomplishing His natural ends by slow successive steps. And there is a plan of things beforehand laid out, which, from the nature of it, requires various systems of means, as well as length of time, in order to the carrying on its several parts into execution.

*The Analogy of Religion, Natural and Revealed, to the Constitution and Course of Nature*

Chapter II, Section 1 (p. 148)

Samuel G. Goodrich. Hartford, Connecticut, USA. 1819

**Card, Orson Scott** 1951–

Science fiction author

All the universe is just a dream in God's mind, and as long as he's asleep, he believes in it, and things stay real.

*Seventh Son*

Chapter 10 (p. 126)

Tom Doherty Associates, Inc. New York, New York, USA. 1987

**Carlyle, Thomas** 1795–1881

English historian and essayist

...Nature, which is the Time-vesture of God, and reveals Him to the wise, hides Him from the foolish.

*Sartor Resartus*

Book III, Chapter VIII (p. 240)

Ginn &amp; Company. Boston, Massachusetts, USA. 1897

[Nature] is a Volume written in celestial hieroglyphs, in a true Sacred-writing; of which even Prophets are happy that they can read here a line and there a line.

*Sartor Resartus*

Book III, Chapter VIII (p. 234)

Ginn &amp; Company. Boston, Massachusetts, USA. 1897

**Carver, George Washington** 1864–1943

American agricultural chemist

God is going to reveal to us things He never revealed before if we put our hands in His. No books ever go into my laboratory. The thing I am to do and the way of doing it are revealed to me. I never have to grope for methods. The method is revealed to me the moment I am inspired to create something new. Without God to draw aside the curtain I would be helpless.

In Ethel Edwards

*Carver of Tuskegee* (pp. 141–142)

Cincinnati, Ohio: Ethel Edwards &amp; James T. Hardwick, a limited edition work compiled in part from over 300 personal letters written by Dr. Carver to James T. Hardwick. 1971

**Compton, Karl Taylor** 1887–1954

American educator and physicist

As the complexity of the structure of matter became revealed through research, its basic simplicity, unity, and dependability became equally evident. So we now see ourselves in a world governed by natural laws instead of by capricious deities and devils. This does not necessarily mean that God has been ruled out of the picture, but it does mean that the architect and engineer of the universe is a far different type of being from the gods assumed by the ancients, and that man lives and dies in a world of logical system and orderly performance.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 3)

Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

**Cowper, William** 1731–1800

English poet

Nature is a name for an effect,  
Whose cause is God.

*The Poetical Works of William Cowper*

The Task, the Winter Walk at Noon

John W. Lovell Company. New York, New York, USA. n.d.

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

If God is a synonym for the deepest principles of physics, what word is left for a hypothetical being who answers prayers, intervenes to save cancer patients or helps evolution over difficult jumps, forgives sins or dies for them?

Snake Oil and Holy Water

*Forbes ASAP*, October 4, 1999**Dick, Thomas** 1600–80

Scottish theologian and philosopher

Here imagination must drop its wing, since it can penetrate no further into the dominions of Him who sits on the Throne of Immensity. Overwhelmed with a view of the magnificence of the Universe, and the perfections of its Almighty Author, we can only fall prostrate in deep humility and exclaim, "Great and marvelous are Thy works, Lord God Almighty."

In Hector Macpherson  
*A Century's Progress in Astronomy*  
 Chapter XIII (p. 288)  
 William Blackwood & Sons, Edinburgh, Scotland. 1909

**Dirac, Paul Adrian Maurice** 1902–84  
 English theoretical physicist

It seems to me one of the fundamental features of nature that fundamental physical laws ...described in terms of mathematical theory of great beauty and power need quite a high standard of mathematics for one to understand .... You may wonder: Why is nature constructed on these lines? One can only answer that our present knowledge seems to show that nature is so constructed.... We simply have to accept it. One could perhaps describe the situation by saying that God is a mathematician of very high order and He used a very advanced mathematics in constructing the Universe...

The Evolution of the Physicist's Picture of Nature  
*Scientific American*, Volume 208, Number 5, May 1963 (p. 53)

**Dyson, Freeman J.** 1923–  
 American physicist and educator

Humanity looks to me like a magnificent beginning but not the last word. Small children often have a better grasp of these questions than grown-ups. It happened to me that I adopted a stepdaughter. I moved into her family when she was five years old. Before that, she had been living alone with her mother. Soon after I moved in, she saw me for the first time naked. "Did God really make you like that?" she asked with some astonishment. "Couldn't he have made you better?" That is a question that every scientific humanist should be confronted with, at least once in a lifetime. The only honest answer is, of course, yes.

*Infinite in All Directions*  
 Part One, Chapter One (p. 9)  
 HarperCollins Publishers, New York, New York, USA. 1988

**Einstein, Albert** 1879–1955  
 German-born physicist

To be sure, the doctrine of a personal God interfering with natural events could never be refuted, in the real sense, by science, for this doctrine can always take refuge in those domains in which scientific knowledge has not yet been able to set foot. But I am persuaded that such behavior on the part of the representatives of religion would not only be unworthy but also fatal. For a doctrine which is able to maintain itself not in clear light but only in the dark, will of necessity lose its effect on mankind, with incalculable harm to human progress. In their struggle for the ethical good, teachers of religion must have the stature to give up the doctrine of a personal God, that is, give up that source of fear and hope which in the past placed such vast power in the hands of priests. In their labors they will have to avail themselves of those forces which are

capable of cultivating the Good, the True, and the Beautiful in humanity itself. This is, to be sure, a more difficult but an incomparably more worthy task.

*Science, Philosophy, and Religion*  
 A 1934 Symposium, published by the Conference on Science, Philosophy and Religion in Their Relation to the Democratic Way of Life, Inc.  
 New York, New York. 1941

What I'm really interested in is whether God could have made the world in a different way; that is, whether the necessity of logical simplicity leaves any freedom at all.

In A.P. French  
*Einstein: A Centenary Volume*  
 Chapter 4 (p. 128)  
 Harvard University Press, Cambridge, Massachusetts, USA. 1979

I cannot imagine a God who rewards and punishes the objects of his creation, whose purposes are modeled after our own — a God, in short, who is but a reflection of human frailty. Neither can I believe that the individual survives the death of his body, although feeble souls harbor such thoughts through fear or ridiculous egotisms.

*New York Times*, Obituary, 19 April 1955

**Erath, Vinzenz** 1906–76  
 German storyteller

God is a child; and when he began to play, he cultivated mathematics. It is the most godly of man's games.

In Stanley Gudder  
*A Mathematical Journey* (p. 269)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Erdős, Paul** 1913–96  
 Hungarian mathematician

God created two acts of folly. First, He created the Universe in a Big Bang. Second, He was negligent enough to leave behind evidence for this act, in the form of the microwave radiation.

In John D. Barrow and Frank J. Tipler  
*The Anthropic Cosmological Principle*  
 Chapter 6.7 (p. 401)  
 Clarendon Press, Oxford, England. 1986

**Fernel, Jean** 1497–1558  
 French physician

Nature embracing all things and entering into each, governs the courses and the revolutions of the sun and the moon, and of the other stars, and the succession of times, the change of the season, and the ocean's ebb and flow. Nature rules this immensity of things with an order assured and unvarying. How were it possible for Nature so to conduct and direct all this thus well but for the interposition of a divine Intelligence, which, having produced the world, preserves it?

In Sir Charles Sherrington  
*Man on His Nature*  
 Chapter I (p. 21)  
 Doubleday Anchor Books, Garden City, New York, USA. 1955

**Feynman, Richard P.** 1918–88

American theoretical physicist

God was always invented to explain mystery. God is always invented to explain those things that you do not understand. Now when you finally discover how something works, you get some laws which you're taking away from God; you don't need him anymore. But you need him for the other mysteries. So therefore you leave him to create the universe because we haven't figured that out yet; you need him for understanding those things which you don't believe the laws will explain, such as consciousness, or why you only live to a certain length of time — life and death — stuff like that. God is always associated with those things that you do not understand. Therefore I don't think that the laws can be considered to be like God, because they have been figured out.

In P.C.W. Davies and J. Brown (eds.)

*Superstrings: A Theory of Everything*

Chapter 9 (pp. 208–209)

Cambridge University Press. Cambridge, England. 1988

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew**

American physicist

The next great awakening of human intellect may well produce a method of understanding the qualitative content of equations. Today we cannot. Today we cannot see that the water flow equations contain such things as the barber pole structure of turbulence that one sees between rotating cylinders. Today we cannot see whether Schrödinger's equation contains frogs, musical composers, or morality — or whether it does not. We cannot say whether something beyond it like God is needed, or not. And so we can all hold strong opinions either way.

*The Feynman Lectures on Physics* (Volume 2)

Chapter 41–6 (p. 41–12)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

But I do not feel obliged to believe that the same God who has endowed us with senses, reason, and intellect has intended to forgo their use and by some other means to give us knowledge which we can attain by them.

Translated by Stillman Drake

*Discoveries and Opinions of Galileo*

Letter to Madame Christina of Lorraine (p. 183)

Doubleday. New York, New York, USA. 1957

**Goodspeed, Edgar J.** 1871–1962

American scholar

...science is seen to be just one more of those great flights of altar stairs that lead through darkness up to God.

*The Four Pillars of Democracy*

Chapter II (p. 55)

Harper &amp; Brothers. New York, New York, US. 1940

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Since creationist-bashing is a noble and necessary pursuit these days, readers may wonder why I am praising such an invocation of God's power to create immutable entities all at once — especially since Linnaeus substituted this idea for earlier notions of looser definition and mutability. But, as I [have] argued..., the history of science progresses in such a manner — from theory to theory along a complex surface with a slant toward greater empirical adequacy, not along a straight and narrow path pushed by a gathering snowball of factual accumulation. The conceptual change was surely enormous, but Darwin's invocation of natural selection in steps as a replacement for God all at once did not require any major overhaul in practice. Species are real whether created by God or constructed by natural selection — and Darwin's conceptual shift, the second unmasking, required little revision in Linnaean methods.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Eight, Chapter 32 (p. 423)

Random House, Inc. New York, New York, USA. 1995

**Graham, Aelred**

Benedictine monk

Broadly speaking, all nature, since it has no claim to existence, manifests the grace of God.

*Christian Thought in Action*

Chapter Eight (p. 139)

Collins. London, England. 1958

**Greenstein, George** 1940–

American astronomer

As we survey all the evidence, the thought insistently arises that some supernatural agency — or, rather, Agency — must be involved. Is it possible that suddenly, without intending to, we have stumbled upon scientific proof of the existence of a Supreme Being? Was it God who stepped in and so providentially crafted the cosmos for our benefit?

*The Symbiotic Universe*

Prologue (p. 27)

William Morrow &amp; Company, Inc. New York, New York, USA. 1988

**Haldane, John Scott** 1860–1936

Scottish physiologist

The existence of God must be the central feature in future developments of philosophy.

*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*

Lecture III, *The Deeper Meaning of Berkeley's Reasoning* (p. 120)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Hardin, Garrett** 1915–2003  
American ecologist and microbiologist

The god who is reputed to have created fleas to keep dogs from moping over their situation must have also created fundamentalists to keep rationalists from getting flabby. Let us be duly thankful for our blessings.

In Ashley Montagu

*Science and Creationism*

Introduction (p. 3)

Oxford University Press, Inc. New York, New York, USA. 1984

**Hawking, Stephen William** 1942–  
English theoretical physicist

Up to now, most scientists have been too occupied with the development of new theories that describe what the universe is to ask the question why.... If we find the answer to that, it would be the ultimate triumph of human reason — for then we would know the mind of God.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 11 (p. 174–175)

Bantam Books. Toronto, Ontario, Canada. 1988

We still believe that the universe should be logical and beautiful; we just dropped the word “God.”

Quoted by Renée Weber

*Dialogues with Scientists and Sages: The Search For Unity* (p. 21)

Routledge & Kegan Paul. London, England. 1986

The idea that space and time may form a closed surface without boundary also has profound implications for the role of God in the affairs of the universe. With the success of scientific theories in describing events, most people have come to believe that God allows the universe to evolve according to a set of laws and does not intervene in the universe to break these laws. However, the laws do not tell us what the universe should have looked like when it started — it would still be up to God to wind up the clockwork and choose how to start it off. So long as the universe had a beginning, we could suppose it had a creator. But if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end: it would simply be. What place, then, for a creator?

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 8 (pp. 140–141)

Bantam Books. Toronto, Ontario, Canada. 1988

Science seems to have uncovered a set of laws that, within the limits set by the uncertainty principle, tell us how the universe will develop with time, if we know its state at any one time. These laws may have originally been decreed by God, but it appears that he has since left the universe to evolve according to them and does not now intervene in it.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 8 (p. 122)

Bantam Books. Toronto, Ontario, Canada. 1988

...but if he [God] had started it [the universe] off in such an incomprehensible way, why did he choose to let it evolve according to laws that we could understand?

*A Brief History of Time: The Updated Expanded Tenth Anniversary Edition*

Chapter 8 (p. 127)

Bantam Books. Toronto, Ontario, Canada. 1998

...you don't have to say that the way the universe began was the personal whim of God. But you still have the question: Why does the universe bother to exist? If you like, you can define God to be the answer to that question.

*Black Holes and Baby Universes and Other Essays*

Desert Island Discs (p. 173)

Bantam Books. New York, New York, USA. 1993

**Herrick, Robert** 1591–1674  
English poet

Science in God, is known to be  
A Substance, not a Qualitie.

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

Science in God

W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Hill, Thomas**

No biographical data available

The genuine spirit of Mathesis is devout. No intellectual pursuit more truly leads to profound impressions of the existence and attributes of a Creator, and to a deep sense of our filial relations to him, than the study of these abstract sciences. Who can understand so well how feeble are our conceptions of Almighty Power, as he who has calculated the attraction of the sun and the planets, and weighed in his balance the irresistible force of the lightning? Who can so well understand how confused is our estimate of the Eternal Wisdom, as he who has traced out the secret laws which guide the hosts of heaven, and combine the atoms on earth? Who can so well understand that man is made in the image of his Creator, as he who has sought to frame new laws and conditions to govern imaginary worlds, and found his own thoughts similar to those on which his Creator has acted?

*The Imagination in Mathematics*

*North American Review*, Volume 85, Number 176, July 1857 (pp. 226–227)

**Hobbes, Thomas** 1588–1679  
English philosopher and political theorist

...it is impossible to make any profound inquiry into natural causes without being inclined thereby to believe there is one God eternal...

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 11 (p. 78)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huxley, Aldous** 1894–1963  
English writer and critic

About God. You know the formula:  $m$  over  $n$ ought equals infinity,  $m$  being any positive number? Well, why not reduce the equation to a simpler form by multiplying both sides by  $n$ ought? In which case, you have  $m$  equals infinity times  $n$ ought. That is to say that a positive number is the product of zero and infinity. Doesn't that demonstrate the creation of the universe by an infinite power out of nothing? Doesn't it...

*Point Counter Point*  
Chapter XI (p. 135)  
Roberts Brothers. Boston, Massachusetts, USA. 1866

**Infeld, Leopold** 1898–1968  
Polish physicist

Einstein uses his concept of God more often than a Catholic priest.

*Quest — An Autobiography*  
Book Three, Part IV (p. 268)  
Chelsea Publishing Company. New York, New York, USA. 1980

**Jacobi, Karl Gustav Jacob** 1804–51  
German mathematician

God ever arithmetizes.

In E. T. Bell  
*Men of Mathematics* (p. xxi)  
Simon & Schuster. New York, New York, USA. 1937

**James, William** 1842–1910  
American philosopher and psychologist

The God whom science recognizes must be a God of universal laws exclusively, a God who does a wholesale, not a retail business. He cannot accommodate his processes to the convenience of individuals.

*The Varieties of Religious Experience*  
Lecture XX (pp. 483–485)  
The Modern Library. New York, New York, USA. 1967

**Jastrow, Robert** 1925–  
American space scientist

When an astronomer writes about God, his colleagues assume he is either over the hill or going bonkers.

*God and the Astronomers*  
Chapter 1 (p. 11)  
W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Keill, John** 1671–1721  
Scottish mathematician and natural philosopher

Among all the Gifts and Benefits the most bountiful God has most plentifully bestowed on Mankind, those are in the first place Valuable which consist in the Improvements of the Mind by Arts and Sciences.

*An Introduction to the True Astronomy*  
The Preface (p. 1)  
Printed for Bernard Lintot. London, England. 1721

**Keillor, Garrison** 1942–  
American humorist and radio broadcaster

We wondered if there is a God or is the universe only one seed in one apple on a tree in another world where a million years of ours is only one of their moments and what we imagine as our civilization is only a tiny charge of static electricity and the great truth that our science is slowly grasping is the fact the apple in which we are part of one seed is falling, has been falling for a million years and in one one-millionth of a second it will hit hard-frozen ground in that other world and split open and lie on the ground and a bear will come along and gobble it up, everything, the Judeo-Christian heritage, science, democracy, the Renaissance, art, music, sex, sweet corn — all disappear into that black hole of a bear.

Leaving Home  
*The Atlantic Monthly*, Volume 260, Number 3 September 1987 (p. 48)

**Kepler, Johannes** 1571–1630  
German astronomer

The chief aim of all investigations of the external world should be to discover the rational order and harmony which has been imposed on it by God and which He revealed to us in the language of mathematics.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 231)  
Oxford University Press, Inc. New York, New York, USA. 1972

...if there are globes in the heaven similar to our Earth, do we vie with them over who occupies the better portion of the universe? For if their globes are nobler, we are not the noblest of rational creatures. Then how can all things be for man's sake? How can we be the master of God's handiwork?

*Conversations with Galileo's Sidereal Messenger*  
Translated by Edward Rosen  
Section VIII (p. 43)  
Johnson Reprint Corp. New York, New York, USA. 1965

**Lalande, Jérôme** 1732–1807  
French astronomer

I have searched through the heavens, and nowhere have I found a trace of God.

In Ludwig Buchner  
*Force and Matter* (p. 105)  
Truth Seeker. New York, New York, USA. 1950

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

...if I find that nature herself works all the wonders... that she has created organisation, life and even feeling,

that she has multiplied and diversified within unknown limits the organs and faculties of the organized bodies whose existence she subserves or propagates...should I not recognise in this power of nature, that is to say in the order of existing things, the execution of the will of her Sublime Author, who was able to will that she should have this power.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter III (p. 41)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Lambert, Johann Heinrich** 1728–77

Swiss German mathematician and astronomer

If we admit the existence of a Supreme Disposer, who brought order out of Chaos, and gave form to the universe, it will follow that the universe is a perfect work, the impression, the character, the reflected image of the perfections of its author.

Translated by James Jacque

*The System of the World*

Part I, Chapter II (p. 9)

Printed for Vernor and Hood. London, England. 1800

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

The history of the cosmos  
is the history of the struggle of becoming.  
When the dim flux of unformed life  
struggled, convulsed back and forth upon itself,  
and broke at last into light and dark  
and came into existence as light,  
came into existence as cold shadow  
then every atom of the cosmos trembled with delight.  
Behold, God is born!  
He is bright light!

He is pitch dark and cold.

*The Complete Poems of D.H. Lawrence*

God Is Born

Viking Press. New York, New York, USA. 1973

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

As God calculates, so the world is made.

In Morris Kline

*Mathematics and the Physical World*

Chapter 23 (p. 385)

Dover Publications, Inc. New York, New York, USA. 1981

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

Little wonder that God can make souls when his clay is  
star-clusters!

*Science, Matter and Immortality*

Chapter XVI (p. 197)

William & Norgate. London, England. 1909

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

It is impossible to imagine the universe run by a wise, just and omnipotent God, but it is quite easy to imagine it run by a board of gods. If such a board actually exists it operates precisely like the board of a corporation that is losing money.

*Minority Report: H.L. Mencken's Notebooks*

No. 79 (p. 63)

Alfred A. Knopf. New York, New York, USA. 1956

**Michalson, Carl** 1915–65

No biographical data available

One may point to nature and say, "There is a God," but one cannot point to nature and say, "There God is."

In P. Ramsey (ed.)

*Faith and Ethics: The Theology of H. Richard Niebuhr*

Chapter IX (p. 257)

Harper & Brothers. New York, New York, USA. 1957

**Millikan, Robert Andrews** 1868–1953

American physicist

A fire mist and a planet,

A crystal and a cell,

A jelly fish and a saurian

And caves where cavemen dwell.

Then a sense of law and beauty,

And a face turned from the clod.

Some call it evolution

And others call it God.

*Science and the New Civilization*

Chapter I (p. 15)

Charles Scribner's Sons. New York, New York, USA. 1930

**Moynihan, Sir Berkeley** 1865–1936

English surgeon

...the God of Science is a greater and more glorious  
Being than the God of the Theologians.

In Edward H. Cotton

*Has Science Discovered God?*

The Scientific Argument for Personal Survival (p. 260)

Thomas Y. Crowell Company, Publishers. New York, New York, USA.

1931

**Nicholson, Jack** 1937–

American film actor

When God makes a mistake, they call it nature.

*The Witches of Eastwood*

Film (1987)

**Orgel, Irene** 1922–

English poet

"But before Man?" asked Jonah, shocked out of his wits.

"Do you mean you understood nothing at all? Didn't you exist?"

“Certainly,” said God patiently. “I have told you how I exploded in the stars. Then I drifted for aeons in clouds of inchoate gas. As matter stabilized, I acquired the knowledge of valency. When matter cooled, I lay sleeping in the insentient rocks. After that I floated fecund in the unconscious seaweed upon the faces of the deep. Later I existed in the stretching paw of the tiger and the blinking eye of the owl. Each form of knowledge led to the more developed next. Organic matter led to sentience which led to consciousness which led inevitably to my divinity.”

*The Odd Tales of Irene Orgel*

Jonah (pp. 17–18)

Eakins Press. New York, New York, USA. 1967

**Paley, William** 1743–1805

English theologian

In crossing a heath, suppose I pitched my foot against a stone, and were asked how the stone came to be there; I might possibly answer, that, for anything I knew to the contrary, it had lain there forever: nor would it perhaps be very easy to show the absurdity of this answer. But suppose I had found a watch upon the ground, and it should be inquired how the watch happened to be in that place; I should hardly think of the answer which I had before given, that, for anything I knew, the watch might have always been there. Yet why should not this answer serve for the watch as well as the stone?

*The Works of William Paley, D.D.*

Natural Theology

Chapter I (p. 17)

Ward, Lock and Co. London, England. n.d.

**Paré, Ambroise** 1510–90

French surgeon

*Je le pensay, et Dieu le guarit.*

I dressed his wound, and God healed it.

In Oliver Wendell Holmes

*Medical Essays*

The Medical Profession in Massachusetts (p. 365)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Pascal, Blaise** 1623–62

French mathematician and physicist

Nature has some perfections to show that she is the image of God, and some defects, to show that she is only His image.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section VIII, 580

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...I have a hundred times wished that if a God maintains Nature, she should testify to Him unequivocally, and that, if the signs she gives are deceptive, she should suppress them altogether.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section III, 229

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pascual, Jordan** 1902–80

German physicist

And certainly this picture of the universe as exploding fireworks which went off ten billion years ago invites us to consider the remarkable question of Miguel de Unamuno, whether the whole world — and we with it — be not possibly only a dream of God; whether the prayer and ritual perhaps be nothing but attempts to make HIM more drowsy, so that HE does not awaken and stop our dreaming.

*Physics of the 20th Century*

Appendix I (p. 185)

Philosophical Library. New York, New York, USA. 1944

**Pauli, Wolfgang** 1900–58

Austrian-born physicist

I cannot believe God is a weak left-hander.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Interlude C (p. 256)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Peacocke, Arthur** 1924–2006

English biochemist-turned-theologian

...the processes revealed by the sciences are in themselves God acting as Creator and God is not to be found as some kind of additional factor added on to the processes of the world. God, to use the language usually applied to sacramental theology, is “in, with and under” all that-is and all-that-goes-on.

In Mark William Worthing

*God, Creation, and Contemporary Physics*

Chapter Four (p. 157)

Fortress Press. Minneapolis, Minnesota, USA. 1996

**Plato** 428 BCE–347 BCE

Greek philosopher

God ever geometrizes.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

**Polyakov, Alexander**

Russian physicist

We know that nature is described by the best of all possible mathematics because God created it.

In S. Gannes

Alexander Polyakov; 40: Probing the Forces of the Universe

*Fortune*, Volume 114, Number 8, October 13, 1986 (p. 57)

**Popper, Karl R.** 1902–94

Austro-Hungarian-born philosopher of science



The earlier, naturalistic, revolution against God replaced the name “God” by the name “Nature.” Almost everything else was left unchanged. Theology, the Science of God, was replaced by the Science of Nature; God’s laws by the laws of Nature; God’s will and power by the will and power of Nature (the natural forces); and later God’s design and God’s judgment by Natural Selection. Theological determinism was replaced by naturalistic determinism; that is, God’s omnipotence and omniscience were replaced by the omnipotence of Nature and the omniscience of Science.

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 16, Section XII (p. 346)  
Harper & Row, Publishers. New York, New York, USA. 1963

**Pratchett, Terry** 1948–

English author

**Gaiman, Neil**

No biographical data available

God does not play dice with the universe; He plays an ineffable game of His own devising, which might be compared, from the perspective of any of the other players (i.e., everybody), to being involved in an obscure and complex version of poker in a pitch-dark room, with blank cards, for infinite stakes, with a Dealer who won’t tell you the rules, and who smiles all the time.

*Good Omens: The Nice and Accurate Prophecies of Agnes Nutter, Witch*  
(p. 1)

Victor Gollancz Ltd. London, England. 1990

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

God is reduced to a mere archivist turning the pages of a cosmic history book already written.

In Sara Nash (ed.)

*Science and Complexity*

The Rediscovery of Time (p. 23)

Science Reviews Ltd. London, England. 1985

**Proctor, Richard A.** 1837–88

English astronomer

...so far as Science is concerned, the idea of a personal God is inconceivable...

*Our Place Among the Infinities*

The Past and Future of Our Earth (pp. 2–3)

Chatto & Windus. London, England. 1879

**Reade, Winwood** 1838–75

Philosopher and historian

When we have ascertained, by means of Science, the methods of nature’s operations, we shall be able to take her place to perform them for ourselves...men will master the forces of nature; they will become themselves architects of systems, manufacturers of worlds.

Man will then be perfect; he will be a creator; he will therefore be what the vulgar worship as God.

*The Martyrdom of Man*

Chapter IV (pp. 458, 460)

E.F. Dutton & Company. New York, New York, 1926

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

God and immortality, the central dogmas of the Christian religion, find no support in science.

*What I Believe*

Chapter I (p. 5)

E.P. Dutton & Company. New York, New York, USA. 1925

And God smiled; and when he saw that Man had become perfect in renunciation and worship, he sent another sun thru the sky, which crashed into Man’s sun; and all returned again to nebula....

“Yes,” he murmured, “it was a good play; I will have it performed again.”

*Philosophical Essays*

The Free Man’s Worship (p. 60)

Longmans, Green & Company. New York, New York, USA. 1910

**Sagan, Carl** 1934–96

American astronomer and science writer

God may be thought of as the cosmic watchmaker, the engineer who constructed the initial state and lit the fuse.

In Stephen W. Hawking

*A Brief History of Time: From The Big Bang to Black Holes*

Introduction (p. x)

Bantam Books. Toronto, Ontario, Canada. 1988

**Santayana, George (Jorge Augustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

God then becomes a poetic symbol for the material tenderness and the paternal strictness of this wonderful world; the ways of God become the subject-matter of physics.

*The Realm of Matter*

Chapter X (p. 205)

Charles Scribner’s Sons. New York, New York, USA. 1930

**Scripps, Edwin W.**

American newspaper magnate

[Scientists are] so blamed wise and so packed full of knowledge...that they cannot comprehend why God has made nearly all the rest of mankind so infernally stupid.

In Dorothy Nelkin

*Selling Science*

Chapter 6 (p. 81)

W.H. Freeman and Company. New York, New York, USA. 1995

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Science could stand a cruel and unjust god; for nature was full of suffering and injustice. But a disorderly [god] was impossible.

*Back to Methuselah*

Preface (p. xxxviii)

Constable & Company Ltd. London, England. 1921

KNELLER: To you the universe is nothing but a clock that an almighty clockmaker has wound up and set going for all eternity.

NEWTON: Shall I tell you a secret, Mr. Beautymonger? The clock does not keep time. If it did there would be no further need for the Clockmaker... Can you, who know everything because you and God are both artists, tell me what is amiss with the perihelion of Mercury?

KNELLER: The what?

NEWTON: The perihelion of Mercury.

KNELLER: I do not know what it is.

NEWTON: I do. But I do not know what is amiss with it. Not until the world finds this out can it do without the Clockmaker in the heavens.

*In Good King Charles's Golden Days*

Act I

Constable and Company Ltd. London, England. 1946

### **Smullyan, Raymond** 1919–

American mathematician and logician

It has always puzzled me that so many religious people have taken it for granted that God favors those who believe in him. Isn't it possible that the actual God is a scientific God who has little patience with beliefs founded on faith rather than evidence?

*5000 B.C. and Other Philosophical Fantasies*

Chapter 3 (p. 25)

St. Martin's Press. New York, New York, USA. 1983

### **Stanhope, Charles** 1753–1818

British statesman and scientist

To suppose that the Omnipotent God made a world, found it a failure, and broke it up, and then made it again, and again broke it up, as the Geologists say, is all fiddle faddle. Describing Species of birds and shells, & c., is all fiddle faddle...

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to C. Lyell, September 14, 1849 (p. 345)

D. Appleton & Company. New York, New York, USA. 1896

### **Somerville, Mary** 1780–1872

American author and humorist

Nothing has afforded me so convincing a proof of the unity of the Deity as these purely mental conceptions of numerical and mathematical science which have been by slow degrees vouchsafed to man, and are still granted in these latter times by the Differential Calculus, now superseded by the Higher Algebra, all of which must have

existed in that sublimely omniscient Mind from eternity.

In Martha Somerville (ed.)

*Personal Recollections, from Early Life to Old Age, of Mary Somerville*

Chapter IX (pp. 140–141)

Robert Brothers. Boston, Massachusetts, USA. 1874

The traces of extreme antiquity perpetually occurring to the geologist give that information of the origin of things which we in vain look for in the other parts of the universe. They date the beginning of time [and] show that creation is the work of Him with whom "a thousand years are as one day, and one day as a thousand years."

*Mechanism of the Heavens*

Preliminary Dissertation (p. 36)

John Murray. London, England. 1831

### **Steele, Joel Dorman** 1836–86

American educator and textbook writer

God has no idlers in his world. Each atom has its use. There is not an extra particle in the entire universe.

*A Fourteen Weeks Course in Chemistry*

Inorganic Chemistry, Oxygen (p. 27)

A.S. Barnes & Company. New York, New York, USA. 1870

### **Stewart, Ian** 1945–

English mathematician and science writer

Perhaps God can play dice, and create a universe of complete law and order, in the same breath.

*Does God Play Dice: The New Mathematics of Chaos*

Prologue (p. xii)

Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

### **Stoppard, Tom** 1937–

Czech-born English playwright

Mountains are not pyramids and trees are not cones. God must love gunnery and architecture if Euclid is his only Geometry.

*Arcadia*

Act II, Scene Seven (p. 84)

Faber & Faber Ltd. London, England. 1993

### **Teller, Woolsey** 1890–1954

Essayist

And what must we think of this alleged intelligence in the skies, which after toiling for billions of years, produces nothing more imposing than the equivalent of six specks of dust in a great railroad terminal?

*The Atheism of Astronomy*

Chapter VI (p. 120)

Arno Press & The New York Times. New York, New York, USA. 1972

### **Temple, Frederick** 1821–1902

Anglican prelate, archbishop of Canterbury

The fixed laws of science can supply natural religion with numberless illustrations of the wisdom, the beneficence, the order, the beauty that characterizes the workmanship of God; while they illustrate His infinity by the

marvelous complexity of natural combinations, by the variety and order of His creatures, by the exquisite finish alike bestowed on the very greatest and on the very least of His works, as if size were absolutely nothing in His sight.

*Present Relations of Science to Religion* (p. 13)  
J. H. and Jas. Parker. London, England. 1860

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

The heavens are telling the glory of God.

*Concerning Evolution*  
Chapter I, Section 6 (p. 12)  
Yale University Press. New Haven, Connecticut, USA. 1925

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

If Nature is our mother, then God is our father.

*The Writings of Henry David Thoreau* (Volume 1)  
A Week on the Concord and Merrimack Rivers  
Friday (p. 492)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

If I were going to construct a God I would furnish Him with some ways and qualities and characteristics which the Present (Bible) One lacks.... He would spend some of His eternities in trying to forgive Himself for making man unhappy when He could have made him happy with the same effort and He would spend the rest of them in studying astronomy.

In Albert Bigelow Paine (ed.)  
*Mark Twain's Notebook*  
Chapter XXVI (p. 301, 302)  
Harper & Brothers Publishers. New York, New York, USA. 1935

**Updike, John** 1932–  
American novelist, short story writer, and poet

The most miraculous thing is happening. The physicists are getting down to the nitty-gritty, they've really just about pared things down to the ultimate details, and the last thing they ever expected to happen is happening. God is showing through.

"Mr. Kohler, What kind of God is showing through, exactly?"

*Roger's Version*  
Chapter I (p. 10)  
Alfred A. Knopf. New York, New York, USA. 1986

And I'm not sure it isn't a bit heretical of you to toss the fact of God in with a lot of other facts. Even Aquinas, I think, didn't postulate a God Who could be hauled kicking and screaming out from some laboratory closet, over behind the blackboard.

*Roger's Version*  
Chapter I (p. 21)  
Alfred A. Knopf. New York, New York, USA. 1986

**von Braun, Wernher** 1912–77  
German-American rocket scientist

The more we learn about God's creation, the more I am impressed with the orderliness and unerring perfection of the natural laws that govern it.

In Erik Bergaust  
*Wernher von Braun*  
The Starry Sky Above Me (p. 113)  
National Space Institute. Washington, D.C. 1976

**Weil, Simone** 1909–43  
French philosopher and mystic  
A science which does not bring us nearer to God is worthless.  
*Gravity and Grace*  
Illusions (p. 50)  
Routledge & Kegan Paul. London, England. 1952

**Whitcomb, J.**  
No biographical data available

**Morris, H. M.**  
No biographical data available

The more we study the fascinating story of animal distribution around the earth, the more convinced we have become that this vast river of variegated life forms, moving ever outward from the Asiatic mainland, across the continents and seas, has not been a chance and haphazard phenomenon. Instead, we see the hand of God guiding and directing these creatures in ways that man, with all his ingenuity, has never been able to fathom, in order that the great commission to the postdiluvian animal kingdom might be carried out, and that they may breed abundantly in the earth, and be fruitful, and multiply upon the earth (Gen. 8:17).

*The Genesis Flood: The Biblical Record and Its Scientific Implications*  
Chapter III (p. 86)

Presbyterian and Reformed Pub. Co. Philadelphia, Pennsylvania, USA. 1961

**Wilson, Edward O.** 1929–  
American biologist and author

Today, thanks to the relentless advance of the science which Newton pioneered, God's immanence has been pushed to somewhere below the subatomic particles or beyond the farthest visible galaxy.

*On Human Nature*  
Chapter 8 (p. 171)  
Harvard University Press. Cambridge, Massachusetts, USA. 1978

**Zeldovich, Yakov Borisovich** 1914–87  
Russian physicist

...almighty God throwing dice for every single proton or antiproton would soon get tired with the astronomical

number of particles. He could not make the asymmetry large enough.

In Joseph Silk

*Cosmic Enigmas*

Cosmologists and Their Myths (p. 7)

AIP Press. Woodbury, New York, USA. 1994

**Ziman, John M.** 1925–2005

English physicist

As has been said of some experiments in high-energy physics: the process to be observed has never occurred before in the history of the Universe; God himself is waiting to see what will happen!

*Reliable Knowledge*

Chapter 3 (fn 11, p. 62)

Cambridge University Press. Cambridge, England. 1978

## GOUT

**Ray, John** 1627–1705

English naturalist

With respect to gout, the physician is a lout.

*A Complete Collection of English Proverbs* (p. 35)

Printed for G. Cowie. London, England. 1813

## GRAIN

**Heiles, Carl**

Astronomer

...needle-like grains tend to spin end-over-end, like a well-kicked American football.

In D.J. Hollenbach and H.A. Thronson (eds.)

*Interstellar Processes: Proceedings of the Symposium on Interstellar Processes*

Section III (p. 171)

Dordrecht. Boston, Massachusetts, USA. 1987

**Seab, C. G.**

No biographical data available

Once the newly formed grains are injected into the interstellar medium, they are subject to a variety of indignities...

In M.E. Bailey and D.A. Williams (eds.)

*Dust in the Universe: The Proceedings of a Conference at the Department of Astronomy, University of Manchester, 14–18 December 1987*

Chapter 32, Section 32.1 (p. 304)

Cambridge University Press. Cambridge, England. 1988

## GRAPH

### Advertisement

One picture is worth ten thousand words.

Royal Baking Powder

*Printers Ink*, Volume 138, 10 March 1927

Every picture tells a story.

*Doan's Backache Kidney Pills*

Slogan

**Crichton, Michael** 1942–

American novelist

You can draw a lot of curves through three graph points.

You can extrapolate it a lot of ways.

*The Terminal Man*

Chapter 5 (p. 155)

Alfred A. Knopf. New York, New York, USA. 1972

"I'll give you a graphic display," Gerhard said. He punched buttons, wiping the screen. After a moment, cross-hatching for a graph appeared and the points began to blink on...

*The Terminal Man*

Chapter 5 (p. 121)

Alfred A. Knopf. New York, New York, USA. 1972

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The preliminary examination of most data is facilitated by the use of diagrams. Diagrams prove nothing, but bring outstanding features readily to the eye; they are therefore no substitutes for such critical tests as may be applied to the data, but are valuable in suggesting such tests, and in explaining the conclusions founded upon them.

*Statistical Methods for Research Workers*

Chapter II (p. 26)

Oliver & Boyd. Edinburgh, Scotland. 1938

**Malcolm, Andrew H.**

No biographical data available

...no nation ranks higher in its collective passion for statistics. In Japan, statistics are the subject of holidays, local and national conventions, award ceremonies and nationwide statistical collection and graph-drawing contests.

Data-Loving Japanese Rejoice on Statistics Day

*New York Times*, October 26, 1977. A-1

**Moroney, M. J.**

No biographical data available

It pays to keep wide awake in studying any graph. The thing looks so simple, so frank, and so appealing that the careless are easily fooled.

*Facts from Figures*

The Magic Lantern Technique (p. 27)

Penguin Books Ltd. Harmondsworth, England. 1951

**Pearl, Judea**

Computer scientist and statistician

Despite the prevailing use of graphs as metaphors for communicating and reasoning about dependencies, the task of capturing informational dependencies by graphs is not at all trivial.

*Probabilistic Reasoning in Intelligent Systems: Network of Plausible Inference*  
Chapter 3 (p. 81)  
Morgan Kaufmann Publishers, Inc. San Mateo, California, USA. 1988

**Playfair, William** 1759–1823  
Inventor of statistical graphs

As to the propriety and justness of representing sums of money, and time, by parts of space, tho' very readily agreed to by most men, yet a few seem to apprehend there may possibly be some deception in it, of which they are not aware...

*The Commercial and Political Atlas*  
Printed for J. Debrett. London, England. 1786

**Rogers, Will** 1879–1935  
American actor and humorist

You must never tell a thing. You must illustrate it. We learn through the eye and not the noggin.

*The Will Rogers Book*  
June 25, 1933 (p. 121)  
The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1961

**Shakespeare, William** 1564–1616  
English poet, dramatist, and actor

Dost thou love pictures?  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The Taming of the Shrew  
Introduction, Scene ii, l. 51  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tufte, Edward R.** 1942–  
American artist and statistician

Of course statistical graphics, just like statistical calculations, are only as good as what goes into them. An ill-specified or preposterous model or a puny data set cannot be rescued by a graphic (or by calculation), no matter how clever or fancy. A silly theory means a silly graphic.

*The Visual Display of Quantitative Information*  
Part I, Chapter 1 (p. 15)  
Graphic Press. Cheshire, Connecticut, USA. 1983

Graphical integrity is more likely to result if these six principles are followed:

The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented.

Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.

Show data variations, not design variations.

In time-series displays of money, deflated and standardized units of monetary measurements are nearly always better than nominal units.

The number of information-carrying (variable) dimensions depicted should not exceed the number of dimensions in the data.

Graphics must not quote data out of context.  
*The Visual Display of Quantitative Information*  
Part I, Chapter 2 (p. 77)  
Graphic Press. Cheshire, Connecticut, USA. 1983

Excellence in statistical graphics consists of complex ideas communicated with clarity, precision, and efficiency. Graphical displays should show the data, induce the viewer to think about the substance rather than about the methodology, graphic design, the technology of graphic production, or something else, avoid distorting what the data have to say, present many numbers in a small space make large data sets coherent, encourage the eye to compare different pieces of data, reveal the data at several levels of detail, from a broad overview to the fine structure, serve a reasonable clear purpose: description, exploration, tabulation, or decoration [should] be closely integrated with the statistical and verbal descriptions of a data set.

*The Visual Display of Quantitative Information*  
Part I, Chapter 1 (p. 13)  
Graphic Press. Cheshire, Connecticut, USA. 1983

## GRAVITATIONAL LENS

**Drake, Frank**  
No biographical data available

**Sobel, Dava**  
No biographical data available

“I know perfectly well that at this moment the whole universe is listening to us,” Jean Giraudoux wrote in *The Madwoman of Chaillot*, “and that every word we say echoes to the remotest star.” That poetic paranoia is a perfect description of what the Sun, as a gravitational lens, could do for the Search for Extraterrestrial Intelligence.

*Is Anyone Out There?: The Scientific Search for Extraterrestrial Intelligence*  
Chapter 10 (p. 232)  
Delacorte press. New York, New York, USA. 1992

## GRAVITY

**Arnott, Neil** 1788–1874  
Scottish physician

Attraction, as gravitation, is the muscle and tendon of the universe, by which its mass is held together and its huge limbs are wielded. As cohesion and adhesion, it determines the multitude of physical features of its different parts. As chemical or interatomic action, it is the final source to which we trace all material changes.

In J. Dorman Steele  
*Popular Physics*  
 Chapter III (p. 41)  
 American Book Company. New York, New York, USA. 1896

**Blake, William** 1757–1827  
 English poet, painter, and engraver

God keep me...from supposing Up and Down to be the same thing as all experimentalists must suppose.

*The Complete Poetry and Prose of William Blake*  
 Letter to George Cumberland, 12 April 1827  
 University of California Press. Berkeley, California, USA. 1982

**Conduitt, John** 1688–1737  
 French philosopher

Whilst he [Newton] was musing in a garden it came into his thought that the power of gravity (which brought an apple from the tree to the ground) was not limited to a certain distance from the earth but that this power must extend much farther than was usually thought. Why not as high as the Moon said he to himself & if so that must influence her motion & perhaps retain her in her orbit, whereupon he fell a calculating.

*Never at Rest: A Biography of Isaac Newton*  
 Chapter 5 (p. 154)  
 Cambridge University Press. Cambridge, England. 1980

**Dürrenmatt, Friedrich** 1921–90  
 Swiss playwright and novelist

My mission is to devote myself to the problems of gravitation, not the physical requirements of a woman.

Translated by James Kirkup  
*The Physicists*  
 Act One (p. 19)  
 Grove Press, Inc. New York, New York, USA. 1964

**Einstein, Albert** 1879–1955  
 German-born physicist

Falling in love is not at all the most stupid thing that people do — but gravitation cannot be held responsible for it.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side: New Glimpses from His Archives* (p. 56)  
 Princeton University Press. Princeton, New Jersey, USA. 1979

I know that hardly any physicists believe that the gravitational forces can play any part in the constitution of matter. The physicists always argues that the forces are too small. This reminds me of a joke. An unmarried woman had a child and the family was greatly humiliated. So the midwife tried to console the mother by saying: “Don’t worry so much, it’s a very small child!”

In Leopold Infeld  
*Quest — An Autobiography*  
 Book Three, Part IV (p. 266)  
 Chelsea Publishing Company. New York, New York, USA. 1980

I shall conduct the reader over the road that I have myself traveled, rather a rough and winding road, because otherwise I cannot hope that he will take much interest in the result at the end of the journey. The conclusion I shall arrive at is that the field equations of gravitation which I have championed hitherto still need a slight modification.

*Cosmological Considerations on the General Theory of Relativity*  
*Proceedings of the Prussian Academy of Sciences*, Volume X, 1917 (p. 142)

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

The child amidst his baubles is learning the action of light, motion, gravity...

*Ralph Waldo Emerson: Essays and Lectures*  
 Nature: Addresses, and Lectures  
 The Divinity School Address (p. 76)  
 The Library of America. New York, New York, USA. 1983

Let us draw a lesson from nature, which always works by short ways. When the fruit is ripe, it falls. When the fruit is dispatched, the leaf falls. The circuit of the waters is mere falling. The walking of man and all animals is a falling forward. All our manual labor and works of strength, as prying, splitting, digging, rowing, and so forth, are done by dint of continual falling, and the globe, earth, moon, comet, sun, star, fall for ever and ever.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)  
 Essays: First Series  
 Spiritual Laws (p. 137)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Feynman, Richard P.** 1918–88  
 American theoretical physicist

But I would like not to underestimate the value of the world view which is the result of scientific effort. We have been led to imagine all sorts of things infinitely more marvelous than the imaginings of poets and dreamers of the past. It shows that the imagination of nature is far, far greater than the imagination of man. For instance, how much more remarkable it is for us all to be stuck — half of us upside down — by a mysterious attraction to a spinning ball that has been swinging in space for billions of years than to be carried on the back of an elephant supported on a tortoise swimming in a bottomless sea.

*What Do You Care What Other People Think?*  
 The Value of Science (p. 242)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Fuller, Thomas** 1608–61  
 English clergyman and author

Gravity is the ballast of the soul, which keeps the mind steady.

*The Holy and Profane State*  
 Book III, Chapter XXI (p. 199)  
 Printed for Thomas Tegg. London, England. 1841

**Glashow, Sheldon L.** 1932–  
American physicist

I have often said from the podium that although it is gravity that holds my feet to the ground, it is the electromagnetic force that stops me from falling through the ground. Electromagnetism binds the atoms together and puts a solid floor beneath my feet.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*  
Chapter 4 (p. 73)  
Warner Books. New York, New York, USA. 1988

**Heaviside, Oliver** 1850–1925  
English electrical engineer, mathematician, and physicist

...an old idea that the speed of gravitation must be an enormous multiple of the speed of light...is only moonshine.

*Electromagnetic Theory* (Volume 3)  
Chapter X (p. 144)  
“The Electrician” printing and publishing company. London, England.  
1894–1912

**Heyl, Paul R.**  
American scientist

Gravitation appears to be a function of nothing but the masses involved and their space coordinates. As to all other properties the evidence is negative, in most cases of a high degree of precision, reaching a few parts in a billion. The cause of gravitation is hidden in a protective armor on which there is not even a projection upon which to hang a hypothesis.

What is Gravitation?  
*Scientific Monthly*, Volume 47, August 1938 (p. 117)

**King, Alexander** 1900–65  
No biographical data available

Newton saw an apple fall and discovered the Laws of Gravity.

Eve made an apple fall and discovered the Gravity of Law.

*I Should Have Kissed Her More* (p. 51)  
Simon & Schuster. New York, New York, USA. 1961

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

...we must suppose that the gravitating fluid has a velocity which is at least a hundred millions of times greater than that of light...

*Celestial Mechanics*, Volume 4 (p. 645)  
Chelsea Publishing Company. New York, New York, USA. 1966

**Lehman, Robert C.**  
No biographical data available

Archimedes in his bathtub  
Thinking of the king’s new crown.

Was it gold or baser metal?  
On Archy’s brow there was a frown.

Gravitation pulled him downward  
As the tub began to fill.

Buoyant forces lifted upward  
Till the tub began to spill.

Eureka  
*The Physics Teacher*, Volume 21, Number 2, February 1983 (p. 87)

**Lockyer, Joseph Norman** 1836–1920  
English astronomer and physicist

The force of gravity on their surfaces must be very small. A man placed on one of them would spring with ease 60 feet high, and sustain no greater shock in his descent than he does on the Earth from leaping a yard. On such planets giants may exist; and those enormous animals which here require the buoyant power of water to counteract their weight, may there inhabit the land.

*Elements of Astronomy*  
Chapter IX (p. 153)  
D. Appleton and Company. New York, New York, USA. 1885

**Moore, Mary**  
No biographical data available

[A properly fitted corset] prevents gravity from pulling us to far forward or too far backward, which in so doing, makes us old before our time.

In Martin Gardner  
*Fads and Fallacies in the Name of Science*  
Chapter 8 (p. 96)  
Dover Publications, Inc., New York, New York, USA; 1957

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

To understand the motions of the planets under the influence of gravity without knowing the cause of gravity is as good a progress in philosophy as to understand the frame of a clock and the dependence of the wheels upon one another without knowing the cause of the gravity of the weight.

*Memoirs of Literature*  
Chapter XVIII  
Sold by R. Knaplock. London, England. 1722

You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know, and therefore would take more time to consider of it.

In Richard Bentley  
*The Works of Richard Bentley*  
Letters from Sir Isaac Newton, Letter I, Volume 3 (p. 210)

So far I have accounted for the phenomena presented to us by the heavens and the sea by means of the force of gravity, but I have as yet assigned no cause to this gravity.... I have not been able to deduce from phenomena the *raison d’être* of the properties of gravity and I have not set up hypotheses.

In J. Arthur Thomson  
*The System of Animate Nature* (Volume 1)  
 Lecture I (p. 9)  
 William & Norgate. London, England. 1920

Hitherto we have explained the phenomena of the heavens and of our sea by the power of gravity, but have not yet assigned the cause of this power. This is certain, that it must proceed from a cause that penetrates to the very centres of the sun and planets, without suffering the least diminution of its force; that operates not according to the quantity of the surfaces of the particles upon which it acts (as mechanical causes used to do), but according to the quantity of the solid matter which they contain, and propagates its virtue over all sides to immense distances, decreasing always as the inverse square of the distances.

In *Great Books of the Western World* (Volume 34)  
*Mathematical Principles of Natural Philosophy*  
 Book III  
 General Scholium (p. 371)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...what hinders the fixed stars from falling upon one another?

In *Great Books of the Western World* (Volume 34)  
*Optics*  
 Book III, Part I, Query 28 (p. 529)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Philip Morrison

No biographical data available

### Phylis Morrison

No biographical data available

Gravity is exigent; it reaches inside every candy box, no matter what the wrapping, to distinguish the full pound from the empty container.

*Powers of Ten*  
 Looking at the World: An Essay (p. 6)  
 Scientific American Library. New York, New York, USA. 1982

### Ridley, B. K.

No biographical data available

What a remarkable idea, that when you accelerate into a run, your muscles are fighting the influence of galaxies scarcely visible even with the most powerful telescopes!

*Time, Space and Things*  
 Chapter 8 (p. 148)  
 Cambridge University Press. Cambridge, England. 1984

### Thomson, James 1700–48

Scottish poet

...by the blended power  
 Of gravitation and projection, saw  
 The whole in silent harmony revolve...  
 And ruled unerring by that single power  
 Which draws the stone projected to the ground.

*The Complete Poetical Works of James Thomson*

To the Memory of Newton, l. 40–42, l. 75–76  
 H. Frowde. London, England. 1908

### von Braun, Wernher 1912–77

German-American rocket scientist

We can lick gravity, but sometimes the paperwork is overwhelming.

On Bureaucracy  
*Chicago Sun Times*, 10 July 1958

### Wheeler, John Archibald 1911–

American physicist and educator

...one feels that one has, at last in gravitational collapse, a phenomenon where general relativity dramatically comes into its own, and where its fiery marriage with quantum physics will be consummated.

*Relativity, Groups, and Topology*  
 Geometrodynamics and the Issue of the Final State

### Whewell, William 1794–1866

English philosopher and historian

[The law of gravitation] is indisputably and incomparably the greatest scientific discovery ever made, whether we look at the advance which it involved, the extent of truth disclosed, or the fundamental and satisfactory nature of this truth.

*History of the Inductive Sciences, from the Earliest to the Present Time*  
 (Volume 2)  
 Book 7, Chapter 2, article 5 (p. 180)  
 John W. Parker. London, England. 1837

### Whittaker, Sir Edmund

Gravitation simply represents a continual effort of the universe to straighten itself out.

In Robert G. Colodny (ed.)  
*From Quarks to Quasars: Philosophical Problems of Modern Physics*  
 Newtonian Gravity, Limits, and the Geometry of Space (p. 181)  
 University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA.

### Zee, Anthony

American physicist

Of the fundamental forces of nature, we are most intimate with gravity. In the uttermost darkness of night, lost in our private thoughts and shut off from the world of light, we still feel the incessant tug of gravity. No sooner had we come into existence that we became aware of the downwards pull of gravity, balanced by the buoyancy of the fluid inside our mothers' wombs. Yet we do not know gravity.

*An Old Man's Toy: Gravity at Work and Play in Einstein's Universe*  
 Preface (p. ix)  
 The Macmillan Company. New York, New York, USA. 1989

## GREATNESS

### Greene, Edward L.

No biographical data available



...a great man in whatsoever profession, a man of power in any branch of science, is greater than the science to which he devotes himself; that he himself personally is of more moment, and ought to be of deeper interest than his science; yes, than all the sciences that are or ever shall be.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Linnaean Memorial Address (p. 685)  
Government Printing Office, Washington, D.C. 1908

### **Longfellow, Henry Wadsworth** 1807–82

American poet

Lives of great men all remind us  
We can make our lives sublime,  
And, departing, leave behind us  
Footprints on the sands of time.

*The Poetical Works of Henry Wadsworth Longfellow*

A Psalm of Life, Stanza VII

Houghton Mifflin Company, Boston, Massachusetts, USA. 1883

## **GREENHOUSE WARMING**

### **Wohlforth, Charles**

It was certainly possible to argue that other, smaller effects would cancel greenhouse gas warming, but the burden of proof belonged on those who made such claims. Yet even as the evidence piled up on the side of the most reasonable assumption, the public repeatedly spun off in weird directions, with every “what if” given equal weight. It was as if a murder defendant caught with a bloody weapon in one hand and a written confession in the other were acquitted on the theory that an alien might have beamed him into that position.

*The Whale and the Supercomputer: On the Northern Front of Climate Change*

Chapter 6 (p. 168)

North Point Press, New York, New York, USA. 2004

## **GROUP**

### **Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Wherever groups disclosed themselves, or could be introduced, simplicity crystallized out of comparative chaos.

*Mathematics: Queen and Servant of Science*

Groups (p. 164)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

## **GROUP THEORY**

### **Dyson, Freeman J.** 1923–

American physicist and educator

The trouble with group theory is that it leaves so much unexplained that one would like to explain. It isolates in

a beautiful way those aspects of nature that can be understood in terms of abstract symmetry alone. It does not offer much hope of explaining the messier facts of life, the numerical values of particle lifetimes and interaction strengths — the great bulk of quantitative experimental data that is now waiting for explanation. The process of abstraction seems to have been too drastic, so that many essential and concrete features of the real world have been left out of consideration. Altogether group theory succeeds just because its aims are modest. It does not try to explain everything, and it does not seem likely that it will grow into a complete or comprehensive theory of the physical world.

Mathematics in the Physical Sciences

*Scientific American*, Volume 211, Number 3, September 1964 (p. 146)

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The theory of groups is an extensive subject upon which there is much to be said. There are many kinds of groups, and whatever classification may be adopted we will always find new groups which will not fit it.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 137)

Government Printing Office, Washington, D.C. 1910

### **Rota, Gian-Carlo** 1932–

Italian-born American mathematician

Group theory, like lattice theory, is the whipping boy of mathematicians in need of concealing their feelings of insecurity.

*Indiscrete Thoughts*

Chapter XX (p. 221)

Birkhäuser, Boston, Massachusetts, USA. 1997

## **GUESS**

### **Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

There never was a great scientist who did not make bold guesses, and there never was a bold man whose guesses were not sometimes wild.

*Science and Human Values*

The Sense of Human Dignity (p. 64)

Harper & Row, Publishers, New York, New York, USA. 1965

### **Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

No, no: I never guess. It is a shocking habit, — destructive to the logical faculty.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Sign of the Four, Chapter 1 (p. 614)

Wings Books, New York, New York, USA. 1967

**Feynman, Richard P.** 1918–88  
American theoretical physicist

In general we look for a new law by the following process. First we guess it. Then we compute the consequences of the guess to see what would be implied if this law that we guessed is right. Then we compare the results of the computation to nature, with experiment or experience, compare it directly with observation, to see if it works. If it disagrees with experiment it's wrong. In that simple statement is the key to science. It does not make any difference how beautiful your guess is. It does not make any difference how smart you are, who made the guess, or what his name is — if it disagrees with experiment it's wrong.

*The Character of Physical Law*

Chapter 7 (p. 156)

British Broadcasting Company. London, England. 1965

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

I can understand such an attitude directed toward photographs of objects — through opportunities for subtle manipulation are legion even here. But many of our pictures are incarnations of concepts masquerading as neutral descriptions of nature. These are the most potent sources of conformity, since ideas passing as descriptions lead us to equate the tentative with the unambiguously factual. Suggestions for the organization of thought are transformed to established patterns in nature. Guesses and hunches become things.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter I (p. 28)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

To say that Einstein formulated a theory of relativity by guesswork is on all fours with saying that Wordsworth wrote rhymes and Mozart tuneful music. It is cheeky where something grave is called for.

Hypothesis and Imagination

*Times Literary Supplement*, 25 Oct 1963

**Pólya, George** 1887–1985

Hungarian mathematician

Anything new that we learn about the world involves plausible reasoning, which is the only kind of reasoning for which we care in everyday affairs.... Certainly, let us learn proving, but also let us learn guessing.

*Mathematics and Plausible Reasoning* (Volume 1)

Induction and Analogy in Mathematics

Preface

Princeton University Press. Princeton, New Jersey, USA. 1954

## GYNECOLOGIST

**Rivers, Joan** 1933–

American comedian

The gynecologist says, Relax, relax, I can't get my hand out, relax. I wonder why I'm not relaxed. My feet are in the stirrups, my knees are in my face, and the door is open facing me.... And my gynecologist does jokes. Dr. Schwartz at your cervix! I'm dilated to meet you! Say ahhh. There's Jimmy Hoffa! There's no way you can get back at that son of a bitch unless you learn to throw your voice.

In Roz Warren

*Glibquips* (p. 70)

Crossing Press, Freedom, California. USA. 1994

## H

### HAIR

#### Montagna, William

Dermatological researcher

Interest in hair today has grown to the proportion of a fetish. Think of the many loving ways in which advertisements refer to scalp hair — satiny, glowing, shimmering, breathing, living. Living indeed! It is as dead as rope.

*New York Herald Tribune*, August 11, 1963

### HAPPENING

#### Kay, Marshall

American geologist

Anything that has happened, can.

*Mapping Mars: Science, Imagination and the Birth of a World*

Mike Carr's Mars (p. 160)

Fourth Estate. London, England. 2002

#### Leclerc, Georges-Louis, Comte de Buffon 1707–88

French naturalist

To understand what has happened, and even what will happen we have only to examine what is happening.

In Frances Mason

*Creation by Evolution*

The Evolution of the Brain (p. 326)

The Macmillan Company. New York, New York, USA. 1928

### HAPPINESS

#### Morley, Christopher 1890–1957

American writer

...for after all, happiness (as the mathematicians might say) lies on a curve, and we approach it only by asymptote...

*The Haunted Bookshop*

Chapter XIII (p. 242)

Double, Page & Company. New York, New York, USA. 1923

### HARMONIC LAW

#### Kepler, Johannes 1571–1630

German astronomer

But now since the first light eight months ago, since broad day three months ago, and since the sun of my wonderful speculation [relating to the law of planetary motion — harmonic law] has shone fully a very few days ago: nothing holds me back. I am free to give myself up to the sacred madness, I am free to taunt mortals with the frank confession that I am stealing the golden vessels of

the Egyptians, in order to build of them a temple for my God, far from the territory of Egypt. If you pardon me, I shall rejoice; if you are enraged, I shall bear up. The die is cast, and I am writing the book — whether to be read by my contemporaries or by posterity matters not. Let it await its reader for a hundred years, if God Himself has been ready for His contemplator for six thousand years.

In *Great Books of the Western World* (Volume 16)

*Harmonies of the World*

Proem (p. 1010)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### HEADACHE

#### Ray, John 1627–1705

English naturalist

When the head aches all the body is the worse.

*A Complete Collection of English Proverbs* (p. 12)

Printed for G. Cowie. London, England. 1813

#### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

Do not undervalue the headache. While it is as its sharpest it seems a bad investment; but when relief begins, the unexpired remainder is worth \$4 a minute.

*Following the Equator* (Volume 2)

Chapter XVII (p. 215)

Harper & Brothers. New York, New York, USA. 1899

### HEALING

#### Bonaparte, Napoleon 1769–1821

French soldier and emperor of France

You know, my dear doctor, the art of healing is simply the art of lulling and calming the imagination.

In J. Christopher Herold (ed.)

*The Mind of Napoleon*

Science and the Arts (p. 140)

Columbia University Press. New York, New York, USA. 1955

#### Butler, Samuel 1612–80

English novelist, essayist, and critic

Dogs with their tongues their wounds do heal,

But men with hands, as thou shalt feel.

*The Poetical Works of Samuel Butler* (Volume 1)

Part I, canto ii, l. 773–774

Bell & Daldy. London, England. 1835

#### Eddy, Mary Baker 1821–1910

American religious writer

Here comes the question, How do drugs, hygiene and animal magnetism heal? It may be affirmed that they do not heal, but only relieve suffering temporarily, exchanging one disease for another.

*Science and Health with Key to the Scriptures*  
Chapter XIV (p. 483)  
Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Forssmann, Werner** 1904–79  
German physician and physiologist

One may compare the art of healing with a work of art, which from different standpoints and under different lighting reveals ever new and surprising beauty.

*Nobel Lectures, Physiology or Medicine 1942–1962*  
The Role of Heart Catheterization and Angiocardiology in the Development of Modern Medicine (p. 510)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

...it will never get well if you pick it.  
What Is Going on in the World  
*The American Mercury*, Volume XXX, Number 119, November 1933 (p. 257)

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

What wound did ever heal but by degrees?  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Othello, The Moore of Venice  
Act II, Scene iii, l. 375  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## HEALTH

**Amiel, Henri-Frédéric** 1821–81  
Swiss philosopher, poet, and critic

Health is the first of all liberties, and happiness gives us the energy which is the basis of health.  
Translated by Mrs. Humphrey Ward  
*Amiel's Journal*  
April 3, 1865 (p. 132)  
A.L. Burt Company, Publishers. New York, New York, USA. 189?

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

It was a monotonous life, but it was very healthy; and one does not much mind anything when one is well.  
*Erewhon and Erewhon Revisited*  
Chapter I (p. 5)  
The Modern Library. New York, New York, USA. 1955

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Strive to preserve your health; and in this you will the better succeed in proportion as you keep clear of the physicians, for their drugs are a kind of alchemy concerning which there are no fewer books than there are medicines.

*Leonardo da Vinci's Note Books* (p. 65)  
Duckworth & Company. London, England. 1906

**de Cervantes, Miguel** 1547–1616  
Spanish novelist, playwright, and poet

The beginning of health lies in knowing the disease and in the sick man's willingness to take the medicines which the physician prescribes...

In *Great Books of the Western World* (Volume 29)  
*The History of Don Quixote de la Mancha*  
Part II, Chapter 60 (p. 392)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Donleavy, James Patrick** 1926–  
No biographical data available

...when you don't have any money, the problem is food. When you have money, it's sex. When you have both, it's health...

*The Ginger Man*  
Chapter 5 (p. 39)  
Delacorte Press. New York, New York, USA. 1974

**Eddy, Mary Baker** 1821–1910  
American religious writer

Health is not a condition of matter, but of Mind; nor can the material senses bear reliable testimony on the subject of health.

*Science and Health with Key to the Scriptures*  
Chapter VI (p. 120)  
Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

...the rich ate and drank freely, accepting gout and apoplexy as things that ran mysteriously in respectable families...

*Silas Marner*  
Chapter III (pp. 28–29)  
Dodd, Mead & Company. New York, New York, USA. 1948

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

The sense of wellbeing! It's often with us  
When we are young, but then it's not noticed;  
And by the time one has grown to consciousness  
It comes less often.

*The Elder Statesman*  
Act II (p. 54)  
Farrar, Straus & Cudahy. New York, New York, USA. 1959

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The first wealth is health. Sickness is poor-spirited, and cannot serve any one; it must husband its resources to live. But health or fullness answers its own ends and has to spare, runs over, and inundates the neighborhoods and creeks of other men's necessities.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life  
Power (p. 972)  
The Library of America. New York, New York, USA. 1983

**Hawthorne, Nathaniel** 1804–64  
American novelist and short story writer

A bodily disease, which we look upon as whole and entire within itself, may, after all, be but a symptom of some ailment in the spiritual part.

*The Scarlet Letter*  
Chapter 10 (p. 122)  
Modern Library. New York, New York, USA. 2000

**Herophilus** 325 BCE–255 BCE  
Greek physician

To lose one's health renders science null, art inglorious, strength effortless, wealth useless and eloquence powerless.

In Samuel Evans Massengill  
*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 28)  
The S. E. Massengill Company. Bristol, Tennessee, USA. 1943

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

If you mean to keep as well as possible, the less you think about your health the better.

*Over the Teacups*  
Chapter VIII (p. 186)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Jefferson, Thomas** 1743–1826  
3<sup>rd</sup> president of the United States

With your talents and industry, with science, and that steadfast honesty which eternally pursues right, regardless of consequences, you may promise yourself every thing—but health, without which there is no happiness. An attention to health then should take place of every other object. The time necessary to secure this by active exercises, should be devoted to it in preference to every other pursuit.

In Julian P. Boyd (ed.)  
*The Papers of Thomas Jefferson* (Volume 11)  
Letter to Thomas Mann Randolph, Jr, July 6, 1787 (p. 558)  
Princeton University Press. Princeton, New Jersey, USA. 1950

**Melville, Herman** 1819–91  
American novelist

I rejoice in my spine, as in the firm audacious staff of that flag which I fling half out to the world.

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 80 (p. 258)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## Proverb

Health and sickness surely are men's double enemies.  
In George Herbert

*Outlandish Proverbs*  
#1011  
Printed by T. Maxey for T. Garthwait. London, England. 1651

**Ray, John** 1627–1705  
English naturalist

Early to go to bed, and early to rise, makes a man healthy, wealthy, and wise.

*A Complete Collection of English Proverbs* (p. 33)  
Printed for G. Cowie. London, England. 1813

Health is better than wealth.  
*A Complete Collection of English Proverbs* (p. 120)  
Printed for G. Cowie. London, England. 1813

Health without money is half a sickness.  
*A Complete Collection of English Proverbs* (p. 12)  
Printed for G. Cowie. London, England. 1813

**Romains, Jules** 1885–1972  
French author

Healthy people are sick people who don't know it.  
*Knock*

Act 1 (p. 12)  
Barron's Educational Series. Great Neck, New York, USA. 1962

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

One who does not care about his own health, or life, will soon be either disabled or dead.

*Encyclopedia of Thoughts*  
Aphorisms 1033  
Heritage Books. Ithaca, New York, USA. 1975

**Sacks, Oliver W.** 1933–  
American neurologist and author

Health is infinite and expansive in mode, and reaches out to be filled with the fullness of the world; whereas disease is finite and reductive in mode, and endeavors to reduce the world to itself.

*Awakenings*  
Perspectives (p. 234)  
Vintage Books. New York, New York, USA. 1990

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Use your health, even to the point of wearing it out. That is what it is for. Spend all you have before you die; and do not outlive yourself.

*The Doctor's Dilemma*  
Preface on Doctors  
The Latest Theories (p. xcii)  
Brentano's. New York, New York, USA. 1920

**Simmons, Charles** 1798–1856  
American clergy and litterateur

He that wants health wants everything.  
*Laconic Manual and Brief Remarker Containing Over a Thousand*

*Subjects Alphabetically and Systematically Arranged* (p. 234)  
Robert Dick. Toronto, Ontario, Canada. 1853

A man too busy to take care of his health is like a mechanic too busy to take care of his tools.

*Laconic Manual and Brief Remarker Containing Over a Thousand Subjects Alphabetically and Systematically Arranged* (p. 234)  
Robert Dick. Toronto, Ontario, Canada. 1853

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

It is better to lose health like a spend thrift than to waste it like a miser.

*Virginibus Puerisque & Familiar Studies of Men & Books*  
Aes Triplex (p. 68)  
J.M. Dent & Sons Ltd. London, England. No date

**Thomson, James** 1700–48  
Scottish poet

Health is the vital Principle of Bliss,  
And Exercise of Health.

*The Castle of Indolence*  
Canto II, Stanza lvii  
William Smith. London, England. 1842

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

There are people who strictly deprive themselves of each and every eatable, drinkable and smokable which has in any way acquired a shady reputation. They pay this price for health. And health is all they get for it. How strange it is. It is like paying out your whole fortune for a cow that has gone dry.

*Mark Twain's Autobiography* (Volume 1)  
Chapters Begun in Vienna (p. 98)  
Harper & Brothers. New York, New York, USA. 1924

He had much experience of physicians, and said “the only way to keep your health is to eat what you don’t want, drink what you don’t like, and do what you’d druther not.”

*Following the Equator* (Volume 2)  
Chapter XIII (p. 151)  
Harper & Brothers. New York, New York, USA. 1899

**Walton, Izaak** 1593–1683  
English writer

...look to your health: and if you have it, praise God, and value it next to a good conscience; for health is the second blessing that we mortals are capable of; a blessing that money cannot buy.

*The Complete Angler*  
The Fifth Day, Chapter XXI (pp. 225–226)  
T.N. Foulis. London, England. 1913

## HEART

**Barnard, Christiaan N.** 1923–  
South African heart surgeon

...it is infinitely better to transplant a heart “than to bury it so it can be devoured by worms.”

People  
*Time*, October 31, 1969 (p. 36)

**Barnes, Djuna** 1892–1982  
American author

We are adhering to life now with out last muscle — the heart.

*Nightwood*  
La Somnambule (p. 50)  
Harcourt, Brace & Company. New York, New York, USA. 1937

**De Bakey, Michael E.**  
American cardiovascular surgeon

If you can think of how much love there would be in hundreds of hearts, then that is how much love there is in a plastic heart. When you grow up you will understand how very much love that is.

Heart of the Matter  
*Newsweek*, June 6, 1966 (p. 56)

**Harvey, William** 1578–1657  
English physician

The heart, consequently, is the beginning of life; the sun of the microcosm, even as the sun in his turn might well be designated the heart of the world; for it is the heart by whose virtue and pulse the blood is moved, perfected, made apt to nourish, and is preserved from corruption and coagulation; it is the household divinity which, discharging its function, nourishes, cherishes, quickens the whole body, and is indeed the foundation of life, the source of all action. But of these things we shall speak more opportunely when we come to speculate upon the final cause of this motion of the heart.

In *Great Books of the Western World* (Volume 28)  
*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*  
Chapter 8 (p. 286)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The heart of animals is the foundation of their life, the sovereign of everything within them, the sun of their microcosm, that upon which all growth depends, from which all power proceeds.

In *Great Books of the Western World* (Volume 28)  
*An Anatomical Disquisition on the Motion of the Heart and Blood In Animals*  
Dedication (p. 267)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hellerstein, Herman**  
Physician

Coronary heart disease is a silent disease and the first manifestation frequently is sudden death.

Tests to Avoid Attack

*Newsweek*, August 6, 1984 (p. 64)

### Legrain, G.

No biographical data available

The heart is a god...the stomach is its chapel.

*Répertoire Généalogique et Onomastique du Musée du Caire*

Statues et Statuettes, III, 42225, e, I, II (p. 60)

## HEAT

### Baumel, Judith

No biographical data available

Think of the complexity  
of temperature, quantification  
of that elusive quality "heat."

Tonight, for instance,  
your hands are colder than mine.

Someone could measure  
more precisely than we  
the nature of this relationship.

*The Weight of Numbers*

Fibonacci (p. 20)

Wesleyan University Press, Middletown, Connecticut, USA; 1988

### Carnot, Sadi Nicolas Leonhard 1796–1832

French physicist and engineer

The phenomenon of the production of motion by heat has not been considered in a sufficiently general way.... It is necessary to establish proofs applicable not only to steam engines but to all other heat-engines, irrespective of the working substance and the manner in which it acts.

Translated by W.F. Maggie

*The Second Law of Thermodynamics: Memoirs by Carnot, Clausius, and Thompson*

Reflections on the Motive Power of Heat, and on Engines Suitable for Developing this Power (p. 6)

Harper & Brothers. New York, New York, USA. 1899

### Flanders, Michael 1922–75

English actor and singer

### Swann, Donald 1923–94

English composer, musician, and entertainer

You can't pass heat from a cooler to a hotter.  
Try if you like, you far better notter,  
cause the cold in the cooler will get hotter as a ruler,  
'cause the hotter body's heat will pass to the cooler.

*At the Drop of Another Hat*

The First and Second Law

CD. Telarc. Cleveland, Ohio, USA. 1994

Heat is work and work's a curse

And all the heat in the universe

Is gonna cool down

Because it can't increase.

*At the Drop of Another Hat*

The First and Second Law

CD. Telarc. Cleveland, Ohio, USA. 1994

### Fourier, (Jean Baptiste-) Joseph 1768–1830

French mathematician and physicist

Heat, like gravity, penetrates every substance of the universe, its rays occupy all parts of space. The object of our work is to set forth the mathematical laws which this element obeys. The theory of heat will hereafter form one of the most important branches of general physics.

In *Great Books of the Western World* (Volume 43)

*The Analytical Theory of Heat*

Preliminary Discourse (p. 169)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...a very extensive class of phenomena exists, not produced by mechanical forces, but resulting simply from the presence and accumulation of heat. This part of natural philosophy cannot be connected with dynamical theories, it has principles peculiar to itself, and is founded on a method similar to that of other exact sciences.

In *Great Books of the Western World* (Volume 45)

*The Analytical Theory of Heat* (p. 23)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Frost, Robert 1874–1963

American poet

Say something to us we can learn.  
By heart and when alone repeat.  
Say something! And it says, "I burn."  
But say with what degree of heat.  
Talk Fahrenheit, Talk Centigrade.  
Use language we can comprehend.  
Tell us what elements you blend.

*Complete Poems of Robert Frost*

Choose Something Like a Star, I, 9–15

Henry Holt & Company. New York, New York, USA. 1949

### Hoyle, Sir Fred 1915–2001

English mathematician and astronomer

### Hoyle, Geoffrey 1942–

English science fiction writer

The Yela can destroy the Earth by wrapping a blanket of hydrogen around our atmosphere. Then all it needs do to destroy us is just press a little of the hydrogen into the atmosphere itself. The hydrogen and the oxygen in our atmosphere combine together with an immense release of heat. The generation of heat causes the gas to rise and more hydrogen is sucked down. Within seconds the whole atmosphere is a raging inferno.

*Into Deepest Space*

Chapter I (p. 6)

Harper & Row, Publishers. New York, New York, USA. 1974

### Joyce, James 1882–1941

Expatriate Irish writer and poet

Be a warm day I fancy. Specially in these black clothes feel it more. Black conducts, reflects (refracts is it?) the heat.

*Ulysses* (p. 57)

Random House, Inc. New York, New York, USA. 1946

### Keane, Bill Joseph

No biographical data available

Heat makes things expand. That's why the days are longer in the summer.

*Cartoon caption*

### Locke, John 1632–1704

English philosopher and political theorist

Heat is a very brisk agitation of the insensible parts of the object, which produces in us that sensation, from whence we denominate the object hot; so what in our sensation is heat, in the object is nothing but motion.

*The Works of John Locke In Nine Volumes* (Volume 2)

Elements of Natural Philosophy

Chapter XI

Of the Five Senses, of Touch

### Maxwell, James Clerk 1831–79

Scottish physicist

The distinction between hot bodies and cold ones is familiar to all, and is associated in our minds with the difference of the sensations which we experience in touching various substances, according as they are hot or cold. The intensity of these sensations susceptible of degrees, so that we may estimate one body to be hotter or colder than another by touch. The words hot, warm, cool, cold are associated in our minds with a series of sensations which we suppose to indicate a corresponding series of states of an object with respect to heat.

*Theory of Heat*

A Treatise on Heat

Chapter I (p. 1)

Longmans, Green & Company. London, England. 1871

### Mayer, Julius Robert von Joseph 1904–83

German physician and physicist

Concerning the intimate nature of heat, or of electricity, etc., I know nothing, any more than I know the intimate nature of any matter whatsoever, or of anything else.

Quoted by Pierre Duhem

*The Aim and Structure of Physical Theory*

Part I, Chapter III (p. 52)

Princeton University Press. Princeton, New Jersey, USA. 1954

### McNeil, I. Joseph

No biographical data available

In the beginning God created the heaven and the earth are the opening words of the Bible, which goes on, in verse 3, and God said Let there be light: and there was light. It must be assumed that the Cosmic Illuminator had to

abide by the laws of physics like the rest of us for, after all, He had created them. In the nature of things, sensible heat comes long before visible light in the spectrum of electromagnetic wavelengths. Thus, when God said Let there be light, he implied, Let there also be heat — and there was heat.

In R. Angus Buchanan

*Engineers and Engineering*

Blast: From Blowpipe to Blowing Engine (p. 79)

Bath University Press. Bath, England. 1996

### Metsler, William Joseph

No biographical data available

The stove is hot, but that's no change

Heat's what it's supposed to make

Resistance generates the energy to bake

So its always Ohm Ohm on the range.

The Cowboy's Lament

*The Physics Teacher*, Volume 15, Number 2, February 1977 (p. 127)

### Mott-Smith, Morton Joseph

People are always exaggerating temperatures. If the day is hot, they add on a few degrees; if it is cold they deduct a few. No one ever gives the air temperature to a fraction of a degree, but only to whole degrees. Now on the Fahrenheit scale, on account of the small size of its degree, these whoppers and inaccuracies are only about half as big as they are on the other scales.

*Heat and Its Workings* (p. 24)

D. Appleton & Company. New York, New York, USA. 1933

### Newton, Sir Isaac 1642–1727

English physicist and mathematician

Do not all fixed bodies, when heated beyond a certain degree, emit light and shine; and is not this emission performed by the vibrating motions of their parts?

In *Great Books of the Western World* (Volume 34)

*Optics*

Book III, Part 1, Query 8

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Planck, Max 1858–1947

German physicist

The concept of heat, like all other physical concepts, originates in a sense-perception, but it acquires its physical significance only on the basis of a complete separation of the events in the sense-organs from the external events which excite the sensation. So heat, regarded physically, has no more to do with the sense of hotness than colour, in the physical sense, has to do with the perception of colour.

Translated by Henry L. Brose

*Theory of Heat*

Introduction (p. 1)

The Macmillan Company. New York, New York, USA. 1957



**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

And a well-made language is no indifferent thing; not to go beyond physics, the unknown man who invented the word heat devoted many generations to error. Heat has been treated as a substance, simply because it was designated by a substance, and it has been thought indestructible.

*The Foundations of Science*  
The Value of Science, Analysis and Physics (p. 289)  
The Science Press. New York, New York, USA. 1913

**Rothman, Tony** 1953–  
American cosmologist

Like atoms, heat is so intangible that it was one of the last concepts in classical physics to be sorted out. In the process, the science of thermodynamics was created. Pollyannas who believe anything is possible should be subjected to a course in thermodynamics.

*Instant Physics: From Aristotle to Einstein, and Beyond*  
Chapter 3 (p. 68)  
Ballentine Books. New York, New York, USA. 1995

## HEAVENS

**Addison, Joseph** 1672–1719  
English essayist, poet, and statesman

The ways of Heaven are dark and intricate,  
Puzzled in Mazes and perplex'd with errors:  
Our understanding traces 'em in vain,  
Lost and bewilder'd in the fruitless search;  
Nor sees with how much art the winding run,  
Nor where the regular confusion ends.

*Cato*  
Act One, Scene I  
J. Dicks. London, England. 1883

**Alighieri, Dante** 1265–1321  
Italian poet and writer

...Heaven calls you, and revolves around you, displaying to you its eternal beauties....

In *Great Books of the Western World* (Volume 21)  
*The Divine Comedy of Dante Alighieri*  
Purgatory, Canto XIV, l. 47–48  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Browne, J. Stark**  
No biographical data available

Awe-inspiring in its grandeur is that wonderful panorama which, on clear dark nights, we see in the heavens above us — that jeweled canopy sparkling from east to west, and from north to south, with its myriad diamond points of light.

The Number and Distances of the Stars  
*The Rationalist Annual*, 1931 (p. 61)

**Browning, Robert** 1812–89  
English poet  
Ah, but a man's reach should exceed his grasp,  
Or what's a heaven for?  
*The Poems and Plays of Robert Browning*  
Andrea del Sarto, 97  
The Modern Library. New York, New York, USA. 1934

**Burnham, Jr., Robert Jr.** 1931–93  
American astronomer

Here, in the dark unknown immensity of the heavens, we shall meet the glories beyond description and witness scenes of inexpressible splendor. In the great black gulfs of space and in the realm of the innumerable stars, we shall find mysteries and wonders undreamed of.

*Burnham's Celestial Handbook*  
Chapter 2 (p. 13)  
Celestial Handbook Publications. Flagstaff, Arizona, USA.

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Oh with what prayers and fasting  
Shall mortal man deserve  
To see that glimpse of Heaven.

*The Coloured Lands*  
The Joys of Science (p. 209)  
Sheed & Ward. New York, New York, USA. 1938

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

If a man should ascend alone into heaven and behold clearly the structure of the universe and the beauty of the stars, there would be no pleasure for him in the awe-inspiring sight, which would have filled him with delight if he had had someone to whom he could describe what he had seen.

Translated by William Armistead Falconer  
*De Amicitia*  
XXIII (p. 195)  
Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Copernicus, Nicolaus** 1473–1543  
Polish astronomer

...the heavens are immense in comparison with the Earth...

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
Book One, Chapter 6 (p. 516)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Dickinson, Emily** 1830–86  
American lyric poet

What once was "Heaven"  
is "Zenith" now —  
Where I proposed to go  
When Time's brief masquerade was done  
Is mapped, and charted too.

*The Complete Poems of Emily Dickinson*

No. 70 (p. 37)

Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1960

**Donne, John** 1572–1631

English poet and divine

Man has weav'd out a net, and this net throwne  
Upon the Heavens, and now they are his owne.

*An Anatomy of the World*

The First Anniversary

Presented for presentation to members of the Roxburghe Club. Cambridge, England. 1951

And then that heaven, which spreads so farre, as that  
subtill men have, with some appearance of probabilitie,  
imagined, that in that heaven, in those manifold Sphere  
of the Planets and the Starres, there are many earths,  
many worlds, as big as this which we inhabit...

*Donne's Sermons*

The Heavens and Earth, Sermon 98 (p. 161)

Clarendon Press. Oxford, England. 1942

**Grondal, Florence Armstrong**

American astronomer and photographer

To the true lover of the stars, one universe or a million  
makes not a whit of difference. The silent song of the  
heavens is as sweet today, its mystery as alluring, its  
delights more marvelous, than in the days of yore when  
planets rolled out heavenly notes and stars shone through  
the seven spheres of pure, translucent crystal.

*The Music of the Spheres: A Nature Lover's Astronomy*

Chapter IX (p. 200)

The Macmillan Company. New York, New York, USA. 1926

**Herschel, Friedrich Wilhelm** 1738–1822

English astronomer

*Coelorum perrupit claustra*

He broke through the barriers of the heavens

*Epitaph*

Upton Church

The subject of the Construction of the Heavens is of so  
extensive and important a nature, that we cannot exert  
too much attention in our endeavors to throw all possible  
light upon it.

On the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London*, 1783

**Kepler, Johannes** 1571–1630

German astronomer

My aim is to show that the heavenly machine is not a  
kind of divine, live being, but a kind of clockwork, in-  
sofar as nearly all the manifold motions are caused by  
a most simple, magnetic, and material force, just as all  
motions of the clock are caused by a simple weight. And  
I also show how these physical causes are to be given  
numerical and geometrical expression.

In Michael Polyani

*The Logic of Personal Knowledge*

Letter to Herwart von Hohenburg, February 10, 1605 (p. 52)

The Free Press. Glencoe, Illinois, USA. 1961

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

No man is so utterly dull and obtuse, with head so bent  
on Earth, as never to lift himself up and rise with all his  
soul to the contemplation of the starry heavens, espe-  
cially when some fresh wonder shows a beacon-light in  
the sky.

*Physical Science In the Time of Nero, being a Translation of the Quaes-  
tiones Naturales of Seneca*

Book VII, Chapter I (p. 271, 272)

Macmillan & Company Ltd. London, England. 1910

**Shelley, Percy Bysshe** 1792–1822

English poet

Heaven's ebon vault

Studded with stars unutterably bright,

Through which the moon's unclouded grandeur rolls,

Seems like a canopy which love has spread

To curtain her sleeping world.

*The Complete Poetical Works of Percy Bysshe Shelley*

Queen Mab, IV

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Simes, James**

No biographical data available

The prose of the heavens surpasses the brightest poetry  
of earth.

In James Sime

*William Herschel and His Work*

Star-Dust, Chapter V, Ocean of Ether (p. 153)

Charles Scribner's Sons. New York, New York, USA. 1900

**Somerville, Mary** 1780–1872

English mathematician

The heavens afford the most sublime subject of study  
which can be derived from science. The magnitude and  
splendor of the objects, the inconceivable rapidity with  
which they move, and the enormous distances between  
them, impress the mind with some notion of the energy  
that maintains them in their motions, with a durability to  
which we can see no limit.

*The Connexion of the Physical Sciences* (9<sup>th</sup> edition)

Introduction (p. 2)

John Murray. London, England. 1858

...however profoundly we may penetrate the depths  
of space, there still remain innumerable systems,  
compared with which, those which seem so mighty to  
us must dwindle into insignificance, or even become  
invisible....

*Mechanism of the Heavens*

Preliminary Dissertation (p. 2)

John Murray. London, England. 1831

**Spencer, Herbert** 1820–1903  
English social philosopher

Sad, indeed is it to see how men occupy themselves with trivialities, and are indifferent to the grandest phenomena — care not to understand the architecture of the Heavens, but are deeply interested in some contemptible controversy about the intrigues of Mary Queen of Scots!

*Education: Intellectual, Moral and Physical*  
A.L. Fowle. New York, New York, USA. 1860

## HEILIGENSCHIEIN

**Matthews, L.**

No biographical data available

But whereas the sylvanshine on a tree is visible to anyone in the car or holding a torch, heiligenschein, the result of sunlight focused by dewdrops held above a leaf's surface by fine hairs, appears to each observer as a halo around the head of just his own shadow on the grass. In his Memoirs of 1562, Benvenuto Cellini, no expert on the laws of optics, interpreted this instead as a sign of divine grace towards himself; and, says Fraser wryly, evidently none of those to whom Cellini vouchsafed his secret dared mention the halo about his own head.

*Reflections on a Summer's Night*  
*Nature*, Volume 369, Number 6480, 9 June 1994 (p. 441)

## HEMATOCRIT

**Wintrobe, Maxwell M.**

Canadian-born physician

I...discovered that there were no reliable normal blood values. What was called "normal" was based on only a few counts that had been made in the nineteenth century. So I proceeded to collect normal blood values. Others elsewhere, also mindful of this deficiency, were beginning to do the same. A major problem, however, was methodology, and this was what led me to devise the hematocrit as a simple and accurate means of quantitating blood.

In A.B. Weisse  
*Conversations in Medicine: The Story of Twentieth-Century American Medicine in the Words of Those Who Created It* (p. 83)  
New York University Press. New York, New York, USA. 1984

## HEREDITY

**Bateson, William** 1861–1926  
English biologist and geneticist

Evolution is a process of Variation and Heredity. The older writers, though they had some vague idea that it must be so, did not study Variation and Heredity. Darwin did, and so begot not a theory, but a science.

In A.C. Seward  
*Heredity and Variation in Modern Lights*  
Darwin and Modern Science Heredity and Variation in Modern Light (p. 88)

**Kingsley, Charles** 1819–75  
English clergyman and author

...a great man of science...knows everything about everything, except why a hen's egg don't turn into a crocodile, and two or three other little things.

*The Water-Babies*  
Chapter VIII (p. 267)  
Dodd, Mead & Company. New York, New York, USA. 1910

## HERITAGE

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

We humans carry with us the heritage of a long past, extending backward in time for hundreds of millions of years. Our society is built not on the joy and happiness of the past, but on the agonies experienced by the long line of our predecessors. Whether or not all the agonies and struggles of the past will emerge into a great future, or will vanish into nothing at all, is likely to be decided in the next few tens of human generations.

*Ten Faces of the Universe*  
Everyman's Universe (p. 203)  
W.H. Freeman & Company. San Francisco, California, USA. 1977

**Salam, Abdus** 1926–  
Theoretical physicist

...scientific thought and its creation is the common and shared heritage of mankind.

*Nobel Lectures, Physics 1971–1980*  
Nobel lecture for award received in 1979  
Gauge Unification of Fundamental Forces (p. 513)  
World Scientific Publishing Company. Singapore. 1992

## HERNIA

**Jonson, Ben** 1573?–1637  
English dramatist and poet

He has a rupture, he has sprung a leake.

*The Staple of News*  
Act I, Scene ii  
Henry Holt & Company. New York, New York, USA. 1905

## HERPES

**Nahmias, André**  
Virologist and animal researcher

Herpes is from the Greek word for serpent, and herpes viruses really are creeps.

*Medical World News*, May 12, 1980

**HETEROCHRONIC CHANGE**

**Garstang, Walter** 1868–1949  
English embryologist and amateur poet

Ambystoma is a giant newt who rears in swampy waters,  
As other newts are wont to do, a lot of fishy daughters:  
These Axolotls, having gills, pursue a life aquatic,  
But, when they should transform to newts, are naughty  
and erratic.

They change upon compulsion, if the water grows too foul,  
For then they have to use their lungs, and go ashore to  
prowl:

But when a lake's attractive, nicely aired, and full of food,  
They cling to youth perpetual, and rear a tadpole brood.  
And newts Perennibranchiate have gone from bad to  
worse:

They think aquatic life is bliss, terrestrial a curse.  
They do not even contemplate a change to suit the  
weather,

But live as tadpoles, breed as tadpoles, tadpoles  
altogether!

*Larval Forms, and Other Zoological Verses*

The Axolotl and the Ammocoele

The University of Chicago Press. Chicago, Illinois, USA. 1985

**HETEROGENEITY**

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

As among plants and animals, so among lifeless things  
there is extraordinary heterogeneity. There are over eighty  
different kinds of elements; the number of different min-  
erals is legion; the multitude of the stars is untold.

*The System of Animate Nature* (Volume 1)

Lecture II (p. 64)

William & Norgate. London, England. 1920

**HEXAGON**

**Pappas of Alexandria** 250–320  
Greek style geometer

Bees...by virtue of a certain geometrical forethought...  
know that the hexagon is greater than the square and the  
triangle, and will hold more honey for the same expendi-  
ture of material.

In Sanderson Smith

*Agnesi to Zeno: Over 100 Vignettes from the History of Math*

Bees as Mathematicians (p. 173)

Key Curriculum Press. Emeryville, California, USA. 1996

**HIEROGLIPHICS**

**Birmingham Brown**

Fictional character

The higher gliphics is higher than the lower gliphics.

*The Feathered Serpent*

Film (1934)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

These hieroglyphics have evidently a meaning. If it is a  
purely arbitrary one, it may be impossible for us to solve  
it. If, on the other hand, it is systematic, I have no doubt  
that we shall get to the bottom of it.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of the Dancing Men (pp. 530–531)

Wings Books. New York, New York, USA. 1967

**HILBERT**

**Dirac, Paul Adrian Maurice** 1902–84  
English theoretical physicist

Hilbert...was perhaps the most absent-minded man  
who ever lived. He was a great friend of the physicist  
James Franck. One day when Hilbert was walking in  
the street he met James Franck and he said, "James, is  
your wife as mean as mine?" Well, Franck was taken  
aback by this statement and didn't know quite what to  
say, and he said, "Well, what has your wife done?" And  
Hilbert said, "It was only this morning that I discov-  
ered quite by accident that my wife does not give me  
an egg for breakfast. Heaven knows how long this has  
been going on.

In T. Ferris (ed.)

*The World Treasury of Physics, Astronomy and Mathematics*

Hilbert (p. 604)

Little Brown & Company. Boston, Massachusetts, USA. 1991

**HILBERT SPACE**

**von Neumann, John** 1903–57  
Hungarian-American mathematician

I would like to make a confession which may seem im-  
moral: I do not believe in Hilbert space anymore.

*Proceedings of Symposia in Pure Mathematics*

Letter to G. Birkhoff dated 13 Nov (Birkhoff believes the year was  
1935), Volume 2, 1961 (p. 158)

**HISTORIAN**

**Thorne, Kip S.** 1940–  
American theoretical physicist

I do not aspire to a historian's standards of completeness,  
accuracy, or impartiality.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 19)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

**HISTORY**

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

We must not let our pride in our achievements blind us to the lessons of history. Over the first cities of mankind, the desert sands now lie centuries deep. Could the builders of Ur and Babylon — once the wonders of the world — have pictured London or New York? Nor can we imagine the citadels that our descendants may build beneath the blinding Sun on Mercury, or under the stars of the cold Plutonian wastes. And beyond the planets, though ages still ahead of us in time, lies the unknown and infinite promise of the stellar universe.

*Interplanetary Flight: An Introduction to Astronautics*  
Chapter 10 (p. 126)  
Harper & Row, Publishers. New York, New York, USA. 1960

**Ford, Henry** 1863–1947  
American industrialist

History is more or less bunk. It's tradition. We want to live in the present and only the history that is worth a tinker's damn is the history we make today.

Interview with Charles Wheeler  
*Chicago Tribune*, May 25, 1916

**Geikie, Sir Archibald** 1835–1924  
English geologist

While eagerly pressing forward in the search after the secrets of Nature, we are apt to keep the eye too constantly fixed on the way that has to be traveled, and to lose sight and remembrance of the paths already trodden.

*The Founders of Geology*  
Lecture I (p. 1)  
Macmillan & Company Ltd. London, England. 1897

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

History subverts the stereotype of science as a precise, heartless enterprise that strips the uniqueness from any complexity and reduces everything to timeless, repeatable, controlled experiments in a laboratory.

*The Flamingo's Smile*  
Prologue (p. 18)  
W.W. Norton & Company, Inc. New York, New York, USA. 1985

I regard the failure to find a clear “vector of progress” in life's history as the most puzzling fact of the fossil record. But I also believe we are now on the verge of a solution, thanks to a better understanding of evolution in both normal and catastrophic times.

*The Flamingo's Smile*  
Part 4, Chapter 15 (p. 241)  
W.W. Norton & Company, Inc. New York, New York, USA. 1985

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Let us not let go the guiding hand of history. History has made all; history can alter all.

*History and Root of the Principle of the Conservation of Energy*  
Chapter I (p. 18)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1911

**Nernst, Walther** 1864–1941  
German physicist and chemist

It is often easy to write history, but it is always more difficult to learn anything from the history after it is written.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*  
Development of General and Physical Chemistry During the Last Forty Years (p. 253)  
Government Printing Office. Washington, D.C. 1909

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

History is simply the biography of the mind of man; and our interest in history, and its educational value to us, is directly proportionate to the completeness of our study of the individuals through whom this mind has been manifested.

*An Alabama Student: And Other Biographical Essays*  
Harvey and His Discovery (p. 296)  
Oxford University Press, Inc, American Branch. New York, New York, USA. 1908

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

There is no longer any doubt in our day that the history of the world must from time to time be rewritten. However, such a necessity does not develop because many new events have been discovered, but because new perspectives are being expressed, ...the companion of a progressive era is being led to a position [from] which the past can be viewed and evaluated in a new way.

In Karl J. Fink  
*Goethe's History of Science*  
Chapter 4 (p. 57)  
Cambridge University Press. Cambridge, England. 1991

**HIVES**

**Eisenschiml, Otto** 1880–1963  
Austrian-American chemist and historian

The Indian medicine man used weird chants and dances to mystify his tribe. The medicine man of today uses cryptic cabalas in his prescription, and long Latin words for simple diseases. This impresses the patient, who in turn relishes to regale his visitor with expressions they cannot understand and are ashamed to have explained to them.

After all, it does make a difference whether you suffer from agoneurotic edema or only have the hives.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Eleven (p. 135)  
Duell, Sloan & Pearce. New York, New York, USA. 1947

## HOLOTYPE

Holotypes, syntypes, lectotypes, and neotypes are the bearers of the scientific names of all animal taxa. They are the international standards of reference that provide objectivity in zoological nomenclature. They are held in trust for science by all zoologists and by persons responsible for their safe keeping.

*International Code of Zoological Nomenclature* (3<sup>rd</sup> edition)  
Article 72(g)  
Iowa State University Press. Ames, Iowa, USA. 1982

## HOMEOPATHY

**Darwin, Charles Robert** 1809–82  
English naturalist

You speak about Homoeopathy, which is a subject which makes me more wrath even than does Clairvoyance. Clairvoyancy so transcends belief that one's ordinary faculties are put out of the question, but in homoeopathy common sense and common observation come into play, and both those must go to the dogs, if the infinitesimal doses have any effect whatever.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Letter to Fox, September 1850 (p. 341)  
D. Appleton & Company. New York, New York, USA. 1896

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

If you want to be sure not to reach threescore and twenty, get a little box of homeopathic pellets and a little book of homeopathic prescriptions. I had a poor friend who fell into that way.... The poor fellow had cultivated symptoms as other people cultivate roses or chrysanthemums. What a luxury of choice his imagination presented to him!

*Over the Teacups*  
Chapter VIII (p. 187)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

## HOMO SAPIEN

**Margulis, Lynn** 1938–  
American cell biologist and evolutionist

**Sagan, Dorion** 1959–  
American science writer

The question then becomes: If we have been around painting cave walls and designing artifacts for some 30,000 years at least, how long will it be until *Homo*

*sapiens* becomes something else? When will a future descendent species look back on us as their naive predecessors?

*Microcosmos*  
Chapter 12 (p. 226)  
Summit Books. New York, New York, USA. 1986

## HONORS

**Davy, Sir Humphry** 1778–1829  
English chemist

A man should be proud of his honours, not vain of them.  
In Sir William Ramsay  
*Essays Biographical and Chemical*  
The Great London Chemists  
Section II (p. 54)  
Archibald Constable & Company Ltd. London, England. 1908

## HORMONE

**Denckla, W. Donner**  
American endocrinologist

Throughout the history of endocrinology, hormones and vitamins are almost always defined as being good for us, and here I'm getting up and saying that this hormone may actually be part of a self-destruct program.

In Pamela Weintraub (ed.)  
*The Omni Interviews*  
Death Hormone (p. 237)  
Ticknor & Fields. New York, New York, USA. 1984

## HOSPITAL

**Barrett-Browning, Elizabeth** 1806–61  
English poet

I think it frets the saints in heaven to see  
How many desolate creatures on the earth  
Have learnt the simple dues of fellowship  
And social comfort, in a hospital.

*The Complete Poetical Works of Elizabeth Barrett Browning*  
Aurora Leigh, Book III, l. 1120–1123  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Beckett, Samuel** 1906–89  
Irish playwright

What sky! What light! Ah in spite of all it is a blessed thing to be alive in such weather, and out of hospital.

*All That Fall* (p. 9)  
Grove Press. New York, New York, USA. 1957

**Bernard, Claude** 1813–78  
French physiologist

...I consider hospitals only as the entrance to scientific medicine; they are the first field of observation which a physician enters; but the true sanctuary of medical

science is a laboratory; only there can he seek explanations of life in the normal and pathological states by means of experimental analysis.

Translated by Henry Copley Greene

*Experimental Medicine II*

Part II, Chapter II, Section X (p. 140)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bevan, Aneurin** 1897–1960

Welsh-born English politician

I would rather be kept alive in the efficient if cold altruism of a large hospital than expire in a gush of warm sympathy in a small one.

Speech

30 April 1946, House of Commons

**Browne, Sir Thomas** 1605–82

English author and physician

...for the world, I count it not an Inne, but an Hospitall; and a place, not to live, but to die in.

*Religio Medici*

Part II, Section 11 (p. 95)

Elliot Stock. London, England. 1883

**Kerr, Jean** 1922–2003

American author and playwright

One of the most difficult things to contend with in a hospital is the assumption on the part of the staff that because you have lost your gall bladder you have also lost your mind.

*Please Don't Eat the Daisies*

Operation operation (p. 143)

Doubleday & Company, Inc. Garden City, New York, USA. 1957

**Kraus, Jack**

No biographical data available

Hospital: Ail House.

*Quote, the Weekly Digest*, April 2, 1967 (p. 277)

**Mayo, William J.** 1861–1939

American physician

The hospital should be a refuge to which the sick might go for relief as they went before our Savior...

The Teaching Hospital of the University of Michigan

*Journal of the Michigan Medical Society*, Volume 25, January 1926

**Ray, John** 1627–1705

English naturalist

A suit of law and an urinal brings a man to the hospital.

*A Complete Collection of English Proverbs* (p. 14)

Printed for G. Cowie. London, England. 1813

**Southerne, Thomas**

Irish dramatist

...wee'r worn,

Hack'd, hewn with constant service, thrown aside

To rust in peace; or rot in Hospitals.

*The Loyal Brother*

Act 1, Scene I

Printed for William Cademan. London, England. 1682

**Thomson, James** 1700–48

Scottish poet

...!o! A goodly Hospital ascends;

In which they bade each human Aid be nigh,

That could the Sick-Bed smoothe of that unhappy Fry.

It was a worthy edifying Sight,

And gives to Human-Kind peculiar Grace,

To see kind Hands attending Day and Night,

With tender Ministry, from Place to Place.

Some prop the Head; some, from the pallid Face,

Wipe off the faint cold Dewes weak Nature sheds;

Some reach the healing Draught: the whilst, to chase

The Fear supreme, around their soften'd Beds,

Some holy Man by Prayer all opening Heaven dispreeds.

*The Castle of Indolence*

Canto II, Stanza lxxiv–lxxv

William Smith. London, England. 1842

## HUMAN BEINGS

**Delbrück, Max** 1906–81

German-born American biologist

Human beings are organisms capable of manipulating internal representations of the world by means of concrete operations and can transcend the bounds of their biologically given perceptions. They can liberate themselves and construct a view of reality that conflicts with intuition, yet gives a true, more encompassing view.

*Mind from Matter*

Twenty (p. 277)

Blackwell Scientific Publications, Inc., Palo Alto, California, USA. 1986

**Hay, John**

No biographical data available

The cosmic presence whose seas go rocking past is peopled by innumerable beginners in creation. We follow and learn how immensely wide it is, and how far we still have to go. This beach is our original ground, a center of the world. Here is the outward-facing place where human life, even when lost in fear, can declare an eternity, without knowing why.

*The Undiscovered Country*

Coexistence (p. 192)

W.W. Norton & Company, Inc. New York, New York, USA. 1981

**Sagan, Carl** 1934–96

American astronomer and author

A human being is seriously inconvenienced if his body temperature is raised or lowered by a mere 20 degrees. Is this because we happen to live by accident on the one

planet in the Solar System that has a surface at the right temperature for biology? Or is it that our chemistry is delicately attuned to the temperature of the planet on which we have evolved? The latter is almost surely the case. Other temperatures, other biochemistries.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 6 (pp. 45–46)  
Dell Publishing, Inc. New York, New York, USA. 1975

We are like butterflies who flutter for a day and think it is forever.

*Cosmos*  
Chapter II (p. 30)  
Random House, Inc. New York, New York, USA. 1980

## HUMAN BODY

**Henle, Jacob** 1809–85  
German physician

I know of no better food for the imagination than the beautiful formation of the human body, constructed of individual bones and muscles, which I know so well and can assemble accurately.

In R. Kagan (ed.)  
*Leaders of Medicine*  
Chapter I (p. 11)  
The Medico-Historical Press. Boston, Massachusetts, USA. 1941

## HUMAN SPIRIT

**Hawking, Stephen William** 1942–  
English theoretical physicist

To confine our attention to terrestrial matters would be to limit the human spirit.

In Lawrence M. Krauss  
*The Physics of Star Trek*  
Foreword (p. xiii)  
Harp Perennial Publishers. New York, New York, USA. 1995

## HURRICANE

**Blount, Sir Thomas Pope** 1649–97  
English author

Hurricanes by some are call'd HURRACANOS, and by others, ORANCAN. In some of the CARIBBE ISLANDS the Word HURRICA signifies the DEVIL, where the Tempest took its Name, it being commonly call'd in Latine TEMPESTAS DIABOLICA.

*A Natural History*  
Observations Concerning Hurricanes (p. 416)  
Printed for R. Bentley. London, England. 1693

## HYBRID

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

In nature, hybrid species are usually sterile, but in science the reverse is often true. Hybrid subjects are often astonishingly fertile, whereas if a scientific discipline remains too pure it usually wilts.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 14 (p. 150)  
Basic Books, Inc. New York, New York, USA. 1978

## HYDROLOGY

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

It is evident that if anyone tries to compute the volume of water constantly flowing each day and then to visualize a reservoir for it, he will see that to contain the whole yearly flow of water it will have to be as large as the earth in size, or at any rate not much smaller.

In *Great Books of the Western World* (Volume 8)  
*Meteorology*  
Book I, xiii  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## HYPERBOLA

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

What mathematician has ever pondered over an hyperbola, mangling the unfortunate curve with lines of intersection here and there, in his efforts to prove some property that perhaps after all is a mere calumny, who has not fancied at last that the ill-used locus was spreading out its asymptotes as a silent rebuke, or winking one focus at him in contemptuous pity?

*The Complete Works of Lewis Carroll*  
The Dynamics of a Particle (p. 1130)  
The Modern Library. New York, New York, USA. 1936

**Ditton, Humphry** 1675–1715  
English mathematician

We behold indeed, in the motions of the celestial bodies, some effects of [the attraction] that may be call'd more august or pompous. But methinks these little hyperbolas, form'd by a fluid between two glass planes, are not a-whit less fine and curious than the spacious ellipses describ'd by the planets, in the bright expanse of Heaven.

*The New Law of Fluids: or, a Discourse Concerning the Ascent of Liquors, in Exact Geometrical Figures Between Two Nearly Contiguous Surfaces, to Which Is Added the True State of the Case About Matter's Thinking* (p. 41)  
Printed by J. Roberts for B. Cowse. London, England. 1713–14

**Frere, John Hookam** 1769–1846  
British diplomat and man of letters

**Canning, George** 1770–1827  
British statesman and prime minister



Not thus HYPERBOLA; — with subtlest art  
 The blue-eyed wanton plays her changeful part;  
 Quick as her conjugated axes move  
 Through every posture of luxurious love,  
 Her supportive limbs with easiest grace expand....

In Charles Edmonds

*Poetry of the Anti-Jacobin*

The Loves of the Triangle, Canto II, l. 115–119

Printed for J. Wright, by W. Bulmer & Company. London, England. 1801

## HYPERSPACE

### Hans Solo

Fictional character

Traveling through hyperspace ain't like dusting crops, boy.

*Star Wars*

Film (1977)

### Kaku, Michio 1947–

Japanese-American theoretical physicist

Future historians of science may well record that one of the greatest conceptual revolutions in the twentieth-century science was the realization that hyperspace may be the key to unlock the deepest secrets of nature and Creation itself.

*Hyperspace: A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10<sup>th</sup> Dimension*

Chapter 1 (p. 9)

Oxford University Press, Inc. New York, New York, USA. 1995

### Keyser, Cassius Jackson 1862–1947

American mathematician

Creation of hyperspaces is one of the ways by which the rational spirit secures release from limitation. In them it lives ever joyously, sustained by an unfailling sense of infinite freedom.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Mathematical Emancipations: Dimensionality and Hyperspace (p. 110)

Columbia University Press. New York, New York, USA. 1925

## HYPOCHONDRIAC

### Ace, Goodman 1899–1982

American radio writer and performer

If you're a hypochondriac, first class, you awaken each morning with the firm resolve not to worry; everything is going to turn out all wrong.

*The Fine Art of Hypochondria*

Who Am I (p. 13)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

### Askey, Vincent

American physician

When it comes to your health, I recommend frequent doses of that rare commodity among Americans —

common sense. We are rapidly becoming a land of Hypochondriacs, from the ulcer-and-martini executives in the big city to the patent medicine patrons in the sulphur-and-molasses belt.

*The Land of Hypochondriacs*

Address, October 20, 1960, Bakersfield, California

### Colton, Charles Caleb 1780–1832

English sportsman and writer

Those hypochondriacs, who, like Herodius, give up their whole time and thoughts to the care of their health, sacrifice unto life, every noble purpose of living; striving to support a frail and feverish being here, they neglect an hereafter; they continue to patch up and repair their moldering tenement of clay, regardless of the immortal tenant that must survive it; agitated by greater fears than the apostle, and supported by none of his hopes, they “die daily.”

*Lacon; or Many Things in a Few Words*

1.139

William Gowans. New York, New York, USA. 1849

Hypochondriacs squander large sums of time in search of nostrums by which they vainly hope they may get more time to squander.

*Lacon; or Many Things in a Few Words*

2.70

William Gowans. New York, New York, USA. 1849

### Cvikota, Clarence

No biographical data available

Hypochondriac: Pill collector.

*Quote, the Weekly Digest*, April 7, 1968 (p. 277)

### Herold, Don 1889–1966

Cartoonist

Even a hypochondriac can have appendicitis.

*The Happy Hypochondriac* (p. 16)

Dodd, Mead & Company. New York, New York, USA. 1962

### Karch, Carroll S.

No biographical data available

Hypochondriac — Enjoying pill health.

*Quote, the Weekly Digest*, September 15, 1968 (p. 217)

### Ogutsch, Edith ?–1990

Fantasy poet

Hypochondriac: A person of ill repute.

*Quote, the Weekly Digest*, May 7, 1967 (p. 377)

### Thomson, James 1700–48

Scottish poet

And moping here did Hypochondria sit,  
 Mother of Spleen, in Robes of various Dye,  
 Who vexed was full oft with ugly fit,  
 And some her frantic deem'd, and some her deem'd a wit.

A lady proud she was of ancient blood,  
 Yet oft her fear her pride made crouchen low,  
 She felt or fancy'd in her fluttering mood,  
 All the diseases which at the spittles know,  
 And sought all physic which the shops bestow,  
 And still new leaches and new drugs would try,  
 Her humour ever wavering to and fro,  
 For sometimes she would laugh and sometimes cry,  
 Then sudden waxed wroth, and all she knew not why.

*The Castle of Indolence*

Hypochondria, Stanza lxxv–lxxvi

William Smith. London, England. 1842

## HYPODERMIC NEEDLE

### Battles, William Snowden

No biographical data available

For many hold 'twould be so hard  
 Through Heaven's gate to wheedle  
 A doctor as to drive a camel through  
 A hypodermic needle.

In Mary Lou McDonough

*Poet Physician: An Anthology of Medical Poetry Written by Physicians*

The Doctor's Dream (p. 81)

C.C. Thomas. Springfield, Illinois, USA. 1945

### Kernan, F. C.

No biographical data available

Hypodermic needle: Sick shooter.

*Quote, the Weekly Digest*, March 19, 1967 (p. 237)

## HYPOTHESIS

### Amundson, Ronald

No biographical data available

It is commonly held that scientists do not generate hypotheses randomly, but rather with the goal in mind of solving some scientific problem. Now, if a purposively generated hypothesis has a greater chance of scientific success than a randomly generated one (a supposition we must fervently hope is true) then Condition 2 fails fully to be met. There are degrees here, of course. Perhaps “insightful” hypotheses are only slightly more likely than random ones to be successful, and only a tiny bit of the success of science is to be explained by the insights of scientists. Selection would in this case retain much of its force. But if “insightful” hypotheses are much more likely to be successful, selection is much eroded.

In K. Hahlweg and C.A. Hooker (eds.)

*Issues in Evolutionary Epistemology*

The Trials and Tribulations of Selectionist Explanations (p. 427)

State University of New York Press. Albany, New York, USA. 1989

### Asquith, Herbert

1881–1947

English statesman

*Jolie hypothese elle explique tant de chases.*

A pretty hypothesis which explains many things.

Speech

House of Commons, March 29, 1917

### Ayala, Francisco J.

1934–

Spanish American biologist

A hypothesis is empirical or scientific only if it can be tested by experience.... A hypothesis or theory which cannot be, at least in principle, falsified by empirical observations and experiments does not belong to the realm of science.

Biological Evolution: Natural Selection or Random Walk

*American Scientist*, November/December 1974 (p. 700)

### Baez, Joan

1941–

American singer

...hypothetical questions get hypothetical answers.

*Daybreak*

What Would You Do If (p. 134)

The Dial Press, Inc. New York, New York, USA. 1968

### Barfield, Owen

1898–1997

British philosopher, critic, and anthroposophist

...“hypotheses” in the strict sense of the word, that is, [are] assumptions made for the purpose of a particular argument and by the same token not posited as true.

*Saving the Appearances: A Study in Idolatry*

Chapter VII (p. 49)

Faber & Faber. London, England. 1957

### Barry, Frederick

1876–1943

Historian of science

Hypothesis, however, is an inference based on knowledge which is insufficient to prove its high probability.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge*

The Elements of Theory (p. 164)

Columbia University Press. New York, New York, USA. 1927

### Bartlett, Elisha

1804–55

Physician

The restless and inquisitive mind, from its very constitution insatiable, and ever unsatisfied with its actual and absolute possessions, endeavors to imagine the phenomena, which it cannot demonstrate; it struggles to overleap the boundary, whose inexorable circumference cages it in; and, failing to do this, it fills the infinite and unknown regions, beyond and without it, with its own creations.

*An Essay on the Philosophy of Medical Science*

Part I, Chapter 4 (p. 33)

Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1844

### Bernard, Claude

1813–78

French physiologist

An anticipative idea or an hypothesis is, then, the necessary starting point for all experimental reasoning. Without it, we could not make any investigation at all nor learn anything; we could only pile up sterile observations. If we experiment without a preconceived idea, we should move at random...

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section ii (p. 32)

Henry Schuman, Inc. New York, New York, USA. 1927

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

The hypothesis is the principal intellectual instrument in research. Its function is to indicate new experiments and observations and it therefore sometimes leads to discoveries even when not correct itself. We must resist the temptation to become too attached to our hypothesis, and strive to judge it objectively and modify it or discard it as soon as contrary evidence is brought to light. Vigilance is needed to prevent our observations and interpretations being biased in favor of the hypothesis. Suppositions can be used without being believed.

*The Art of Scientific Investigation*

Chapter Four (p. 52)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

...neither the Theory of Gases nor any other physical theory can be quite a congruent account of facts.... Certainly, therefore, Hertz is right when he says: "The rigor of science requires, that we distinguish well the undraped figure of nature itself from the gay-coloured vesture with which we clothe it at our pleasure." But I think the predilection for nudity would be carried too far if we were to forego every hypothesis.

Translated by Stephen G. Brush

*Lectures on Gas Theory*

Translator's Introduction (p. 16)

University of California Press. Berkeley, California, USA. 1964

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

The Requisites of a good Hypothesis are: That it be Intelligible. That it neither Assume nor Suppose anything Impossible, unintelligible, or demonstrably False. That it be consistent with itself. That it be fit and sufficient to Explicate the Phaenomena, especially the chief. That it be, at least, consistent with the rest of the Phaenomena it particularly relates to, and...not contradict any other known Phaenomena of nature....

In Barbara Beigaun Kaplan

*"Divulging of Useful Truths in Physick": The Medical Agenda of Robert Boyle* (p. 50)

Johns Hopkins University Press. Baltimore Maryland, USA. 1993

**Bruner, Jerome Seymour** 1915–

American psychologist

The shrewd guess, the fertile hypothesis, the courageous leap to a tentative conclusion — these are the most valuable coin of the thinker at work.

*The Process of Education*

Introduction (p. 14)

Harvard University Press. Cambridge, Massachusetts, USA. 1961

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

"Would you tell me, please, which way I ought to go from here?"

"That depends a good deal on where you want to get to," said the Cat.

"I don't much care where —" said Alice.

"Then it doesn't matter which way you go," said the Cat.

*The Complete Works of Lewis Carroll*

Alice's Adventures in Wonderland

Chapter VI (pp. 71–72)

The Modern Library. New York, New York, USA. 1936

**Cohen, Morris Raphael** 1880–1947

American philosopher

There is...no genuine progress in scientific insight through the Baconian method of accumulating empirical facts without hypotheses or anticipation of nature. Without some guiding idea we do not know what facts to gather...we cannot determine what is relevant and what is irrelevant.

*A Preface to Logic*

Chapter VII (p. 135)

Henry Holt & Company. New York, New York, USA. 1944

**Cort, David**

No biographical data available

But suspicion is a thing very few people can entertain without letting the hypothesis turn, in their minds, into fact...

*Social Astonishments*

ONE, Believing in Books (p. 27)

The Macmillan Company. New York, New York, USA. 1963

**Dampier-Whetham, William** 1867–1952

English scientific writer

A false hypothesis, if it serve as a guide for further enquiry, may, at the right stage of science, be as useful as, or more useful than, a truer one for which acceptable evidence is not yet at hand.

*Science and the Human Mind*

Science in the Ancient World (p. 39)

Longmans, Green & Company. New York, New York, USA. 1912

**Daniels, Farrington** 1889–1972

Physical chemist

A successful hypothesis is not necessarily a permanent hypothesis, but it is one which stimulates additional research, opens up new fields, or explains and coordinates previously unrelated facts.

*Outlines of Physical Chemistry*

Chapter I (p. 4)

John Wiley & Sons, Inc. New York, New York, USA. 1948

**Darwin, Charles Robert** 1809–82

English naturalist

An unverified hypothesis is of little or not value; but if any one should hereafter be led to make observations by which some such hypothesis could be established, I shall have done good service, as an astonishing number of isolated facts can be thus connected together and rendered intelligible.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 75)

D. Appleton & Company. New York, New York, USA. 1896

I suspect the first expedition I take, clinometer and hammer in hand, will send me back very little wiser and a good deal more puzzled than when I started. As yet I have only indulged in hypotheses, but they are such powerful ones that I suppose, if they were put into action for but one day, the world would come to an end.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter V (p. 164)

D. Appleton & Company. New York, New York, USA. 1896

In scientific investigations, it is permitted to invent any hypothesis and, if it explains various large and independent classes of facts, it rises to the ranks of a well-grounded theory.

*The Variations of Animals and Plants Under Domestication* (Volume 1)

Introduction (p. 9)

D. Appleton & Company. New York, New York, USA. 1896

**Davis, William Morris** 1850–1934

American geomorphologist

The sensible facts are discoverable by our senses, the insensible facts by our thoughts. The invention of hypotheses is therefore nothing more than a mental effort to bring insensible facts into causal relation with sensible facts, and such an effort of correlation is praiseworthy even if it is daring.

In H. Shapley, H. Wright, and S. Rapport (eds.)

*Readings in the Physical Sciences*

The Reasonableness of Science (p. 22)

Appleton-Century-Crofts. New York, New York, USA. 1948

**Davy, Sir Humphry** 1778–1829

English chemist

The only use of an hypothesis is, that it should lead to experiments; that it should be a guide to facts. In this application, conjectures are always of use. The destruction

of an error hardly ever takes place without the discovery of truth.... Hypothesis should be considered merely an intellectual instrument of discovery, which at any time may be relinquished for a better instrument. It should never be spoken of as truth; its highest praise is verisimilitude. Knowledge can only be acquired by the senses; nature has an archetype in the human imagination; her empire is given only to industry and action, guided and governed by experience.

In John Davy (ed.)

*The Collected Works of Sir Humphry Davy* (Volume 8) (pp. 346–347)

Smith, Elder & Company. London, England. 1839–1840

Believing that our philosophical systems are exceedingly imperfect, I never attached much importance to this hypothesis [electro-chemical action]; but having formed it after a copious induction of facts, and having gained immediately by the application of it a number of practical results, and considering myself the author of it as I was of the decomposition of the alkalis, and having developed it in an elementary work, as far as the present state of chemistry seemed to allow. I have never criticised or examined the manner in which different authors have adopted or explained it — contented, if in the hands of others it assisted the arrangement of chemistry or mineralogy, or became an instrument of discovery.

The Bakerian Lecture: On the Relations of Electrical and Chemical Changes

*Philosophical Transactions of the Royal Society of London, B*, Volume 116, 1826 (p. 312)

[Hypotheses were] part of the scaffolding of the building of science [rather] than as belonging either to its foundations, materials, or ornaments.

*Fragmentary Remains*

Chapter VII (pp. 231–232)

John Churchill. London, England. 1858

**de Montaigne, Michel Eyquem** 1533–92

French Renaissance writer

Just as women for themselves make use of teeth of ivory where the natural are wanting, and instead of their true complexion make one of some foreign matter; legs of cloth or felt, and plumpness of cotton, and in the sight and knowledge of everyone paint, patch, and trick up themselves with false and borrowed beauty: so does science (and even our law itself has, they say, legal fictions whereon it builds of its truth its justice); she gives us, in presupposition and for current pay, things which she herself informs us were invented...

Translated by Charles Cotton

In *Great Books of the Western World* (Volume 25)

*The Essays of Michel Eyquem de Montaigne*

Essays II, 12 (pp. 258–259)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Morgan, Augustus** 1806–71

English mathematician and logician

...wrong hypotheses, rightly worked from, have produced more useful results than unguided observation.

*A Budget of Paradoxes*

Francis Bacon (p. 55)

Longmans, Green & Company. London, England. 1872

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

I have devised seven separate explanations, each of which would cover the facts as far as we know them. But which of these is correct can only be determined by the fresh information which we shall no doubt find waiting for us.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of the Copper Beeches (p. 122)

Wings Books. New York, New York, USA. 1967

If the fresh facts which come to our knowledge all fit themselves into the scheme, then our hypothesis may gradually become a solution.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of Wisteria Lodge (p. 245)

Wings Books. New York, New York, USA. 1967

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

The man of science who cannot formulate a hypothesis is only an accountant of phenomena.

*The Road to Reason*

Chapter 3 (p. 77)

Longmans, Green & Company. London, England. 1949

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

In sum, the physicist can never subject an isolated hypothesis to experimental test, but only a whole group of hypotheses; when the experiment is in disagreement with his predictions, what he learns is that at least one of his hypotheses constituting this group is unacceptable and ought to be modified; but the experiment does not designate which one should be changed.

*The Aim and Structure of Physical Theory*

Part II, Chapter VI (p. 187)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Evans, Bergen** 1904–78

Author

We see what we want to see, and observation conforms to hypothesis.

*The Natural History of Nonsense*

Chapter 19 (p. 268)

Alfred A. Knopf. New York, New York, USA. 1947

An honorable man will not be bullied by a hypothesis.

*The Natural History of Nonsense*

Chapter 19 (p. 275)

Alfred A. Knopf. New York, New York, USA. 1947

**Fischer, Martin H.** 1879–1962

German-American physician

Many confuse hypothesis and theory. An hypothesis is a possible explanation; a theory, the correct one.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 7)

C.C. Thomas. Springfield, Illinois, USA. 1944

**Faraday, Michael** 1791–1867

English physicist and chemist

Hypotheses, treated as mere poetic fancies in one age, scouted as scientific absurdities in the next — preparatory only to their being altogether forgotten — have often, when least expected, received confirmation from indirect channels, and, at length, become finally adopted as tenets, deducible from the sober exercise of induction.

*The Subject Matter of a Course of Six Lectures on the Non-Metallic Elements*

Section I (p. 23)

Longman, Brown, Green, Longmans & Robert. London, England. 1853

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

In the complete absence of any theory of the instincts which would help us to find our bearings, we may be permitted, or rather, it is incumbent upon us, in the first place to work out any hypothesis to its logical conclusion, until it either fails or becomes confirmed.

*On Narcissism*

Chapter I

Yale University Press. New Haven, Connecticut, USA. 1991

**Friedman, Milton** 1912–2006

American laissez-faire economist

The construction of hypotheses is a creative act of inspiration, intuition, invention; its essence is the vision of something new in familiar material.

*Essays in Positive Economics*

Part I, Section VI (p. 43)

The University of Chicago Press. Chicago, Illinois, USA. 1953

**Gibbs, J. Willard** 1839–1903

American mathematician

In the present state of science, it seems hardly possible to frame a dynamic theory of molecular action which shall embrace the phenomena of thermodynamics, of radiation, and of the electrical manifestations which accompany the union of atoms. Yet any theory is obviously inadequate which does not take into account...all these phenomena. Even if we confine our attention to the phenomena distinctly thermodynamic, we do not escape difficulties in as simple a matter as the number of degrees of freedom of a diatomic gas. It is well known that while theory would assign to the gas six degrees of freedom per molecule, in our experiments on specific heat we cannot account for

more than five. Certainly, one is building on an insecure foundation, who rests his work on hypotheses concerning the constitution of matter.

*Elementary Principles in Statistical Mechanics: Developed with Especial Reference to the Rational Foundation of Thermodynamics*

Preface (pp. ix–xi)

Charles Scribner's Sons. New York, New York, USA. 1902

**Gilbert, G. K.** 1843–1918

American geologist

The man who produces but one [hypothesis] cherishes and champions that one as his own, and is blind to its faults. With such men, the testing of alternative hypotheses is accomplished only through controversy. Crucial observations are warped by prejudice, and the triumph of truth is delayed.

In William Hoyt

*Coon Mountain Controversies: Meteor Crater and the Development of Impact Theory*

Chapter Two (p. 38)

The University of Arizona Press. Tucson, Arizona, USA. 1987

**Goldenweiser, Alexander** 1880–1940

American anthropologist

Scientific hypotheses are intuitive leaps in the dark.

*Robots or Gods*

Chapter III (p. 46)

Alfred A. Knopf. New York, New York, USA. 1931

**Gregg, Alan** 1890–1957

American medical educator and philosopher

A dream is a firstborn: an hypothesis should be an orphan.

In Wilder Penfield

*The Difficult Art of Giving: The Epic of Alan Gregg*

Chapter 22 (p. 318)

Little, Brown & Company. Boston, Massachusetts, USA. 1967

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The hypothesis which represents an effort of imaginative power not founded upon a wide range of facts may pass as fiction, but it has no place in science.

*Discovery; or, The Spirit and Service of Science*

Chapter VI (p. 161)

Macmillan & Company Ltd. London, England. 1918

**Huxley, Thomas Henry** 1825–95

English biologist

That which we were looking for, and could not find, was a hypothesis representing the origin of known organic forms which assumed the operation of no causes but such as could be proved to be actually at work. We wanted, not to pin our faith to that or any other speculation, but to get hold of clear and definite conceptions which could be brought face to face with facts and have their validity tested.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XIII (p. 182)

D. Appleton & Company. New York, New York, USA. 1901

The great tragedy of Science — the slaying of a beautiful hypothesis by an ugly fact.

*Collected Essays* (Volume 8)

Biogenesis and Abiogenesis (p. 244)

Macmillan & Company Ltd. London, England. 1904

Every hypothesis is bound to explain, or, at any rate, not be inconsistent with, the whole of the facts which it professes to account for; and if there is a single one of these facts which can be shown to be inconsistent with (I do not merely mean inexplicable by, but contrary to) the hypothesis, the hypothesis falls to the ground — it is worth nothing.

*Collected Essays* (Volume 2)

*Darwiniana*

On Our Knowledge of the Causes of the Phenomena of Organic Nature,

Lecture VI (pp. 463)

Macmillan & Company Ltd. London, England. 1904

Any one who has studied the history of science knows that almost every great step therein has been made by the “anticipation of Nature,” that is, by the invention of hypothesis, which, though verifiable, often had very little foundation to start with; and, not unfrequently, in spite of a long career of usefulness, turned out to be wholly erroneous in the long run.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

The Problems of the Deep Sea (p. 62)

Macmillan & Company Ltd. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

A good hypothesis in science must have other than those of the phenomenon it is immediately invoked to explain, otherwise it is not prolific enough.

*The Varieties of Religious Experience*

Lecture XX (p. 508)

The Modern Library. New York, New York, USA. 1967

**Jevons, William Stanley** 1835–82

English economist and logician

I hold that in all cases of inductive inference we must invent hypotheses, until we fall upon some hypothesis which yields deductive results in accordance with experience. Such accordance renders the chosen hypothesis more or less probable, and we may then deduce with some degree of likelihood, the nature of our future experience, on the assumption that no arbitrary change takes place in the conditions of nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book II, Chapter XI (p. 228)

Macmillan & Company Ltd. London, England. 1887

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

I wonder what an astronomy would look like which has been rigorously demonstrated in every respect. It seems as if one can get to the truth only through a series of hypotheses, and that one has to reject each previous one to espouse the next and to abandon it again.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*  
Twentieth Letter (p. 191)

Science History Publications. New York, New York, USA. 1976

A hypothesis will in the end become a truth when all phenomena let themselves be derived from it in a natural and in an obvious manner, when all these consequences are connected with one another and with the general reasons, in short, when that hypothesis is consistent in all its parts with itself.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*  
Eleventh Letter (p. 120)

Science History Publications. New York, New York, USA. 1976

### Levi, Primo 1919–87

Italian writer and chemist

But there is trouble in store for anyone who surrenders to the temptation of mistaking an elegant hypothesis for a certainty: the readers of detective stories know this quite well.

*The Periodic Table*

Chromium (p. 157)

Schocken Books. New York, New York, USA. 1984

### Lorenz, Konrad 1903–89

Austrian zoologist

It is a good morning exercise for a research scientist to discard a pet hypothesis every day before breakfast. It keeps him young.

Translated by Marjorie Kerr Wilson

*On Aggression*

Chapter Two (p. 12)

Harcourt, Brace & World, Inc. New York, New York, USA. 1963

### Mach, Ernst 1838–1916

Austrian physicist and philosopher

The essential function of a hypothesis consists in the guidance it affords to new observations and experiments, by which our conjecture is either confirmed or refuted.

*Knowledge and Error: Sketches on the Psychology of Enquiry*

Chapter XIV (p. 176)

D. Reidel Publishing Company. Dordrecht, Netherlands. 1976

### Machover, Maurice

No biographical data available

My name is A (known as c),  
You have no upper bound for me.

I go as low as A1,

And then soar back restrained by none.

The hierarchies of steps I roam,

And almost every step, my home.

Of course J. König has ordained

That certain first steps can't be gained.

But Cohen and Gödel set me free,

AW I can be.

You cannot catch me in your net,

Discreteness hasn't trapped me yet.

So learn the moral of my tale,

I cannot fit into a scale.

For any scale you think will serve,

Might press me down, but then I'll swerve.

Ode to the Continuum Hypothesis

*Mathematics Magazine*, Volume 50, Number 2, March 1977 (p. 94)

### Maine, Sir Henry 1822–88

English jurist

... a modern satirist has called "Hypothetics" — the science of that which might have happened but did not...

*Popular Government: Four Essays*

Essay I (p. 32)

Liberty Classics. Indianapolis, Indiana, USA. 1976

### Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

The formulation of a hypothesis carries with it an obligation to test it as rigorously as we can command skills to do so.

*Times Literary Supplement*

*Hypothesis and Imagination*, 25 Oct 1963

The formulation of a natural law begins as an imaginative exploit and imagination is a faculty essential to the scientist's task.... In a modern professional vocabulary a hypothesis is an imaginative preconception of what might be true in the form of a declaration with verifiable deductive consequences. It no longer touts "gratuitous," "mere," or "wild" behind it, and the pejorative usage ("Evolution is a mere hypothesis," "It is only a hypothesis that smoking causes lung cancer") is one of the outward signs of little learning.

*Hypothesis and Imagination*

*Times Literary Supplement*, 25 October 1963

### Mendeleyev, Dmitry 1834–1907

Russian chemist

Hypotheses help and guide scientific work — the search for truth — as the tiller's plough helps the cultivation of useful plants.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneierman

Progress Publishers. Moscow, Russia. 1979

### Newton, Sir Isaac 1642–1727

English physicist and mathematician

I frame no hypotheses; for whatever is not deduced from the phenomena is to be called an hypothesis;

and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy.

*Mathematical Principles of Natural Philosophy*

Book III, General Scholium

E.P. Dutton & Company. New York, New York, USA. 1922

In experimental philosophy we are to look upon propositions inferred by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.

*Mathematical Principles of Natural Philosophy*

Book III, Rule IV

E.P. Dutton & Company. New York, New York, USA. 1922

### **Nordmann, Charles** 1881–1940

French astronomer

Hypotheses usually spring up like mushrooms in every dark corner of science. You get a score of them to explain the slightest obscurity.

Nordmann, Charles

*Einstein and the Universe: A Popular Exposition of the Famous Theory*

Chapter II (p. 40)

T. Fisher Unwin Ltd. London, England. 1922

Hypotheses in science are a kind of soft cement which hardens rapidly in the open air, thus enabling us to join together the separate blocks of the structure and to fill up the breaches made in the walls by projectiles with artificial stuff which the superficial observer presently mistakes for stone. It is because hypotheses are something like that in science that the best scientific theories are those which include the least hypotheses.

Translated by Joseph McAbee

*Einstein and the Universe: A Popular Exposition of the Famous Theory*

Chapter II (p. 40)

T. Fisher Unwin Ltd. London, England. 1922

### **Osiander, Andrew** 1498–1552

Lutheran minister

...it is not necessary that these hypotheses should be true, or even probably; but it is enough if they provide a calculus which fits the observations...

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Introduction, to the Reader Concerning the Hypothesis of this Work (p. 505)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Pascal, Blaise** 1623–62

French mathematician and physicist

For sometimes an obvious absurdity follows from its negation, and then the hypothesis is true and certain; or an obvious absurdity follows from its affirmation, and then the hypothesis is considered false; and when we have not yet been able to draw an absurdity either from its

negation or from its affirmation, the hypothesis remains doubtful. So that to establish the truth of an hypothesis it is not enough that all the phenomena should follow from it, whereas if there follows from it something opposed to a single phenomenon, that is enough to make certain its falsity.

In *Great Books of the Western World* (Volume 33)

*Scientific Treatises*

Concerning the Vacuum, Pascal's Answer to the Reverend Noel (p. 368)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The great difference between induction and hypothesis is that the former infers the existence of phenomena such as we have observed in cases which are similar, while hypothesis supposes something of a different kind from what we have directly observed, and frequently something which it would be impossible for us to observe directly.

*Chance, Love and Logic: Philosophical Essays*

Deduction, Induction, Hypothesis (p. 149)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

If hypotheses are to be tried haphazard, or simply because they will suit certain phenomena, it will occupy the mathematical physicists of the world say half a century on the average to bring each theory to the test, and since the number of possible theories may go up into the trillion, only one of which can be true, we have little prospect of making further solid additions to the subject in our time.

The Architecture of Theories

*The Monist*, Volume I, Number 2, January 1891 (p. 164)

### **Pirsig, Robert M.** 1928–

American writer

For every fact there is an infinity of hypotheses.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*

Part III, Chapter 16 (p. 191)

William Morrow & Company, Inc. New York, New York, USA. 1974

### **Planck, Max** 1858–1947

German physicist

An indispensable hypothesis, even though still far from being a guarantee of success, is however the pursuit of a specific aim, whose lighted beacon, even by initial failures, is not betrayed.

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1918 (p. 407)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

The measure of the value of a new hypothesis in physics is not its obviousness but its utility.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Place of Modern Physics in the Mechanical View of Nature (p. 39)

Methuen & Company Ltd. London, England. 1925



...every hypothesis in physical science has to go through a period of difficult gestation and parturition before it can be brought out into the light of day and handed to others, ready-made in scientific form so that it will be, as it were, fool-proof in the hands of outsiders who wish to apply it.

*Where Is Science Going?*

Chapter VI (p. 178)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Plato** 428 BCE–347 BCE

Greek philosopher

I think that you should...consider not only the consequences which flow from a given hypothesis; but also the consequences which flow from denying the hypothesis.

In *Great Books of the Western World* (Volume 7)

*Parmenides*

Section 135 (p. 491)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The firm determination to submit to experiment is not enough; there are still dangerous hypotheses; first, and above all, those which are tacit and unconscious. Since we make them without knowing it, we are powerless to abandon them.

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 134)

The Science Press. New York, New York, USA. 1913

For a Latin, truth can be expressed only by equations; it must obey laws simple, logical, symmetric and fitted to satisfy minds in love with mathematical elegance. The Anglo-Saxon to depict a phenomenon will first be engrossed in making a model, and he will make it with common materials, such as our crude, unaided senses show us them.... He concludes from the body to the atom. Both therefore make hypotheses, and this indeed is necessary, since no scientist has ever been able to get on without them. The essential thing is never to make them unconsciously.

*The Foundations of Science*

Author's Preface to Translation (p. 6)

The Science Press. New York, New York, USA. 1913

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The best we can say of a hypothesis is that up to now it has been able to show its worth, and that it has been more successful than other hypotheses although, in principle, it can never be justified, verified or even shown to be probable. The appraisal of the hypothesis relies solely upon deductive consequences (predictions) which may be drawn from the hypothesis: There is no need even to mention "induction."

*The Logic of Scientific Discovery*

New Appendices, Two Notes on Induction and Demarcation 1933–1934 (p. 315)

Basic Books, Inc. New York, New York, USA. 1959

**Poynting, John Henry** 1852–1914

English physicist

The hypotheses of science are continually changing. Old hypotheses break down and new ones take their place. But the classification of known phenomena which a hypothesis has suggested, and the new discoveries of phenomena to which it has led, remain as positive and permanent additions to natural knowledge when the hypothesis itself has vanished from thought.

In J.A. Thomson

*Introduction to Science*

Chapter I (p. 27)

Williams & Norgate Ltd. London, England. 1916

**Priestley, Joseph** 1733–1804

English theologian and scientist

Hypotheses, while they are considered merely as such, lead persons to try a variety of experiments, in order to ascertain them. In these experiments, new facts generally arise. These new facts serve to correct the hypothesis which gave occasion to them. The theory, thus corrected, serves to discover more new facts, which, as before, bring the theory still nearer to the truth. In this progressive state, or method of approximation, things continue...

*The History and Present State of Electricity*

Part III, Section I (p. 445)

Printed for J. Dodsley. London, England. 1767

**Richet, Charles** 1850–1935

French physiologist

Be as bold in the conception of hypotheses as rigorous in their demonstration.

*The Natural History of a Savant*

Chapter X (p. 123)

J.M. Dent & Sons Limited. London, England. 1927

**Sagan, Carl** 1934–96

American astronomer and author

There are many hypotheses in physics of almost comparable brilliance and elegance that have been rejected because they did not survive such a confrontation with experiment. In my view, the human condition would be greatly improved if such confrontations and willingness to reject hypotheses were a regular part of our social, political, economic, religious and cultural lives.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 7 (p. 184)

Random House, Inc. New York, New York, USA. 1977

Spin more than one hypothesis. If there's something to be explained, think of all the different ways in which it

could be explained. Then think of tests by which you might systematically disprove each of the alternatives. What survives, the hypothesis that resists disproof in this Darwinian selection among “multiple working hypotheses,” has a much better chance of being the right answer than if you had simply run with the first idea that caught your fancy.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 12 (p. 210)  
Random House, Inc. New York, New York, USA. 1995

It seems to me what is called for is an exquisite balance between two conflicting needs: the most skeptical scrutiny of all hypotheses that are served up to us and at the same time a great openness to new ideas. If you are only skeptical, then no new ideas make it through to you. You never learn anything new. You become a crotchety old person convinced that nonsense is ruling the world. (There is, of course, much data to support you.) On the other hand, if you are open to the point of gullibility and have not an ounce of skeptical sense in you, then you cannot distinguish useful ideas from worthless ones. If all ideas have equal validity then you are lost, because then, it seems to me, no ideas have any validity at all.

*The Burden of Skepticism*  
Pasadena lecture, 1987

If you spend any time spinning hypotheses, checking to see whether they make sense, whether they conform to what else we know, thinking of tests you can pose to substantiate or deflate your hypotheses, you will find yourself doing science. And as you come to practice this habit of thought more and more you will get better and better at it. To penetrate into the heart of the thing — even a little thing, a blade of grass, as Walt Whitman said — is to experience a kind of exhilaration that, it may be, only human beings of all the beings on this planet can feel. We are an intelligent species and the use of our intelligence quite properly gives us pleasure. In this respect the brain is like a muscle. When we think well, we feel good.

*Broca's Brain: Reflections on the Romance of Science*  
Part I, Chapter 2 (p. 14)  
Random House, Inc. New York, New York, USA. 1979

### Smith, Robertson

No biographical data available

The very object of hypothesis is to inquire whether a real cause has not had a wider operation that there is any direct evidence for.

In R.A. Fisher  
*The Genetical Theory of Natural Selection*  
Chapter III (p. 52)  
Dover Publications, Inc. New York, New York, USA. 1958

### Steinbeck, John 1902–68

American novelist

There is one great difficulty with a good hypothesis. When it is completed and rounded, the corners smooth and the content cohesive and coherent, it is likely to become a thing in itself, a work of art. It is then like a finished sonnet or a painting completed. One hates to disturb it. Even if subsequent information should shoot a hole in it, one hates to tear it down because it once was beautiful and whole.

*Sea of Cortez*  
Chapter 17 (p. 180)  
Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

When a hypothesis is deeply accepted it becomes a growth which only a kind of surgery can amputate.

*Sea of Cortez*  
Chapter 17 (p. 180)  
Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

### Sterne, Laurence 1713–68

English novelist and humorist

It is the nature of an hypothesis when once a man has conceived it, that it assimilates every thing to itself, as proper nourishment, and from the first moment of your begetting it, it generally grows the stronger by every thing you see, hear, read or understand.

*The Life and Opinions of Tristram Shandy, Gentleman and a Sentimental Journey Through France and Italy* (Volume 1)  
Book II, Chapter XIX (p. 135)  
Macmillan & Company Ltd. London, England. 1900

### Synge, John L. 1897–1995

Irish mathematician and physicist

Life is complicated enough...without inventing hypothetical complications.

*Kandelman's Krim*  
Chapter Five (p. 89)  
Jonathan Cape. London, England. 1957

### Timiryazev, K. A.

No biographical data available

Should hypothesis, that is the guiding thought, be totally renounced, science will become an agglomeration of naked facts.

Compiled by V.V. Vorontsov  
*Words of The Wise: A Book of Russian Quotations*  
Translated by Vic Schneiererson  
Progress Publishers. Moscow, Russia. 1979

### Verworn, M.

No biographical data available

...without hypothesis there can be no progress in knowledge.

*Irritability*  
Chapter IX (p. 259)  
Yale University Press. New Haven, Connecticut, USA. 1913

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

No hypothesis can lay claim to any value unless it assembles many phenomena under one concept.

*Wisdom and Experience*

Science and Philosophy (p. 115)

Routledge & Kegan Paul Ltd. London, England. 1949

Hypotheses are the scaffolds which are erected in front of a building and removed when the building is completed.

They are indispensable to the worker; but he must not mistake the scaffolding for the building.

*The Maxims and Reflections of Goethe*

Macmillan & Company Limited. London, England. 1908

Hypotheses are lullabies with which the teacher lulls his pupils to sleep. The thinking and faithful observer learns to know his limitation more and more; he sees that the further knowledge extends the more problems arise.

*Goethe's Poems and Aphorisms* (p. 197)

Oxford University Press, Inc. New York, New York, USA. 1932

### **Weismann, August** 1834–1914

German biologist

...when we are confronted with facts which we see no possibility of understanding save on a single hypothesis, even though it be an undemonstratable one, we are naturally led to accept the hypothesis, at least until a better one can be found.

*The Evolution Theory* (Volume 1)

Lecture XII (p. 242)

Edward Arnold Publishers Ltd. London, England, 1904

### **Whewell, William** 1794–1866

English philosopher and historian

To discover a Conception of the mind which will justly represent a train of observed facts is, in some measure, a process of conjecture...and the business of conjecture is commonly conducted by calling up before our minds several suppositions, selecting that one which most agrees with what we know of the observed facts. Hence he who has to discover the laws of nature may have to invent many suppositions before he hits upon the right one; and among the endowments which lead to his success, we must reckon that fertility of invention which ministers

to him such imaginary schemes, till at last he finds the one which conforms to the true order of nature. A faculty in devising hypotheses, therefore, is so far from being a fault in the intellectual character of a discoverer, that it is, in truth, a faculty indispensable to his task....

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Part II, Book XI, Chapter V, Section II, Article 6 (p. 54)

John W. Parker. London, England. 1847

The hypotheses which we accept ought to explain phenomena which we have observed. But they ought to do more than this: our hypotheses ought to foretell phenomena which have not yet been observed.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Part II, Book XI, Chapter V, Section III, article 10 (p. 62)

John W. Parker. London, England. 1847

Hypotheses may be useful, though involving much that is superfluous, and even erroneous: for they may supply the true bond of connection of the facts; and the superfluity and error may afterwards be pared away.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 2)

Aphorisms, Aphorisms Concerning Science, XI (p. 468)

John W. Parker. London, England. 1847

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

If science is not to degenerate into a medley of ad hoc hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations.

*Science and the Modern World*

Chapter I (p. 17)

The Macmillan Company. New York, New York, USA. 1929

### **Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

It is an hypothesis that the sun will rise tomorrow: and this means that we do not know whether it will rise.

Translated by D.F. Pears & B.F. McGuinness

*Tractatus Logico-Philosophicus*

6.36311 (p. 143)

Routledge & Kegan Paul. London, England. 1961

# I

## ICE

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

And now there came both mist and snow,  
And it grew wondrous cold:  
And ice, mast high, came floating by,  
As green as emerald.  
And through the drifts the snowy clifts,  
Did send a dismal sheen:  
No shapes of men nor beast we ken —  
The ice was all between.  
The ice was here, the ice was there,  
The ice was all around:  
It crack'd and growl'd, and roar'd and howl'd,  
Like noises in a swound.

*The Rime of the Ancient Mariner and Other Poems*  
Rime of the Ancient Mariner, Part I, l. 51–60  
Little Leather Library Corporation. New York, New York, USA. 1915

**Faraday, Michael** 1791–1867  
English physicist and chemist

The world of ice and of eternal snow, as unfolded to us on the summits of the neighboring Alpine chain, so stern, so solitary, so dangerous, it may be, has yet its own peculiar charm. Not only does it enchain the attention of the natural philosopher, who finds in it the most wonderful disclosures as to the present and past history of the globe, but every summer it entices thousands of travelers of all conditions, who find there mental and bodily recreation.

In Hermann von Helmholtz  
Translated by Edmund Atkinson  
*Popular Lectures on Scientific Subjects*  
Ice and Glaciers (p. 107)  
D. Appleton & Company. New York, New York, USA. 1873

**Nansen, Fridtjof** 1861–1930  
Norwegian explorer, oceanographer, and statesman

Unseen and untrodden under this spotless mantle of ice the rigid polar regions slept profound sleep of death from the earliest dawn of time.

*Farthest North*  
Chapter I (p. 1)  
Harper & Brothers. New York, New York, USA. 1899

**Oz**  
Fictional character

Ice is cool. It's water, but it's not.  
*Buffy, the Vampire Slayer*  
Helpless  
TV series  
Episode 46 (1999)

## ICE STORMS

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

It occurs to me now that I have never seen the ice-storm put upon canvas, and have not heard that any painter has tried to do it. I wonder why that is. Is it that paint cannot counterfeit the intense blaze of a sun-flooded jewel?

*Following the Equator* (Volume 2)  
Chapter XXIII (p. 279)  
Harper & Brothers. New York, New York, USA. 1899

...in America the ice-storm is an event. And it is not an event which one is careless about. When it comes, the news flies from room to room in the house, there are bangings on the doors, and shoutings, "The ice-storm! the ice-storm!" and even the laziest sleepers throw off the covers and join the rush for the windows.

*Following the Equator* (Volume 2)  
Chapter XXIII (p. 277)  
Harper & Brothers. New York, New York, USA. 1899

...the Taj has had no rival among the temples and palaces of men, none that even remotely approached it — it was man's architectural ice-storm.

*Following the Equator* (Volume 2)  
Chapter XXIII (p. 277)  
Harper & Brothers. New York, New York, USA. 1899

## ICEBERG

**Dana, Richard Henry** 1815–82  
American lawyer and author

No pencil has ever yet given anything like the true effect of an iceberg. In a picture, they are huge, uncouth masses, stuck in the sea, while their chief beauty and grandeur — their slow, stately motion; the whirling of the snow about their summits, and the fearful groaning and cracking of their parts — the picture cannot give. This is the large iceberg; while the small and distant islands, floating on the smooth sea, in the light of a clear day, look like little floating fairy isles of sapphire.

*Two Years Before the Mast*  
Chapter 32 (p. 303)  
Doubleday & Company, Inc. Garden City, New York, USA. 1949

**Esar, Evan** 1899–1995  
American humorist  
[Iceberg] A permanent wave.  
*Esar's Comic Dictionary*  
Iceberg  
Doubleday & Company, Inc. Garden City, New York, USA. 1983

**Muir, John** 1838–1914  
American naturalist

When sunshine is sifting through the midst of the multitude of icebergs that fill the fiord and through the jets of radiant spray ever rising from the tremendous splashing of the falling and upspringing bergs, the effect is indescribably glorious. Glorious, too, are the shows they make in the night when the moon and stars are shining. The berg-thunder seems far louder than by day, and the projecting buttresses seem higher as they stand forward in the pale light, relieved by gloomy hollows, while the new-born bergs are dimly seen, crowned with faint lunar rainbows in the up-dashing spray.

*Travels in Alaska*

Chapter XVI (p. 269)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

On days like this, true sun-days, some of the bergs show a purplish tinge, though most are white from the disintegrating of their weathered surfaces. Now and then a new-born one is met that is pure blue crystal throughout, freshly broken from the fountain or recently exposed to the air by turning over.

*Travels in Alaska*

Chapter XIV (p. 232)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

### Jones, William

No biographical data available

Among the most imposing and grand of the many wonders of the ocean world, are the fixed and floating icebergs, the “palaces of nature,” which assume extraordinary and fantastic shapes, and more than realize the most sublime conceptions of the imagination.

*The Broad, Broad Ocean and Some of its Inhabitants*

Chapter III (p. 31)

Frederick Warne & Company. London, England. 1871

## ICHOLOGY

### Frey, Robert W.

No biographical data available

In a sense, the field of ichnology is both old and new. Its guiding principles were known to a few workers many years ago, and these principles are now being rediscovered by scores of current workers. As is true in the development of any science, ichnologists have indeed gotten some occasional pebbles mixed in with their snowball; but they have also exposed many misconceptions and have made numerous positive gains. Ichnology today is rapidly approaching that plateau at which the subdiscipline will settle comfortably into the ever-growing accumulation of “standard” but highly useful methods or procedures in geology. Ichnology is not a new “magic wand,” to render sister subdisciplens obsolete, but neither can it be glibly ignored by anyone seriously interested in ancient life or environmental reconstructions.

*The Study of Trace Fossils*

Prologue (p. ix)

Springer-Verlag. New York, New York, USA. 1975

## ICHTHYOLOGIST

### Cuppy, Will 1884–1929

American humorist and critic

...it is the chief function of the ichthyologists, or fish people, to keep pointing out, day after day, the perfect fitness of fish for existence in a liquid medium. And they're right, at that. But I sometimes think that if fish were not well adapted for an aquatic life — if they were square, say — then it would be time to talk.

*How to Become Extinct*

Fish and Democracy (p. 2)

Dover Publications. New York, New York, USA. 1964

### Fishback, Margaret 1904–85

No biographical data available

An ichthyologist is he,

Well versed in anthropology

To boot, so maybe he will know

Why God or nature bothered so

To give us beards and shiny noses

While fish still live on beds of roses.

*I Take It Back*

Fish Course

E.P. Dutton & Company. New York, New York, USA. 1935

## IDEA

### Abbey, Edward 1927–89

American environmentalist and nature writer

I'd sooner exchange ideas with the birds on earth than learn to carry on intergalactic communications with some obscure race of humanoids on a satellite planet from the world of Betelgeuse.

*Desert Solitaire*

The First Morning (p. 7)

Ballantine Books. New York, New York, USA. 1968

### Acton, John Emerich 1834–1902

English historian and political scientist

Ideas have a radiation and development, an ancestry and posterity of their own, in which men play the part of godfathers and godmothers more than that of legitimate parents.

In Gertrude Himmelfard

*Darwin and the Darwinian Revolution*

Chapter XVIII (p. 380)

Doubleday & Co, Inc. Garden City, New York, USA. 1962

### Agnew, Ralph Palmer

American mathematician

It is better to have ideas that are not quite right than to have no ideas at all.

*Differential Equations*

Chapter 1, Problem 1.491) (p. 16)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

The same ideas, one must believe, recur in men's mind not once or twice but again and again.

In *Great Books of the Western World* (Volume 8)

*On the Heavens*

Book I, Chapter 3, 270b [20]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bagehot, Walter** 1826–77  
English journalist

One of the greatest pains to human nature is the pain of a new idea.

*Physics and Politics*

Chapter 5 (p. 145)

Ivan R. Dee, Publisher. Chicago, Illinois, USA. 1999

**Belinsky, Vissarion Grigorievich** 1811–48  
Russian writer and literary critic

In science you must look for ideas. No ideas, no science. Knowledge of the facts is precious, because facts are laden with ideas. Facts without ideas are tripe for the brain and for the memory.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Bernard, Claude** 1813–78  
French physiologist

The experimental method, then, cannot give new and fruitful ideas to men who have none; it can serve only to guide the ideas of men who have them, to direct their ideas and to develop them so as to get the best possible results. The idea is a seed; the method is the earth furnishing the conditions in which it may develop, flourish, and give the best fruit according to its nature. But as only what has been sown in the ground will ever grow in it, so nothing will be developed by the experimental method except the ideas submitted to it.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section ii (p. 34)

Henry Schuman, Inc. New York, New York, USA. 1927

Our ideas are only intellectual instruments which we use to break into phenomena; we must change them when they have served their purpose, as we change a blunt lancet that we have used long enough.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section iv (p. 41)

Henry Schuman, Inc. New York, New York, USA. 1927

If an idea presents itself to us, we must not reject it simply because it does not agree with the logical deductions of a reigning theory.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section iii (p. 36)

Henry Schuman, Inc. New York, New York, USA. 1927

It is impossible to devise an experiment without a preconceived idea; devising an experiment, we said, is putting a question; we never conceive a question without an idea which invites an answer. I consider it, therefore, an absolute principle that experiments must always be devised in view of a preconceived idea, no matter if the idea be not very clear nor very well defined. As for noting the results of the experiment, which is itself only an induced observation, I posit it similarly as a principle that we must here, as always, observe without a preconceived idea.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section vi (p. 23)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bly, Robert** 1926–  
American poet

A great idea is a useful invention, like an eyeglass or a new fuel.

*The Winged Life. The Poetic Voice of Henry David Thoreau*

Part Two (p. 25)

Sierra Club Books. San Francisco, California, USA. 1986

**Bragg, Sir William Lawrence** 1890–1971  
Australian-born English physicist

It is not easy to be sure whether the crucial idea is really one's own or has been unconsciously assimilated in talks with others.

In J. Watson

*The Double Helix: A Personal Account of the Discovery of the Structure of DNA*

Forward by Sir Lawrence Bragg (p. viii)

Athenaeum. New York, New York, USA. 1985

**Buchanan, Scott** 1895–1968  
American educator and philosopher

The clarification of any idea, however simple or complex it may be, begins with its location on that translucent phosphorescent surface of man's thought that Plato called opinion or belief.

*Poetry and Mathematics*

Chapter I

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Every idea has something of the pain and peril of child-birth about it; ideas are just as mortal and just as immortal as organized beings are.

*The Note-books of Samuel Butler* (p. 108)  
A. C. Fifield. London, England. 1913

**Camus, Albert** 1913–60

Algerian-French novelist, essayist, and playwright

...we know, and what we really know, practical assent and simulated ignorance...allows us to live with ideas which, if we truly put them to the test, ought to upset our whole life.

Translated by Justin O'Brien  
*The Myth of Sisyphus and Other Essays*  
An Absurd Reasoning (p. 18)  
Alfred A. Knopf. New York, New York, USA. 1961

**Cloud, Preston Eccelle** 1912–91

American biogeologist, paleontologist, and humanist

Acceptance of new ideas is usually contingent on three preconditions: (1) the world must be ready for them; (2) they must be convincingly advocated by a persuasive person or group; and (3) they must be perceived as clearly superior to (or, at least, not in serious conflict with) other widely held beliefs.

*Oasis in Space: Earth History from the Beginning*  
Chapter Three (p. 49)  
W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Cohen, I. Bernard** 1914–2003

American physicist and science historian

Scientific ideas change so rapidly that we would have to add the qualification: important to whom — to us? To our children? Or to our fathers?

*Franklin and Newton*  
Chapter One (p. 13)  
Harvard University Press. Cambridge, Massachusetts, USA. 1966

**Collins, Wilkie** 1824–89

English novelist

Habits of literary composition are perfectly familiar to me. One of the rarest of all the intellectual accomplishments that a man can possess, is the grand faculty of arranging his ideas. Immense privilege! I possess it. Do you?

*The Woman in White*  
The Story Concluded by Walter Hartright  
Chapter VII (p. 538)  
Everyman's Library. London, England. No date

**Darwin, Charles Robert** 1809–82

English naturalist

...the force of impressions generally depends on pre-conceived ideas...

*The Voyage of The Beagle*  
Chapter XXI (p. 503)  
Heron Books. 1968

**de Bono, Edward** 1933–

Maltese psychologist and writer

Pouncing on an idea as soon as it appears kills the idea. Too early and too enthusiastic logical attention either freezes the idea or forces it into the old moulds. Concentration on an idea isolates it from its surroundings and arrests its growth. The glare of attention inhibits the fertile semi-conscious processes that go to develop an idea.

*New Think: The Use of Lateral Thinking in the Generation of New Ideas*  
(p. 138)  
Avon Books. New York, New York, USA. 1971

An idea is far more fertile if seduced rather than raped.

*New Think: The Use of Lateral Thinking in the Generation of New Ideas*  
(p. 139)  
Avon Books. New York, New York, USA. 1971

**Dennett, Daniel Clement** 1942–

American philosopher

If I were to give an award for the single best idea anyone has ever had, I'd give it to Darwin, ahead of Newton and Einstein and everyone else. In a single stroke, the idea of evolution by natural selection unifies the realm of life, meaning, and purpose with the realm of space and time, cause and effect, mechanism and physical laws.

*Darwin's Dangerous Idea*  
Chapter One, Section 1 (p. 21)  
Simon & Schuster. New York, New York, USA. 1995

**Dewey, John** 1859–1952

American philosopher and educator

Old ideas give way slowly, for they are more than abstract forms and categories. They are habits, predispositions, deeply engrained attitudes of aversion and preference. Moreover, the conviction persists — though history shows it to be a hallucination — that all the questions that the human mind has asked are questions that can be answered in terms of the alternatives that the questions themselves present. But in fact intellectual progress usually occurs through sheer abandonment of questions together with both of the alternatives they assume — an abandonment that results from their decreasing vitality and a change of urgent interest. We do not solve them: we get over them. Old questions are solved by disappearing, evaporating, while new questions corresponding to the changed attitudes of endeavor and preference take their place. Doubtless the greatest dissolvent in contemporary thought of old questions, the greatest precipitant of new methods, new intention, new problems, is the one effected by the scientific revolution that found its climax in the "Origin of Species."

*The Influence of Darwin on Philosophy, and Other Essays in Contemporary Thought*  
The Influence of Darwinism on Philosophy, Section IV (p. 19)  
Henry Holt & Company. New York, New York, USA. 1910

**Dirac, Paul Adrian Maurice** 1902–84  
English theoretical physicist

It seems that some essentially new physical ideas are here needed.

*The Principles of Quantum Mechanics* (2<sup>nd</sup> edition)  
Chapter XIII, Section 81 (p. 297)  
At The Clarendon Press. Oxford, England. 1935

...it is a general rule that the originator of a new idea is not the most suitable person to develop it because his fears of something going wrong are really too strong and prevent his looking at the method from a purely detached point of view in the way that he ought to.

*The Development of Quantum Theory* (p. 24)  
Gordon & Breach Science. New York, New York, USA. 1971

**Dobzhansky, Theodosius** 1900–75  
Russian-American scientist

Great ideas often seem simple and self-evident, but only after somebody has explained them to us. Then, how interesting they become! The act of insight is among the most exciting and pleasurable experiences a scientist can have, when he recognizes what all the time was there to be seen, and yet he did not see it.

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas 1974*  
Advancement and Obsolescence in Science (p. 56)

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

One's ideas must be as broad as Nature if they are to interpret Nature.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
A Study in Scarlet, Chapter 5 (p. 179)  
Wings Books. New York, New York, USA. 1967

**Drexler, K. Eric** 1955–  
American nanotechnology engineer and researcher, and futurist

Because of our superficial self-awareness, we often wonder where an idea in our heads came from. Some people imagine that these thoughts and feelings come directly from agencies outside their own minds; they incline towards a belief in haunted heads.

*Engines of Creation*  
Chapter 5 (p. 67)  
Anchor Press/Doubleday. Garden City, New York, USA. 1986

**Duckworth, Eleanor** 1935–  
Psychologist

Wonderful ideas cannot spring out of nothing. They build on a foundation of other ideas.

The Having of Wonderful Ideas  
*Harvard Educational Review*, May, 1972 (pp. 222–223)

Wonderful ideas build on other wonderful ideas. They are not had without content...

The Having of Wonderful Ideas  
*Harvard Educational Review*, May, 1972 (p. 224)

The having of wonderful ideas is what I consider to be the essence of intellectual development.

The Having of Wonderful Ideas  
*Harvard Educational Review*, May, 1972 (p. 218)

**Easton, William**  
No biographical data available

A creative thinker evolves no new ideas. He actually evolves new combinations of ideas that are already in his mind.

In Alex F. Osborn  
*Applied Imagination: Principles and Procedures of Creative Problem-Solving*  
Chapter XIV (pp. 168–169)  
Charles Scribner's Sons. New York, New York, USA. 1957

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968  
Polish physicist

Most of the fundamental ideas of science are essentially simple, and may, as a rule, be expressed in a language comprehensible to everyone.

In Albert Einstein and Leopold Infeld  
*The Evolution of Physics*  
The Riddle of Motion (p. 27)  
Simon & Schuster. New York, New York, USA. 1938

**Eisenschiml, Otto** 1880–1963  
Austrian-American chemist and historian

Fine ideas, unless put into words, are like water in a jug which has no outlet.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Nine (p. 112)  
Duell, Sloan & Pearce. New York, New York, USA. 1947

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

The moment of finding a fellow-creature is often as full of mingled doubt and exultation as the moment of finding an idea.

*Daniel Deronda*  
Book II, Chapter XVII  
Harper & Brothers. New York, New York, USA. 1876

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

Between the idea  
And the reality  
Between the notion  
And the act  
Falls the shadow.

*The Collected Poems and Plays 1909–1950*



The Hollow Men, Part V, stanza 3 (p. 59)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

God screens us evermore from premature ideas.  
*Ralph Waldo Emerson: Essays and Lectures*  
Essays: First Series  
Spiritual Laws (p. 313)  
The Library of America. New York, New York, USA. 1983

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

There is no idea, however ancient and absurd, that is not capable of improving our knowledge.  
*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Chapter 4 (p. 47)  
Verso. London, England. 1978

**Feynman, Richard P.** 1918–88  
American theoretical physicist

There is no authority who decides what is a good idea. We have lost the need to go to an authority to find out whether an idea is true or not. We can read an authority and let him suggest something; we can try it out and find out if it is true or not. If it is not true, so much the worse — so the “authorities” lose some of their functions.  
*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter 1 (p. 21)  
Perseus Books. Reading, Massachusetts, USA. 1998

...there are great ideas developed in the history of man, and these ideas do not last unless they are passed purposely and clearly from generation to generation.  
*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter 1 (p. 4)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

It is easy to dismiss a crazy theory with laughter that debars any attempt to understand a man’s motivation — and the nummulosphere is a crazy theory. I find that few men of imagination are not worth my attention. Their ideas may be wrong, even foolish, but their methods often repay a close study. Few honest passions are not based upon some valid perception of unity or some anomaly worthy of note. The different drummer often beats a fruitful tempo.  
*The Panda’s Thumb: More Reflections in Natural History*  
Chapter 22 (pp. 234–235)  
W.W. Norton & Company, Inc. New York, New York, USA. 1980

**Hadamard, Jacques** 1865–1963  
French mathematician

The ideas chosen by my unconscious are those which reach my consciousness, and I see that they are those which agree with my aesthetic sense.  
*The Psychology of Invention in the Mathematical Field* (p. 39)  
Princeton University Press. Princeton, New Jersey, USA. 1945

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

Ideas, once born, seemingly have a life of their own. Like germs they breed, spread, mutate, and catch their invaded victims by surprise. When and where an idea originated is often unknown, and many a person believes the idea, as recounted by him, springs unprompted from the recesses of his own mind. A thought drifts as light as thistledown, and sensitive minds responding to its novel vibrations “independently” discover the new idea.  
*Masks of the Universe*  
Chapter 6 (p. 87)  
Macmillan Publishing Company. New York, New York, USA. 1985

**Hayes, Brian**  
American scientist, columnist, and author

The nature of the mathematical enterprise may raise the stakes even higher than they are elsewhere in the world of science and scholarship. In other fields, an idea that proves fruitful for a time but eventually has to be discarded is counted a partial success. In mathematics, a proof that turns out to have a serious flaw is nothing but an embarrassment.  
Aftermath  
*The Emissary*, Fall 1999 (p. 13)

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

...we see from these formulations how difficult it is when we try to push new ideas into an old system of concepts belonging to an earlier philosophy, or, to use an old metaphor, when we attempt to put new wine into old bottles. Such attempts are always distressing, for they mislead us into continually occupying with the inevitable cracks in the old bottles, instead of rejoicing over the new wine.  
In Wolfgang Pauli (ed.)  
*Niels Bohr and the Development of Physics*  
The Development of the Interpretation of the Quantum Theory (p. 23)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1955

**Henderson, John R.**  
No biographical data available

Almost anybody can have an idea. Ideas are the small change of science: it is conviction — zany, indestructible belief — that is the real pot of gold.  
Who Discovered Insulin?  
*Guy’s Hospital Gazette*, Volume 85, 1971

**Hoefler, Don C.**  
No biographical data available

Develop a honeybee mind, gathering ideas everywhere and associating them fully.

But You Don't Understand the Problem  
*Electronic News*, July 17, 1967

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

Man's claim to have progressed far beyond his fellow animals must be supported, not by his search for food, warmth, and shelter (however ingeniously conducted) but by his penetration into the very fabric of the Universe. It is in the world of ideas and in the relation of his brain to the Universe itself, that the superiority of Man lies. The rise of Man may justly be described as an adventure in ideas.

*Frontiers of Astronomy*

Chapter One (p. 1)

Harper & Row, Publishers. New York, New York, USA. 1955

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Man is not a circle with a single centre; he is an ellipse with two foci. Facts are one, ideas are the other.

*Les Miserables*

Volume 4, Book VII, Chapter 1 (p. 167)

The Heritage Press. New York, New York, USA. 1938

An idea is a meteor; at the moment of success, the accumulated meditations which have preceded it open a little, and a spark flashes forth from it....

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part I, Book Sixth, Chapter VI (p. 255)

The Heritage Press. New York, New York, USA. 1961

**Huxley, Thomas Henry** 1825–95

English biologist

Men can intoxicate themselves with ideas as effectually as with alcohol or with bang, and produce, by dint of intense thinking, mental conditions hardly distinguishable from monomania.

*Collected Essays* (Volume 5)

*Science and Christian Traditions*

An Episcopal Trilogy (p. 136)

Macmillan & Company Ltd. London, England. 1904

...whatever practical people may say, this world is, after all, absolutely governed by ideas, and very often by the wildest and most hypothetical ideas.

*Collected Essays* (Volume 3)

*Science and Education*

On the Study of Biology (p. 273)

Macmillan & Company Ltd. London, England. 1904

**Ingle, Dwight J.** 1907–78

Biologist and endocrinologist

We have been warned against accepting ideas because they seem self-evident. However, there are some assumptions

we can accept. The whole world of science and knowledge is built on a set of assumptions that seem self-evident but cannot be independently proved.

*Is It Really So?: A Guide to Clear Thinking*

Chapter 4 (p. 38)

The West Minster Press. Philadelphia, Pennsylvania, USA. 1976

**James, William** 1842–1910

American philosopher and psychologist

An idea, to be suggestive, must come to the individual with the force of a revelation.

*The Varieties of Religious Experience*

Lectures IV & V (p. 112)

The Modern Library. New York, New York, USA. 1967

**Kekulé, Friedrich August** 1829–96

German chemist

Certain ideas at certain times are in the air; if one man does not enunciate them, another will do so soon afterwards.

In O. Theodor Benfey

*From Vital Force to Structural Formulas*

Epilogue (p. 98)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Kepler, Johannes** 1571–1630

German astronomer

...some things will be said which time will prove, but many things will be refuted by time and experience as vain and worthless; as is customary with the people, the latter will be committed to the winds, and the former, entirely to memory.

*Concerning the More Certain Fundamentals of Astrology*

Thesis 2 (p. 3)

Clancy Publications, Inc. New York, New York, USA. 1942

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

I have no objection to the standardizing of bolts and nuts and screws...but I do have a terrible obsession against the standardization of ideas.

In T.A. Boyd

*Professional Amateur*

Part III Chapter XIV (p. 137)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

**Keynes, John Maynard** 1883–1946

British economist

The difficulty lies, not in the new ideas, but in escaping the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds.

In K. Eric Drexler

*Engines of Creation: The Coming Era of Nanotechnology* (p. 231)

Bantam Books. New York, New York, USA. 1987

**Knuth, Donald E.** 1938–

Creator of TeX

It's the idea that counts true; but we need a name for the idea, so we can apply it more easily next time.

*Surreal Numbers*

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1974

### **Krantz, David L.**

No biographical data available

### **Wiggins, Lynda**

No biographical data available

Scientific ideas compete in an open marketplace. Each offers the possibility of a plausible solution to what might be a potentially significant problem. In its promise, an idea will attract other scientists — fellow explorers who will articulate, criticize, and ultimately determine the idea's actuality. While these explorers can breathe life into an idea, their absence or defection leads to its death. Ideas without recruits become like Bishop Berkeley's proverbial unheard falling tree.

Personal and Impersonal Channels of Recruitment in the Growth of Theory

*Human Development*, Volume 16, 1973 (p. 133)

### **Langer, Susanne Knauth** 1895–1985

American philosopher

The limits of thought are not so much set from outside, by the fullness or poverty of experiences that meet the mind, as from within, by the power of conceptions, the wealth of formulative notions with which the mind meets experience.... A new idea is a light that illuminates presences which simply had no form for us before the light fell on them.

*Philosophy in a New Key*

Chapter 1 (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

### **Lavoisier, Antoine Laurent** 1743–94

French chemist

When we begin the study of any science, we are in a situation, respecting that science, similar to that of children; and the course by which we have to advance is precisely the same which Nature follows in the formation of their ideas. In a child, the idea is merely an effect produced by a sensation; and, in the same manner, in commencing the study of a physical science, we ought to form no idea but what is a necessary consequence, and immediate effect, of an experiment or observation.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xvi)

Printed for William Creech. Edinburgh, Scotland. 1790

Like three impressions of the same seal, the word ought to produce the idea, and the idea to be a picture of the fact.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xiv)

Printed for William Creech. Edinburgh, Scotland. 1790

### **Lederman, Leon** 1922–

American high-energy physicist

If the basic idea is too complicated to fit on a T-shirt, it's probably wrong.

In Timothy Ferris (ed.)

*The Whole Shebang: A State-of-the-Universe's Report*

Quantum Weirdness (p. 272)

Simon & Schuster. New York, New York, USA. 1996

### **Ley, Willy**

American scientist

Ideas, like large rivers, never have just one source. Just as the waters of a river near its mouth is composed largely of the waters of many tributaries, so an idea, in its final form, is composed largely of later additions.

*Rockets, Missiles, and Space Travel*

Chapter 1 (p. 3)

The Viking Press. New York, New York, USA. 1951

The study of an idea is, of necessity, the story of many things. Ideas, like large rivers, never have just one source. Just as the water of a river near its mouth, in its final form, is composed largely of many tributaries, so an idea, in its final form, is composed largely of later additions.

*Rockets, Missiles and Space Travel*

Chapter 1 (p. 3)

The Viking Press. New York, New York, USA. 1951

### **Locke, John** 1632–1704

English philosopher and political theorist

...there seems to be a constant decay of all our ideas; even of those which are struck deepest, and in minds the most retentive; so that if they be not sometimes renewed, by repeated exercises of the senses, or reflection on those kinds of objects which at first occasioned them, the print wears out, and at last there remains nothing to be seen.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter X, Section 5 (p. 143)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Lowell, Percival** 1855–1916

American astronomer

Only the accustomed and the commonplace do men take kindly at once. The strange terrifies them. It is with ideas in men as with unfamiliar sights in beasts. Both shy at first at what they have never seen before. Scientists and layman alike are afraid to commit themselves to that upon which they have not been brought up.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 298)

University of Arizona Press. Tucson, Arizona, USA. 1976

An idea... is a mode of motion, not in any figurative sense but in an actual one, and as such possesses inertia. That is, it takes force to start it going; and once set going, force

to make it stop. A new idea entering the field encounters, opposed to it, the momentum of those already there. It has got to overcome this before it can prevail. Then it in turn grows hard to oust. The ripple of yesterday has become the roller of today. The despised is not the despotic.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 300)

University of Arizona Press. Tucson, Arizona, USA. 1976

### **Lyttleton, R. A.**

English astronomer

A new idea may be likened to a new-born babe: it is to be carefully nurtured and given every consideration rather than attacked with the choking diet of a multitude of so-called facts because it cannot prove at once that it will one day grow into a Samson.

In Ronald Duncan and Miranda Weston-Smith (eds.)

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The Nature of Knowledge (p. 11)

Pergamon Press. Oxford, England. 1977

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Ideas are not all of life. They are only momentary efflorescences of light, designed to illuminate the paths of the will.

*Popular Scientific Lectures*

On Transformation and Adaptation in Scientific Thought (p. 233)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

### **Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

...the proof of an idea is not to be sought in the soundness of the man fathering it, but in the soundness of the idea itself. One asks of a pudding, not if the cook who offers it is a good woman, but if the pudding itself is good.

*The Philosophy of Friedrich Nietzsche*

Nietzsche the Prophet

Chapter II (p. 271)

Kennikat Press, Inc. Port Washington, New York, USA. 1913

### **Milne, A. A. (Alan Alexander)** 1882–1956

English poet, children's writer, and playwright

When you are a Bear of Very Little Brain, and you Think of Things, you find sometimes that a Thing which seemed very Thingish inside you is quite different when it gets out into the open and has other people looking at it.

*The Complete Tales & Poems of Winnie-the-Pooh*

The House at Pooh Corner (p. 266)

Dutton Children's Books. New York, New York, USA. 2001

### **Mullis, Kary B.**

No biographical data available

Sometimes a good idea comes to you when you are not looking for it. Through an improbable combination of coincidence, naiveté and lucky mistakes.

The Unusual Origin of the Polymerase Chain Reaction

*Scientific American*, Volume 262, Number 4, April 1990 (p. 445)

### **Oliver, Mary**

No biographical data available

A fact: one picks it up and reads it, and puts it down, and there is an end to it. But an idea! That one may pick up, and reflect upon, and oppose, and expand, and so pass a delightful altogether.

*Blue Pastures*

Pen and Paper and a Breath of Air (p. 57)

Harcourt Brace & Company. New York, New York, USA. 1995

### **Papert, Seymour** 1928–

South African mathematician

What matters most is...one comes to appreciate how certain ideas can be used as tools to think with over a lifetime. One learns to enjoy and respect the power of powerful ideas. One learns that the most powerful idea of all is the idea of powerful ideas.

*Mindstorms: Children, Computers and Powerful Ideas*

Chapter 3 (p. 76)

Basic Books, Inc. New York, New York, USA. 1980

### **Perl, Martin L.** 1927

American physicist

My final remark to young women and men going into experimental science is that they should pay little attention to the speculative physics ideas of my generation. After all, if my generation has any really good speculative ideas, we will be carrying these ideas out ourselves.

*Nobel Lectures, Physics 1991–1995*

Nobel lecture for award received in 1995

Reflections on the Discovery of the Tau Lepton (p. 193)

World Scientific Publishing Company. Singapore. 1997

### **Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

It is terrible to see how a single unclear idea, a single formula without meaning, lurking in a young man's head, will sometimes act like an obstruction of inert matter in an artery, hindering the nutrition of the brain, and condemning its victim to pine away in the fullness of his intellectual vigor and in the midst of intellectual plenty.

*Chance, Love and Logic: Philosophical Essays*

Second Paper, Section I (p. 37)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

### **Planck, Max** 1858–1947

German physicist

When a scientific idea first takes shape in the brain of a researcher its origin is always due to some concrete experience. This experience may be in the nature of a

discovery or an observation. It is a verification of some sort or other, whether in relation to a measurement in physics or astronomy, a chemical or biological observation, some document that has been brought to light from historical archives or some monument that has been excavated from the ruins of a past civilisation.

The Origin and Effect of Scientific Ideas

*Research and Progress*, Volume 1, Number 1, January 1935 (p. 3)

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, turned philosopher, and social scientist

A vital judgment practiced in science is the assessment of plausibility. Only plausible ideas are taken up, discussed and tested by scientists. Such a decision may later be proved right, but at the time that it is made, the assessment of plausibility is based on a broad exercise of intuition guided by many subtle indications, and thus it is altogether undemonstrable. It is tacit.

*Knowing and Being*

Part Two Chapter 5. The Growth of Science in Society (p. 76)

The University of Chicago Press. Chicago, Illinois, USA. 1969

**Pólya, George** 1887–1985

Hungarian mathematician

...it is hard to have a good idea if we have little knowledge of the subject, and impossible to have it if we have no knowledge. Good ideas are based on past experience and formerly acquired knowledge.

*How to Solve It: A New Aspect of Mathematical Method*

Part I, Section 9 (p. 9)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Bold ideas, unjustifiable anticipations, and speculative thought, are our only means for interpreting nature: our only organon, our only instrument, for grasping her.

*Logic of Scientific Discovery*

Part II Chapter 10 (p. 280)

Routledge. New York, New York, USA. 1992

**Priest, Graham** 1848–

English philosopher

Historians of ideas soon learn — to their dismay — that their subject appears to be mathematically dense: between any two people who wrote on the matter there appears to be another.

*Beyond the Limits of Thought*

Chapter 1 (p. 6)

University Press. Cambridge, England. 1995

**Proust, Marcel** 1871–1922

French novelist

A powerful idea communicates some of its strength to him who challenges it.

Translated by C.K. Scott Moncrieff

*Within a Budding Grove*

Part I, Madame Swann at Home (p. 191)

The Modern Library. New York, New York, USA. 1951

**Sagan, Carl** 1934–96

American astronomer and author

Someone has to propose ideas at the boundaries of the plausible, in order to so annoy the experimentalists or observationalists that they'll be motivated to disprove the idea.

In J. Achenbach

The Final Frontier?

*The Washington Post*, C1–C2, May 30, 1996

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

An idea is an eddy, an island of the mind, connected with a vast mainland.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #432 (p. 157)

Definition Press. New York, New York, USA. 1972

**Spencer, Herbert** 1820–1903

English social philosopher

Early ideas are not usually true ideas.

*The Principles of Biology* (Volume 1)

Part III, Chapter II, Section 110 (p. 333)

D. Appleton & Company. New York, New York, USA. 1897

**Stewart, Ian** 1945–

English mathematician and science writer

Really good mathematical ideas are hard to come by. They result from the combined work of many people over long periods of time. Their discovery involves wrong turnings and intellectual dead ends. They cannot be proved at will: truly novel mathematics is not amenable to an industrial “Research and Development” approach. But they pay for all that effort by their durability and versatility.

*The Problems of Mathematics*

Chapter 1 (pp. 11–12)

Oxford University Press, Inc. Oxford, England. 1987

**Stinton, D.**

No biographical data available

One should never have too much reverence for ideas, no matter whose they are. Ideas are meant to be kicked around, stood upon their heads, and looked at backwards through mirrors. It is only in this way that they can grow up in the way that they should, without excessive self-importance. The ideas of one man are the food for thought of another.

*The Anatomy of the Aeroplane*

Preface (p. ix)

American Elsevier Publishing Company. New York, New York, USA.

1966

**Thagard, Paul**

No biographical data available

Because the variation, selection, and transmission of scientific ideas differ in such fundamental ways from their biological analogs, Darwinian natural selection provides a poor model for understanding the growth of science. It misleadingly suggests that variation in scientific ideas is blind, that their selection is by local criteria, and that their transmission is genetic. It ignores the pragmatic, problem-solving context of induction. Thus employment of the evolutionary analogy leads away from solutions to important problems about the growth of knowledge, not toward them. Hence, evolutionary epistemology, conceived as the application of the Darwinian model to scientific development, should be abandoned.

*Computational Philosophy of Science*

Chapter 6 (pp. 110–111)

MIT Press. Cambridge. 1988

**Thomson, James** 1700–48

Scottish poet

Ten thousand great ideas filled his mind;  
But with the clouds they fled, and left no trace behind.

*Castle of Indolence*

Canto I, stanza 59

William Smith. London, England. 1842

**Toulmin, Stephen** 1922–

Anglo-American English philosopher

**Goodfield, June**

Science writer and historian

New ideas are the tools of science, not its end-product. They do not *guarantee* deeper understanding, yet our grasp of Nature will be extended only if we are prepared to welcome them and give them a hearing. If at the outset exaggerated claims are made on their behalf, this need not matter. Enthusiasm and deep conviction are necessary if men are to explore all possibilities of any new idea, and later experience can be relied on either to confirm or to moderate the initial claims — for science flourishes on a double programme of speculative liberty and unsparing criticism.

*The Architecture of Matter*

Chapter 2 (p. 41)

The University of Chicago Press. Chicago, Illinois, USA. 1982

**Trotter, Wilfred** 1872–1939

Surgeon and sociologist

The mind likes a strange idea as little as the body likes a strange protein, and resists it with similar energy. It would not be too fanciful to say that a new idea is the most quickly acting antigen known to science. If we watch ourselves honestly we shall often find that we have begun to argue against a new idea before it has been completely stated.

*Collected Papers*

Has the Intellect a Function?

Oxford University Press, Inc. Oxford, England. 1941

It is a mistake to suppose, as it is so easy to do, that science enjoins upon us the view that any given idea is true or false and there is an end of it; an idea may be neither demonstrably true nor false and yet be useful, interesting, and good exercise. Again, it is poverty rather than fertility of ideas that causes them to be used as a substitute for experiment, to be fought for with prejudice or decried with passion. When ideas are freely current they keep science fresh and living and are in no danger of ceasing to be the nimble and trusty servants of truth. We may perhaps allow ourselves to say that the body of science gets from the steady work of experiment and observation its proteins, its carbohydrates, and — sometimes too profusely — its fats, but that without its due modicum of the vitamin of ideas the whole organism is apt to become stunted and deformed, and above all to lose its resistance to the infection of orthodoxy.

Observation and Experiment and Their Use in the Medical Science

*British Medical Journal*, July 26, 1930 (p. 132)

**Tucker, Abraham** 1705–74

English writer

...an idea, on being displaced by another, does not wholly vanish, but leaves a spice and tincture of itself behind, by which it operates with a kind of attraction upon the subsequent ideas, determining which of their associates they shall introduce, namely such as carry some conformity with itself.... This regular succession of ideas, all bearing a reference to some one purpose retained in view, is what we call a train; and daily experience testifies how readily they follow one another in this manner of themselves, without any pains or endeavor of ours to introduce them.

*The Light of Nature Pursued* (Volume 1)

Trains (p. 147)

Hilliard & Brown. Cambridge, England. 1831

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

His head was an hour-glass; it could stow an idea, but it had to do it a grain at a time, not the whole idea at once.

*A Connecticut Yankee in King Arthur's Court*

Chapter XXVIII (p. 255)

Harper & Brothers. New York, New York, USA. 1899

**von Bubnoff, S.**

No biographical data available

The logical continuity of science is only a pious wish; the progress of knowledge is erratic and irrational. Ideas die not because they are wrong but because they find no substance and are reborn and become capable of development when the substance is available.

In Jochen Helms

*Fossils: The Oldest Treasures That Ever Lived*  
The Beginnings of Knowledge and Understanding (p. 32)  
T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

Happy ideas come unexpectedly without effort like an inspiration, as far as I am concerned. They have never come to me when my mind was fatigued or when I was at my working table.

*Radhakrishnan: An Idealist View of Life*  
Chapter V, Section 1 (p. 142)  
Unwin Paperbacks. London, England. 1980

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

...I have long since come to see that no one deserves either praise or blame for the ideas that come to him, but only for the actions resulting there from. Ideas and beliefs are certainly not voluntary acts. They come to us — we hardly know how or whence, and once they have got possession of us we can not reject or change them at will. It is for the common good that the promulgation of ideas should be free — uninfluenced by either praise or blame, reward or punishment.

The Origin of the Theory of Natural Selection  
*Popular Science Monthly*, Volume 74, 1909 (p. 400)

**Weber, Max** 1864–1920  
German founder of modern sociology and economic thinker

Ideas come in their own good time, not when we want them. In fact, the best ideas occur to us while smoking a cigar on the sofa, as Ihering says, or during a walk up a gently rising street, as Helmholtz observes of himself with scientific precision, or in some such way. At any rate, ideas come when they are least expected, rather than while you are racking your brains at your desk.

Translated by Rodney Livingstone  
*The Vocation Lectures*  
Science as a Vocation (p. 9)  
Hackett Publishing Company. Indianapolis, Indiana, USA. 2004

**Weidlein, Edward Ray**  
Chemical engineer

If one were asked to name the most dynamic force in the known universe, he might grope for some time before he made a hesitant choice, wavering between such imponderables as the power of the sun and the energy hidden within the atom. His reluctant choice in any event would probably be wrong — for the most powerful force known to man still is an idea.

Cooperation — A Responsibility of the Scientist  
*American Scientist*, March 1962 (p. 29)

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

...it is not surprising that, after a long period of searching and erring, some of the concepts and ideas in human thinking should have come gradually closer to the fundamental laws of this world...

*Knowledge and Wonder: The Natural World as Man Knows It*  
Epilogue (p. 270)  
Doubleday & Company. Garden City, New York, USA. 1966

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...he had ideas about everything. He could no more help having ideas about everything than a dog can resist smelling at your heels.

*Mr. Britling Sees It Through*  
Book I, Chapter I, Section 2 (p. 10)  
The Macmillan Company. New York, New York, USA. 1917

**Wheeler, John Archibald** 1911–  
American physicist and educator

To my mind there must be, at the bottom of it all, not an equation, but an utterly simple idea. And to me that idea, when we finally discover it, will be so compelling, so inevitable, that we will say to one another, "Oh, how beautiful. How could it have been otherwise."

In Timothy Ferris (ed.)  
*Coming of Age in the Milky Way*  
Chapter 17 (p. 346)  
William Morrow & Company, Inc. New York, New York, USA. 1988

**Whewell, William** 1794–1866  
English philosopher and historian

Facts are the materials of science, but all Facts involve Ideas. Since, in observing Facts, we cannot exclude Ideas, we must, for the purposes of science, take care that the Ideas are clear and rigorously applied.

*The Philosophy of the Inductive Sciences Founded Upon Their History*  
(Volume 2)  
Aphorisms, Aphorisms Concerning Science, IV (p. 467)  
John W. Parker. London, England. 1847

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

To talk sense is to talk quantities.  
*The Aims of Education and Other Essays*  
Chapter I (p. 11)  
The Macmillan Company. New York, New York, USA. 1959

If you have had your attention directed to the novelties in thought in your own lifetime, you will have observed that almost all really new ideas have a certain aspect of foolishness when they are first produced.

*Science and the Modern World*  
Chapter III (p. 70)  
The Macmillan Company. New York, New York, USA. 1929

In the study of ideas, it is necessary to remember that insistence on hard-headed clarity issues from sentimental feeling, as it were a mist, cloaking the perplexities of

fact. Insistence on clarity at all costs is based on sheer superstition as to the mode in which human intelligence functions. Our reasonings grasp at straws for premises and float on gossamers for deductions.

*Adventures of Ideas*

Chapter V (p. 91)

The Macmillan Company. New York, New York, USA. 1956

...traditional ideas are never static. They are either fading into meaningless formulae, or are gaining power by the new lights thrown by a more delicate apprehension. They are transformed by the urge of critical reason, by the vivid evidence of emotional experience, and by the cold certainties of scientific perception. One fact is certain, you cannot keep them still.

*Science and the Modern World*

Chapter XII (p. 269)

The Macmillan Company. New York, New York, USA. 1929

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

He played with the idea, and grew willful; tossed it into the air and transformed it; let it escape and recaptured it; made it iridescent with fancy, and winged it with paradox.

*The Picture of Dorian Gray*

Chapter 3 (p. 46)

The Modern Library. New York, New York, USA. 1992

**Wilson, Edward O.** 1929–

American biologist and author

These whispering denizens of the mind are sensed but rarely seen. They rustle the foliage, leave behind a pug mark filling with water and a scent, excite us for an instant and vanish. Most ideas are waking dreams that fade to an emotional residue.

*The Diversity of Life*

Chapter One (p. 8)

W.W. Norton & Company, Inc. New York, New York, USA. 1992

Keep in mind that new ideas are commonplace, and almost always wrong. Most flashes of insight lead nowhere; statistically, they have a half-life of hours or maybe days. Most experiments to follow up the surviving insights are tedious and consume large amounts of time, only to yield negative or (worse!) ambiguous results.

Scientists, Scholars, Knaves and Fools

*American Scientist*, Volume 86, January–February 1998 (p. 6)

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Sometimes you see the idea in the way an astronomer sees stars in the far distance. (Or it seems like that anyway.)

Translated by Peter Winch

*Culture and Value* (p. 58e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

Ideas too sometimes fall from the tree before they are ripe.

Translated by Peter Winch

*Culture and Value* (p. 27e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wright, Thomas** 1711–86

English cosmologist

...the author having dug all his Ideas from the Mines of Nature, is surely entitled to every kind of Indulgence.

*An Original Theory or New Hypothesis of the Universe*

Preface (p. iv)

Printed for the Author. London, England. 1750

## IDEOLOGY

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Biological determinism is, in its essence, a theory of limits. It takes the current status of groups as a measure of where they should and must be...We inhabit a world of human differences and predilections, but the extrapolation of these facts to theories of rigid limits is ideology.

*The Mismeasure of Man*

Chapter One (p. 60)

W.W. Norton & Company, Inc. New York, New York, USA. 1996

## IGNORANCE

**Adams, George** 1750–95

English instrument maker

The natural propensity of the human mind to know the cause of every effect often leads men into errors, and makes them satisfied with a word which does not remove their ignorance.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture I (p. 14)

Printed by R. Hindmarsh. London, England. 1794

**Bernstein, Jeremy** 1929–

American physicist, educator, and writer

Ignorance of science and technology is becoming the ultimate self-indulgent luxury.

*Cranks, Quarks, and the Cosmos: Writings on Science*

Chapter 16 (p. 202)

Basic Books. New York, New York, USA. 1993

**Berry, Arthur**

No biographical data available

The larger the sphere of our knowledge, the greater its contact with the infinity of our ignorance.

*A Short History of Astronomy*

Chapter XIII

Volume 83, Number 1, January 1978 (p. 354)

John Murray. London, England. 1898



**Bertotti, Bruno**

Physicist

The catalogue of our ignorance has two, not one, gates: there is the obvious exit gate, through which questions answered and settled by experimental and theoretical developments march out and disappear into the textbooks and the applications; but there is also a more important, albeit less conspicuous, entrance gate, through which new riddles come to life in the scientific world.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The Riddles of Gravitation (p. 92)

Pergamon Press. Oxford, England. 1977

**Brecht, Bertolt** 1898–1956

German writer

GALILEO: Truth is born of the times, not of authority. Our ignorance is limitless: let us lop one cubic millimeter off it. Why try to be clever now that we at last have a chance of being just a little less stupid?

Translated by John Willett

*Life of Galileo*

Scene 4 (p. 42)

Arcade Publishing. New York, New York, USA. 1994

**Bruno, Giordano** 1548–1600

Italian philosopher and pantheist

Ignorance is the most delightful science in the world because it is acquired without labor or pains and keeps the mind from melancholy.

In David Starr Jordan

*The Higher Foolishness, with Hints as to the Care & Culture of Aristocracy; Followed by Brief Sketches on Ecclesiasticism, Science & the Unfathomed Universe*

Title page

The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1927

**Cuvier, Georges** 1769–1832

French zoologist and statesman

The time is past for ignorance to assert that these remains of organized bodies are mere *lusus naturae*, — productions generated in the womb of the earth by its own creative powers.

*An Essay on the Theory of the Earth*

Section 4 (p. 31)

Kirk & Mercein. New York, New York, USA. 1818

**Darwin, Charles Robert** 1809–82

English naturalist

It has often and confidently been asserted that man's origin can never be known: but ignorance more frequently begets confidence than does knowledge: it is those who know little, and not those who know so much, who so positively assert that this or that problem will never be solved by science.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Introduction (p. 253)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Davy, Sir Humphry** 1778–1829

English chemist

Man is formed for pure enjoyment; his duties are high, his destination is lofty; and he must, then, be most accused of ignorance and folly when he grovels in the dust, having wings which can carry him to the skies.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Introductory Lecture for the Courses of 1805 (p. 9)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

**Duncan, Ronald**

No biographical data available

**Weston-Smith, Miranda**

No biographical data available

Compared to the pond of knowledge, our ignorance remains Atlantic.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

Editorial Preface (p. ix)

Pergamon Press. Oxford, England. 1977

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

In order to arrive at what you do not know  
You must go by a way which is the way of ignorance.

*The Collected Poems and Plays 1909–1950*

East Coker, Part III, stanza 2 (p. 127)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The precise specification of our knowledge is, however, the same as the precise specification of our ignorance.

*Statistical Methods and Scientific Inference*

Chapter II (pp. 28–29)

Hafner Publishing Company. New York, New York, USA. 1959

**Franklin, Alfred**

No biographical data available

Men are enclosed in their own ignorance as in a prison with slowly receding walls. Unable to see beyond, they marvel at the vastness of their mansion without ever suspecting the existence of an infinite world outside.

In Charles Noël Martin

*The Role of Perception in Science*

Conclusion (p. 138)

Hutchinson of London. London, England. 1963

**Gilbert, G. K.** 1843–1918

American geologist

It is not altogether pleasant to deal with a subject in regard to which the domain of our ignorance is so broad; but if we are optimists we may be comforted by the reflection that the geologists of this generation, at least, will have no occasion like Alexander, to lament a dearth of worlds to conquer.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1895*

Continental Problems of Geology (p. 173)  
Government Printing Office. Washington, D.C. 1896

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

Consider the unlearned, unaware of their ignorance, who think they know everything! As knowledge increases, ignorance decreases, but this kind of ignorance — unlearned ignorance — is no more than the lack of knowledge. With knowledge comes awareness of ignorance — learned ignorance — and the more we know, the more aware we become of what we do not know.

*Masks of the Universe*

Chapter 17 (p. 273)

Macmillan Publishing Company. New York, New York, USA. 1985

**Hellman, C. Doris**

Translator and editor

There are many things whose existence we allow, but whose character we are still in ignorance of.... Why should we be surprised, then, that comets, so rare a sight in the universe, are not embraced under definite laws, or that their return is at long intervals?...The day will yet come when the progress of research through long ages will reveal to sight the mysteries of nature that are now concealed.... The day will yet come when posterity will be amazed that we remained ignorant of things that will to them seem so plain.

*The Comet of 1577: Its Place in the History of Astronomy*

Chapter I (p. 33)

Columbia University Press. New York, New York, USA. 1944

**Hilbert, David** 1862–1943

German mathematician

...in mathematics there is no ignorabimus.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902 (p. 445)

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

You cannot and need not expect to disturb the public in the possession of its medical superstitions. A man's ignorance is as much his private property, and as precious in his own eyes, as his family Bible.

*The Young Practitioner*

Speech

Bellevue Hospital College

March 2, 1871

Our task is only that of sending out a few pickets under the starry flag of science to the edge of that dark domain where the ensigns of the obstinate rebel, Ignorance, are flying undisputed.

*Medical Essays 1842–1882*

Chapter IV (p. 212)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Huxley, Thomas Henry** 1825–95

English biologist

Ignorance is visited as sharply as willful disobedience — incapacity meets with the same punishment as crime. Nature's discipline is not even a word and a blow, and the blow first; but the blow without the word. It is left to you to find out why your ears are boxed.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 85)

Macmillan & Company Limited. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

Our science is a drop, our ignorance a sea. Whatever else be certain, this at least is certain — that the world of our present natural knowledge is enveloped in a larger world of some sort whose residual properties [about which] we at present can frame no positive idea.

*The Will to Believe and Other Essays in Popular Philosophy*

Is Life Worth Living? (p. 54)

Dover Publications, Inc. New York, New York, USA. 1956

**Kingdon, Clifford W.**

No biographical data available

A wise man only remembers his ignorance in order to destroy it.

Aims and Instruments of Scientific Thought

*The Popular Science Monthly*, Volume 2, December 1872 (p. 179)

**Lodge, Sir Oliver** 1851–1940

English physicist

The ordinary run of men live among phenomena of which they know nothing and care less. They see bodies fall to the earth, they hear sounds, they kindle fires, they see the heavens roll above them, but of the causes and inner working of the whole they are ignorant, and with their ignorance they are content.

*Pioneers of Science and the Development of Their Scientific Theories*

Lecture I (p. 5)

Dover Publications, Inc. New York, New York, USA. 1926

In regions where our ignorance is great, occasional guesses are permissible.

On the Supposed Weight and Ultimate Fate of Radiation

*Philosophical Magazine*, Volume 41, 1921

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

We are not today tempted to search for these keys that unlock the whole of human knowledge and man's experience. We know that we are ignorant; we are well taught it, and the more surely and deeply we know our own job the better able we are to appreciate the full measure of our pervasive ignorance.

*Science and the Common Understanding*  
Chapter 6 (pp. 89–90)  
Simon & Schuster. New York, New York, USA. 1954

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

Never think that you already know all. However highly you are appraised, always have the courage to say to yourself — I am ignorant.

Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

**Pratchett, Terry** 1948–  
English author

But then...it used to be so simple, once upon a time. Because the universe was full of ignorance all around and the scientist panned through it like a prospector crouched over a mountain stream, looking for the gold of knowledge among the gravel of unreason, the sand of uncertainty and the little whiskery eight-legged swimming things of superstition. Occasionally he would straighten up and say things like "Hurrah, I've discovered Boyle's Third Law." And everyone knew where they stood. But the trouble was that ignorance became more interesting, especially big fascinating ignorance about huge and important things like matter and creation, and people stopped patiently building their little houses of rational sticks in the chaos of the universe and started getting interested in the chaos itself — partly because it was a lot easier to be an expert on chaos, but mostly because it made really good patterns that you could put on a t-shirt.

*Witches Abroad* (p. 7)  
Victor Gollancz Ltd. London, England. 1991

**Recorde, Robert** 1510?–58  
English mathematician and writer

...the greatest point of all ignorance, not to know the gooseness of ignorance, and not to understand the benefite of knowledge...

*The Castle of Knowledge*  
The First Treatise (pp. 1–2)  
Imprinted by R. Wolfe. London, England. 1556

**Rowan-Robinson, Michael**  
English astronomer

To be a true scientist is only to have an inkling of the full extent of man's ignorance.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*  
Galaxies, Quasars and the Universe (p. 62)  
Pergamon Press. Oxford, England. 1977

In extragalactic astrophysics we suffer from three types of ignorance: ignorance in principle, ignorance due to observational limitations, and ignorance due to inadequacy of theory and observation.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*  
Galaxies, Quasars and the Universe (p. 58)  
Pergamon Press. Oxford, England. 1977

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

In an honest search for knowledge you quite often have to abide by ignorance for an indefinite period. Instead of filling a gap by guesswork, genuine science prefers to put up with it; and this, not so much from conscientious scruples above telling lies, as from the consideration that, however irksome the gap may be, its obliteration by a fake removes the urge to seek after a tenable answer.

*Nature and the Greeks*  
Chapter I (p. 6)  
At The University Press. Cambridge, England. 1954

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...there is no darkness but ignorance...  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Twelfth Night  
Act IV, Scene ii  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Walker, Kenneth** 1882–1966  
Physician

And how small is the sum of our actual knowledge. With regards to all the more important things, to the questions which concern us more nearly, it amounts to little beyond a consciousness of our own ignorance.

*Meaning and Purpose*  
Chapter XV (p. 168)  
Jonathan Cape. London, England. 1944

**Watts, Alan Wilson** 1915–73  
American philosopher

The greater the scientist, the more he is impressed with his ignorance of reality, and the more he realizes that his laws and labels, descriptions and definitions, are the products of his own thought.

*The Wisdom of Insecurity*  
Chapter IX (p. 149)  
Pantheon. New York, New York, USA. 1951

## ILLNESS

**Bisch, Louis E.**

No biographical data available

Like any other major experience, illness actually changes us. How? Well, for one thing we are temporarily relieved from the pressure of meeting the world head-on.... We enter a realm of introspection and self-analysis. We think soberly, perhaps for the first time, about our past and future.... Illness...gives us that rarest thing in the world — *a second chance*, not only at health but at life itself!”

Turn Your Sickness into an Asset

*Reader's Digest*, November 1937 (p. 2)

**Bond, J.**

No biographical data available

**Bond, S.**

No biographical data available

A simple distinction we need to make here is between illness and disease. Disease refers to a medical concept of pathology, which is indicated by a group of signs and symptoms. The presence or absence of a disease, as indicated by signs and symptoms, is clinically defined by the medical profession. The doctor or his substitute, using a common body of knowledge, makes the decision as to whether or not a person has a disease. In contrast, illness is defined by the person who had the signs and symptoms' experience of "health" and "ill-health" and is indicated by the persons reactions to the symptoms.

*Sociology and Health Care: An Introduction for Nurses and Other Health Care Professionals*

Chapter 8 (p. 200)

Churchill Livingstone. Edinburgh, Scotland. 1986

**Bonnett, O. T.**

No biographical data available

A little illness is truly a wonderful thing to have if you are afraid of life.

*Why Healing Happens* (p. 109)

MacMurray & Beck, Aspen. 1996

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

...I reckon being ill as one of the great pleasures of life, provided one is not too ill and is not obliged to work till one is better.

*The Way of All Flesh*

Chapter LXXX (p. 346)

Rinehart & Company, Inc. New York, New York, USA. 1955

**Cassell, Eric J.**

No biographical data available

Illness [stands] for what the patient feels when he goes to the doctor and disease for what he has on the way home

from the doctor's office. Disease...is something an organ has; illness is something a man has.

*The Healer's Art: A New Approach to the Doctor-Patient Relationship* (p. 48)

Lippincott. New York, New York, USA. 1976

**Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

If doctors prescribe too many remedies for an illness it probably means that the illness can't be cured at all.

Translated by Sir John Gielgud

*The Cherry Orchard: A Comedy in Four Acts*

Act 1 (p. 21)

Heinemann Educational Books Ltd. London, England. 1963

**Glasow, Arnold**

No biographical data available

Spring fever in some areas is double pneumonia.

*Quote, the Weekly Digest*, June 18, 1967 (p. 497)

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Nature is a benevolent old hypocrite; she cheats the sick and dying with illusions better than any anodynes.

*Medical Essays*

The Young Practitioner (p. 388)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Jaspers, Karl** 1883–1969

German psychiatrist and philosopher

What "sick" in general may mean depends less on a doctor's judgment than on the judgment of the patient and the prevailing conceptions of the contemporary culture.... With psychic illnesses [this] is very much so. The same psychic state will bring the one individual to the psychiatrist as a sick person while it will take another to the confessional as one suffering from sin and guilt.

*General Psychopathology* (p. 780)

The University of Chicago Press. Chicago, Illinois, USA. 1963

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Twice in my life I very nearly died as a result of cerebral vascular accidents, and I don't look forward a bit to making, in due course, a clean job of it. I neither cursed God for depriving me of the use of two limbs nor thanked and praised Him for sparing me the use of two others. On these two occasions I derived no comfort from religion or from the thought that God was looking after me.

*The Limits of Science*

Chapter 7 (pp. 96–97)

Harper & Row, Publishers. New York, New York, USA. 1984

**Moore, Anthony R.**

No biographical data available

The experiences of illness are protean. In some cases disease can dignify, in others it creates heroic capacities. It can lead to self-realization; it can level unequal men; it can be thought of as an agent of retribution.... Even patients who see disease as a despoiler often experience sentiments of greater complexity. They see illness as an ever-present reminder of the unexpected, and of man's fundamental vulnerability.

*The Missing Medical Text: Humane Patient Care* (p. 36)  
Melbourne University Press, Victoria. 1978

**Sigerist, Henry E.** 1891–1957  
Medical historian

Illness, in general, is not a good literary subject.  
*Civilisation and Disease*  
Chapter IX (p. 182)  
Cornell University Press. Ithaca, New York, New York. 1943

**Södergran, Edith** 1892–1923  
Finland-Swedish poet

I lie all day and wait for night,  
I lie all night and wait for day.  
*We Women: Selected poems of Edith Södergran*  
Days of Sickness  
Oyez. Berkeley, California, USA. 1977

**Sontag, Susan** 1933–2004  
American critic and writer

Fatal illness has always been viewed as a test of moral character, but in the nineteenth century there is a great reluctance to let anybody flunk the test.  
*Illness as Metaphor*  
Chapter 5 (p. 41)  
Farrar, Straus & Giroux. New York, New York, USA. 1978

Illness is the night-side of life, a more onerous citizenship. Everyone who is born holds dual citizenship, in the kingdom of the well and in the kingdom of the sick. Although we all prefer to use only the good passport, sooner or later each of us is obliged, at least for a spell, to identify ourselves as citizens of that other place.

*Illness as Metaphor*  
Chapter 1 (p. 3)  
Farrar, Straus & Giroux. New York, New York, USA. 1978

**Trilling, Lionel** 1905–75  
American critic, author, and teacher

We are all ill: but even a universal sickness implies an idea of health.  
*The Liberal Imagination*  
Art and Neurosis (p. 179)  
Charles Scribner's Sons. New York, New York, USA. 1950

**von Ebner-Eschenbach, Marie** 1830–1916  
Austrian writer

It is not the mortal but the incurable illnesses which are the worst.

Translated by David Scrase and Wolfgang Mieder  
*Aphorisms* (p. 44)  
Aridne Press. Riverside, California, USA. 1994

Imaginary ills belong to the incurable.  
Translated by David Scrase and Wolfgang Mieder  
*Aphorisms* (p. 24)  
Aridne Press. Riverside, California, USA. 1994

**Welty, Eudora** 1909–2001  
American writer

He did not like illness, he distrusted it, as he distrusted the road without signposts.  
*Selected Stories of Eudora Welty*  
Death of a Traveling Salesman (p. 232)  
Modern Library. New York, New York, USA. 1954

**Wilder, Thornton** 1897–1975  
American playwright and novelist

For what human ill does not dawn seem to be an alleviation?  
*The Bridge of San Luis Rey*  
Part 3 (p. 119)  
Albert & Charles Boni. New York, New York, USA. 1928

**Wiltshire, John**  
No biographical data available

Illness has from ancient times been conceived as punishment, as a derivative of sin (with venereal disease providing the obvious paradigm), and even when this nexus is broken or disavowed by the conscious mind, it is always creeping back in less conscious forms...as in the production of “asthmatic” or “cancer prone” personality types. Or it may take another form when a sudden “attack” of disease is connected — to all intents and purposes arbitrarily — with some personal guilt, and thereby given a form of explanation.  
*Samuel Johnson in the Medical World: The Doctor and the Patient* (p. 6)  
Cambridge University Press. Cambridge, England. 1991

**Woolf, Virginia** 1882–1941  
English novelist and essayist

There is, let us confess it (and illness is the great confessional), a childish outspokenness in illness; things are said, truths blurted out, which the cautious respectability of health conceals.  
*The Moment*  
On Being Ill (p. 13)  
Harcourt, Brace & Company. New York, New York, USA, 1948

Considering how common illness is, how tremendous the spiritual change that it brings, how astonishing, when the lights of health go down, the undiscovered countries that are then disclosed, what wastes and deserts of the soul a slight attack of influenza brings to view, what precipices and lawns sprinkled with bright flowers a little rise of temperature reveals, what

ancient and obdurate oaks are uprooted in us by the act of sickness...

*The Moment*

On Being III (p. 9)

Harcourt, Brace & Company. New York, New York, USA, 1948

## ILLUSION

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The distinction between horizontal and vertical is not an illusion; and the man who thinks it is is likely to come to an untimely end. Yet we can not arrive at a comprehensive view of nature unless we combine horizontal and vertical dimensions into three dimensional space.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 45)

At The University Press. Cambridge, England. 1921

**Pólya, George** 1887–1985

Hungarian mathematician

In our personal life we often cling to illusions. That is, we do not dare to examine certain beliefs which could be easily contradicted by experience, because we are afraid of upsetting our emotional balance.

*Induction and Analogy in Mathematics* (Volume 1)

Chapter I (p. 7)

Princeton University Press. Princeton, New Jersey, USA. 1954

## ILLUSTRATION

**Downy, J. C.**

No biographical data available

**Kelly, J. L.**

No biographical data available

While skill at drawing, or a steady hand, may help a person create an illustration, his skill will be of little help if he lacks the quality of careful observation, of attention to every detail of the subject; accuracy is the most sought after virtue in biological illustration.

*Biological Illustration: Techniques and Exercises* (p. viii)

Iowa State University Press. Ames, Iowa, USA. 1982

## IMAGINATION

**Akenside, Mark** 1721–70

English poet and physician

There are certain powers in human nature which seem to hold a middle place between the organs of bodily sense and the faculties of moral perception: They have been Call'd by a very general name, THE POWERS OF IMAGINATION.

*The Poetical Works of Mark Akenside*

The Powers of Imagination

Associated University Presses. Cranbury, New Jersey, USA. 1996

**Atchity, Kenneth** 1944–

Writer

That's what imagination is for: to go in advance so action can follow.

*A Writer's Time: Making the Time to Write* (p. 34)

W.W. Norton & Company, Inc. New York, New York, USA. 1995

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

We are not...to imagine or suppose, but to discover, what Nature does or may be made to do.

In Henry Hobhouse

*Seeds of Change, Five Plants that Transformed Mankind*

Quinine and the White Man's Burden (p. 14)

Harper & Row, Publishers. New York, New York, USA. 1987

**Barfield, Owen** 1898–1997

British philosopher, critic, and anthroposophist

Imagination is really thinking with a bit of will in it.

*History, Guilt, and Habit*

Chapter 3 (p. 80)

Wesleyan University Press. Middletown, Connecticut, USA. 1979

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

The imagination merely enables us to wander into the darkness of the unknown where, by the dim light of the knowledge that we carry, we may glimpse something that seems of interest. But when we bring it out and examine it more closely it usually proves to be only trash whose glitter had caught our attention. Imagination is at once the source of all hope and inspiration but also of frustration. To forget this is to court despair.

*The Art of Scientific Investigation* (p. 58)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Blake, William** 1757–1827

English poet, painter, and engraver

The tree which moves some to tears of joy is in the Eyes of others only a Green thing that stands in the way. Some see Nature all Ridicule & Deformity...& Some Scarce see Nature at all. But to the Eyes of the Man of Imagination, Nature is Imagination itself.

*The Letters of William Blake*

Letter to Dr. Trusler, 23 August 1799 (p. 34)

Harvard University Press. Cambridge, Massachusetts, USA. 1968

Nature has no outline:

but Imagination has.

Nature has no tune:

but Imagination has!

Nature has no supernatural & dissolves:

Imagination is Eternity.

*The Complete Poetry and Prose of William Blake*

The Ghost of Abel  
University of California Press. Berkeley, California, USA. 1982

**Borland, Hal** 1900–78  
American writer

Give any man a star on which he can fix his eye and he can reach as far as his imagination points the way.

*An American Year*  
June (p. 46)  
Simon & Schuster. New York, New York, USA. 1946

**Born, Max** 1882–1970  
German-born English physicist

Faith, imagination and intuition are decisive factors in the progress of science as in any other human activity.

*Natural Philosophy of Cause and Chance*  
Appendix One, 36 (p. 209)  
At The Clarendon Press. Oxford, England. 1949

**Brillouin, Léon** 1889–1969  
French physicist

An artist's inspiration or a scientist's theory, reveal the unpredictable power of human imagination.

*Scientific Uncertainty and Information*  
Dedication  
Academic Press. New York, New York, USA. 1964

**Brodie, Sir Benjamin Collins** 1817–80  
English chemist

Lastly, physical investigation, more than anything besides, helps to teach us the actual value and right use of the Imagination — of that wondrous faculty, which, left to ramble uncontrolled, leads us astray into a wilderness of perplexities and errors, a land of mists and shadows; but which, properly controlled by experience and reflection, becomes the noblest attribute of man; the source of poetic genius, the instrument of discovery in Science, without the aid of which Newton would never have invented fluxions, nor Davy have composed the earths and alkalies, nor would Columbus have found another Continent.

In John Tyndall  
*Fragments of Science*  
Address to the Royal Society, November 30, 1859, Scientific Use of the Imagination (p. 423)  
D. Appleton & Company. New York, New York, USA. 1898

**Brougham, Henry** 1778–1868  
English statesman

A mere theory...is the unmanly and unfruitful pleasure of a boyish and prurient imagination, or the gratification of a corrupted and depraved appetite...

The Bakerian Lecture on the Theory of Light and Colours  
*Edinburgh Review*, Volume 1, 1801–3 (p. 450)

**Buckley, Arabella B.** 1840–1929  
English naturalist and science writer

...we must have imagination. I do not mean mere fancy, which creates unreal images and impossible monsters, but imagination, the power of making pictures or images in our mind of that which is, though it is invisible to us.

*The Fairy-Land of Science*  
Lecture I (p. 17)  
D. Appleton & Company. New York, New York, USA. 1899

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Nobody can imagine how nothing could turn into something. Nobody can get an inch nearer to it by explaining how something could turn into something else. It is really far more logical to start by saying “In the beginning God created heaven and earth” even if you only mean “In the beginning some unthinkable power began some unthinkable process.” For God is by its nature a name of mystery, and nobody ever supposed that man could imagine how a world was created any more than he could create one. But evolution really is mistaken for explanation. It has the fatal quality of leaving on many minds the impression that they do understand it and everything else; just as many of them live under a sort of illusion that they have read the Origin of Species.

*The Everlasting Man*  
Chapter I (p. 3)  
Dodd, Mead & Company. New York, New York, USA. 1925

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Across the seas of space lie the new raw materials of the imagination, without which all forms of art must eventually sicken and die. Strangeness, wonder, mystery, and magic — these things, which not long ago seemed lost forever, will soon return to the world. And with them, perhaps will come again an age of sagas and epics such as Homer never knew.

*Greetings, Carbon-Based Biped!* (p. 229)  
HarperCollins. London, England, 2000

**Cole, K. C.**  
Science writer

Imagining the unseeable is hard, because imagining means having an image in your mind. And how can you have a mental image of something you have never seen? Like perception itself, the models of science are embedded inextricably in the current worldview we call culture.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*  
Chapter One (p. 18)  
Harcourt Brace & Company. New York, New York, USA. 1999

**Darwin, Charles Robert** 1809–82  
English naturalist

This sketch is *most* imperfect; but in so short a space I cannot make it better. Your imagination must fill up

many wide blanks. Without some reflexion it will appear all rubbish; perhaps it will appear so after reflexion.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter To Asa Gray, September 5, 1857 (p. 481)

D. Appleton & Company. New York, New York, USA. 1887

The value of the products of our imagination depends, of course, on the number, accuracy, and clearness of our impressions, on our judgment and taste in selecting or rejecting the involuntary combinations, and to a certain extent on our power of voluntary [combinations of] them...

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Part I, Chapter III (p. 292)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

And yet there should be no combination of events for which the wit of man cannot conceive an explanation. Simply as a mental exercise, without any assertion that it is true, let me indicate a possible line of thought. It is, I admit, mere imagination; but how often is imagination the mother of truth?

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Valley of Fear

Part I, Chapter 6 (p. 507)

Wings Books. New York, New York, USA. 1967

...for strange effects and extraordinary combinations we must go to life itself, which is always far more daring than any effort of the imagination.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Red-Headed League (p. 419)

Wings Books. New York, New York, USA. 1967

### **Einstein, Albert** 1879–1955

German-born physicist

I am enough of an artist to draw freely upon my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 117)

### **Einstein, Albert** 1879–1955

German-born physicist

### **Infeld, Leopold** 1898–1968

Polish physicist

In imagination there exists the perfect mystery story. Such a story presents all the essential clues, and compels us to form our own theory of the case. If we follow the plot carefully we arrive at the complete solution for ourselves just before the author's disclosure at the end of

the book. The solution itself, contrary to those of inferior mysteries, does not disappoint us; moreover, it appears at the very moment we expect it.

*The Evolution of Physics*

The Great Mystery Story (p. 3)

Simon & Schuster. New York, New York, USA. 1961

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Science does not know its debt to imagination.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Chapter I (p. 10)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Faraday, Michael** 1791–1867

English physicist and chemist

The world little knows how many of the thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and secrecy by his own severe criticism and adverse examination; that in the most successful instances not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized.

In Karl Pearson

*The Grammar of Science*

Introductory, Section 11 (p. 38)

Charles Scribner's Sons. London, England. 1892

The truth of science has ever had not merely the task of evolving herself from the dull and uniform mist of ignorance, but also that of the repressing and dissolving the phantoms of the imagination.

In Bence Jones

*The Life and Letters of Faraday* (Volume 2)

Chapter III (p. 285)

Longmans, Green & Company. London, England. 1870

...in the pursuit of physical science, the imagination should be taught to present the subject investigated in all possible and even impossible views...

*Experimental Researches in Chemistry and Physics*

On Mental Education (p. 480)

Richard Taylor & William Francis. London, England. 1859

### **Fersman, A. E.** 1883–1945

Geochemist and mineralogist

First of all, a scientist must be endowed with an imagination, for imagination plays no less important a part in science than it does in art. Imagination is as necessary as is painstaking work on collected material. Without imagination scientific work is just an assortment of facts and conclusions — empty, chaotic, and often barren.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Progress Publishers. Moscow, Russia. 1979



**Feynman, Richard P.** 1918–88  
American theoretical physicist

...the imagination of nature is far, far greater than the imagination of man.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter 1 (p. 10)  
Perseus Books. Reading, Massachusetts, USA. 1998

What we need is imagination, but imagination in a terrible strait-jacket.

*The Character of Physical Law*  
Chapter 7 (p. 171)  
British Broadcasting Company. London, England. 1965

As usual, nature's imagination far surpasses our own, as we have seen from the other theories which are subtle and deep.

*The Character of Physical Law*  
Chapter 7 (p. 162)  
British Broadcasting Company. London, England. 1965

Imagination reaches out repeatedly trying to achieve some higher level of understanding, until suddenly I find myself momentarily alone before one new corner of nature's pattern of beauty and true majesty revealed.

*Les Prix Nobel. The Nobel Prizes in 1965*  
Nobel banquet speech for award received in 1965  
Nobel Foundation. Stockholm, Sweden. 1966

It is only through refined measurements and careful experimentation that we can have a wider vision. And then we see unexpected things: we see things that are far from what we would guess — far from what we could have imagined. Our imagination is stretched to the utmost, not, as in fiction, to imagine things which are not really there, but just to comprehend those things which are there.

*The Character of Physical Law*  
Chapter 6 (p. 127)  
British Broadcasting Company. London, England. 1965

It is surprising that people do not believe that there is imagination in science. It is a very interesting kind of imagination, unlike that of the artist. The great difficulty is in trying to imagine something that you have never seen, that is consistent in every detail with what has already been seen, and that is different from what has been thought of; furthermore, it must be definite and not a vague proposition. That is indeed difficult.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter 1 (pp. 22–23)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

The whole question of imagination in science is often misunderstood by people in other disciplines...whatever we are allowed to imagine in science must be consistent with everything else we know: that the electric fields and the waves we talk about are not just some happy thoughts which we are free to make as we wish, but ideas which must be consistent with all the laws of physics we know. We can't allow ourselves to seriously imagine things which are obviously in contradiction to the known laws of nature. And so our kind of imagination is quite a difficult game. One has to have the imagination to think of something that has never been seen before, never been heard of before. At the same time the thoughts are restricted in a strait jacket, so to speak, limited by the conditions that come from our knowledge of the way nature really is. The problem of creating something which is new, but which is consistent with everything which has been seen before, is one of extreme difficulty.

*The Feynman Lectures on Physics* (Volume 2)  
Chapter 20–3 (p. 20–10)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Frye, Northrop** 1912–91  
Canadian literary critic

Science begins with the world we have to live in, accepting its data and trying to explain its laws. From there, it moves toward the imagination: it becomes a mental construct, a model of a possible way of interpreting experience.

*The Educated Imagination*  
The Motive for Metaphor (p. 23)  
Indiana University Press. Bloomington, Indiana, USA. 1964

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

I find that few men of imagination are not worth my attention. Their ideas may be wrong, even foolish, but their methods often repay a close study. Few honest passions are not based upon some valid perception of unity or some anomaly worthy of note. The different drummer often beats a fruitful tempo.

*The Panda's Thumb: More Reflections in Natural History*  
Chapter 22 (p. 234–235)  
W.W. Norton & Company, Inc. New York, New York, USA. 1980

**Goya, Francisco Jose** 1746–1828  
Spanish artist

Imagination deserted by reason creates monstrosities. United with reason, imagination gives birth to great marvels and true art.

*Caption to Caprichos, Number 43*

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

Science is vastly more stimulating to the imagination than the classics.

*Daedalus, or Science and the Future*

Paper read to the Heretics, Cambridge, England, February 4<sup>th</sup>, 1923

### Harding, Rosamund E. M.

No biographical data available

Dreaming over a subject is simply...allowing the will to focus the mind passively on the subject so that it follows the trains of thought as they arise, stopping them only when unprofitable but in general allowing them to form and branch naturally until some useful and interesting results occur.

*An Anatomy of Inspiration*

Chapter I (p. 5)

W. Heffer & Sons Ltd. Cambridge, England. 1940

### Harishchandra

Mythical Hindu king

I have often pondered over the roles of knowledge or experience, on the one hand, and imagination or intuition, on the other, in the process of discovery. I believe that there is a certain fundamental conflict between the two, and knowledge, by advocating caution, tends to inhibit the flight of imagination. Therefore, a certain naiveté, unburdened by conventional wisdom, can sometimes be a positive asset.

In R. Langlands

*Biographical Memoirs of Fellows of the Royal Society*

Harish-Chandra, Volume 31, 1985 (p. 206)

### Hawking, Stephen William 1942–

English theoretical physicist

Science fiction like Star Trek is not only good fun but it also serves a serious purpose, that of expanding the human imagination.

In Lawrence M. Krauss

*The Physics of Star Trek*

Forward (p. xi)

Harp Perennial Publishers. New York, New York, USA. 1995

### Herbart, Johann Friedrich 1776–1841

German philosopher and educator

The great science occupies itself at least just as much with the power of imagination as with the power of logical conclusion.

*Werke*

Pestalozzi's Idee eines ABC der Anschauung, Bd. 1 (p. 174)

Langensalza. 1890

### Herschel, Friedrich Wilhelm 1738–1822

English astronomer

If we indulge a fanciful imagination and build worlds of our own, we must not wonder at our going wide from the path of truth and nature; but these will vanish like

the Cartesian vortices, that soon gave way when better theories were offered.

The Construction of the Heavens

*Philosophical Transactions of the Royal Society of London*, Volume LXXV, February 3, 1785 (p. 213)

[I]f we would hope to make any progress in an investigation of this delicate nature, we ought to avoid two opposite extremes, of which I can hardly say which is the most dangerous. If we indulge a fanciful imagination and build worlds of our own, we must not wonder at our going wide from the path of truth and nature; but these will vanish like the Cartesian vortices, that soon gave way when better theories were offered.

On the other hand, if we add observation to observation, without attempting to draw no only certain conclusions, but also conjectural views from them, we offend against the very end for which only observations ought to be made.

On the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London*, Volume LXXV, February 3, 1785 (p. 213)

### Huggins, Sir William 1824–1910

English astronomer

This creative use of the imagination is not only the fountain of all inspiration in poetry and art, but is also the source of discovery in science, and indeed supplies the initial impulse to all development and progress. It is this creative power of the imagination which has inspired and guided all the great discoveries in science.

In William H. George

*The Scientist in Action: A Scientific Study of His Methods*

The Scientific Theory (p. 226)

Williams & Norgate Ltd. London, England. 1936

### Huxley, Julian 1887–1975

English biologist, philosopher, and author

Imagination is needed in science as much as in any other mental activity. But it must not take charge of the scientific mind. If it [were to] do, disaster may follow.

*Essays in Popular Science*

On the History of Science (p. 168)

Chatto & Windus. London, England. 1926

### Huxley, Thomas Henry 1825–95

English biologist

The rapid increase of natural knowledge, which is the chief characteristic of our age, is effected in various ways. The main army of science moves to the conquest of new worlds slowly and surely, nor ever cedes an inch of the territory gained. But the advance is covered and facilitated by the ceaseless activity of clouds of light troops provided with a weapon — always efficient, if not always an arm of precision — the scientific imagination.

*Man's Place in Nature and other Anthropological Essays*

Chapter VI (p. 271)

D. Appleton & Company. New York, New York, USA. 1896

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...are there any limits at all to the extent of space? Even a generation ago, I think most scientists would have answered this question in the negative. They would have argued that space could be limited only by the presence of something which is not space. We, or rather our imaginations, could only be prevented from journeying for ever through space by running against a wall of something different from space. And, hard though it may be to imagine space extending for ever, it is far harder to imagine a barrier of something different from space which could prevent our imaginations from passing into a further space beyond.

*The Universe Around Us*

Chapter I (p. 68)

The Macmillan Company. New York, New York, USA. 1929

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

Although today we look harder and farther than we have ever looked, with all the instruments of modern science, and with all of the imagination and courage we can muster, we are still blind watchers of the sky.

*Blind Watchers of the Sky*

Chapter One (p. 9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1996

...the greatest tool of discovery is the human imagination.

*Blind Watchers of the Sky*

Preface (p. x)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1996

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–

1829

French biologist

Imagination is one of the finest faculties of man: it ennobles and elevates his thoughts and relieves him from the domination of minute details; and when it reaches a very high development, it makes him superior to the great majority of other people.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VIII (p. 390)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The philosopher who is really useful to the cause of science, is he who, uniting to a fertile imagination, a rigid

severity in investigation and observation, is at once tormented by the desire of ascertaining the cause of the phenomena, and by the fear of deceiving himself in that which he assigns.

*System of the World* (Volume 2)

Book V, Chapter IV (pp. 276–277)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

**Lavoisier, Antoine Laurent** 1743–94

French chemist

In the study and practice of the sciences [learning to reason justly] is quite different; the false judgments we form neither affect our existence nor our welfare; and we are not forced by any physical necessity to correct them. Imagination, on the contrary, which is ever wandering beyond the bounds of truth, joined to self-love and that self-confidence we are so apt to indulge, prompts us to draw conclusions which are not immediately derived from facts; so that we become in some measure interested in deceiving ourselves. Hence it is by no means to be wondered, that, in the science of physics in general, men have often made suppositions, instead of forming conclusions. These suppositions, handed down from one age to another, acquire additional weight from the authorities by which they are supported, till at last they are received, even by men of genius, as fundamental truths.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xvii)

Printed for William Creech. Edinburgh, Scotland. 1790

**Leslie, Sir John** 1766–1832

Scottish physicist and mathematician

The gift of a lively fancy is an important requisite for every physical observer.

*Elements of Natural Philosophy*

Introduction (p. xiii)

Printed for W. & C. Tate. Edinburgh, Scotland. 1823

**Lowell, Percival** 1855–1916

American astronomer

Imagination is the single source of the new...reason, like a balance wheel, only keeping the action regular. For reason...compares what we imagine with what we know, and gives us the answer in terms of the here and now, which we call the actual. But the actual...does not mark the limit of the possible.

In William Graves Hoyt

*Lowell and Mars*

Chapter 2 (p. 20)

University of Arizona Press. Tucson, Arizona, USA. 1976

A good education is indispensable, one as broad as it is long; without it he runs the risk of becoming a crank. Then enters the important quality of imagination. This word to the routine rabble of science is a red rag to a bull; partly because it is beyond their conception, partly

because they do not comprehend how it is used. To their thinking to call a man imaginative is to damn him; when, did they but know it, it is admitting the very genius they would fain deny. For all great work imagination is vital; just as necessary in science and business as it is in novels and art.... The difference between the everyday and scientific use of it is in that in science every imagining must be tested to see whether it explains the facts. Imagination harnessed to reason is the force that pulls an idea through. Reason, too, of the most complete, uncompromising kind. Imagination supplies the motive power, reason the guiding rein.

In William Graves Hoyt

*Lowell and Mars*

Chapter 2 (p. 21)

University of Arizona Press. Tucson, Arizona, USA. 1976

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

After having reached an opinion for a special case, one gradually modifies the circumstances of this case in one's imagination as far as possible, and in doing so tries to stick to the original opinion as closely as one can. There is no procedure which leads more safely and with greater mental economy to the simplest interpretation of all natural events.

In Ephraim Avigdor Speiser

*Studies in the History of Science* (p. 105)

University of Pennsylvania Press. Philadelphia, Pennsylvania, USA.

1941

**Mayo, William J.** 1861–1939

American physician

The sciences bring into play the imagination, the building of images in which the reality, of the past is blended with the ideals for the future, and from the picture there springs the prescience of genius.

Contributions of Pure Science to Progressive Medicine

*The Journal of the American Medical Association*, Volume 84 Number

20, May 16, 1925 (p. 1466)

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

All advances of scientific understanding, at every level, begin with a speculative adventure, an imaginative pre-conception of what might be true.... [This] conjecture is then exposed to criticism to find out whether or not that imagined world is anything like the real one. Scientific reasoning is, therefore, at all levels an interaction between two episodes of thought — a dialogue between two voices, the one imaginative and the other critical...

*The Hope of Progress*

Science and Literature (p. 16)

Methuen & Company Ltd. London, England. 1972

**Miller, Hugh** 1802–56

Scottish geologist and theologian

It is said that modern science is averse to the exercise and development of the imaginative faculty. But is it really so?

*Sketch-Book of Popular Geology*

Lecture Second (p. 79)

William P. Nimmo & Company, Edinburgh, Scotland. 1880

**Mitchell, Maria** 1818–89

American astronomer and educator

We especially need imagination in science. It is not all mathematics, nor all logic, but it is somewhat beauty and poetry.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter IX (p. 187)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Patten, William**

No biographical data available

Imagination opens the gates of the universe.

In Austin L. Porterfield

*Creative Factors in Scientific Research*

Chapter IV (p. 61)

Duke University Press. Durham, North Carolina, USA. 1941

**Payne-Gaposchkin, Celia** 1900–79

British-American astronomer

To realize one's limitations marks the awakening of intellectual integrity, without which imagination, integrity and assiduity are barren.

*An Autobiography and Other Recollections*

Chapter 7 (p. 123)

Cambridge University Press. Cambridge, England. 1984

**Pearson, Karl** 1857–1936

English mathematician

Hundreds of men have allowed their imagination to solve the universe, but the men who have contributed to our real understanding of natural phenomena have been those who were unstinted in their application of criticism to the product of their imaginations.

*The Grammar of Science*

Introductory, Section 11 (p. 38)

Charles Scribner's Sons. London, England. 1892

All great scientists have, in a certain sense, been great artists; the man with no imagination may collect facts, but he cannot make great discoveries.

*The Grammar of Science*

Introductory, Section 11 (p. 37)

Charles Scribner's Sons. London, England. 1892

**Peebles, Curtis**

American aerospace historian

Before a discovery can be made, human imagination must be opened to new possibilities.

*Asteroids: A History*

Chapter 1 (p. 3)  
Smithsonian Institution Press. Washington, D.C. 2000

**Planck, Max** 1858–1947  
German physicist

...when the pioneer in science sends for the groping feelers of his thoughts, he must have a vivid intuitive imagination, for new ideas are not generated by deduction, but by an artistically creative imagination. Nevertheless, the worth of a new idea is invariably determined, not by the degree of its intuitiveness — which, incidentally, is to a major extent a matter of experience and habit — but by the scope and accuracy of the individual laws to the discovery of which it eventually leads.

*Scientific Autobiography and Other Papers*  
The Meaning and Limits of Exact Science, Part III (p. 109)  
Philosophical Library. New York, New York, USA. 1949

**Pulitzer, Joseph** 1847–1911  
American journalist and publisher

I know what you mean by imagination! That it is necessarily inexact or irresponsible. I hope you will recover from that. Imagination isn't disorder or sloppiness or substituting misinformation for something that should have been definitely ascertained.... It isn't being lazy or indifferent or lacking personal or professional conscience. No. It is what the astronomer has when he says that right there, though no one has located it, must be a star. It is what Darwin had when, with the long orchid in his hand, he said that somewhere they would find the long-tongued moth who visited it.

In Austin L. Porterfield  
*Creative Factors in Scientific Research*  
Chapter IV (p. 61)  
Duke University Press. Durham, North Carolina, USA. 1941

**Raymo, Chet** 1936–  
American physicist and science writer, teacher, and naturalist

No more of the universe is visible to our unaided eyes than to the eyes of our Neanderthal ancestors. But science, the product of our imagination, has immensely extended the range of our imagination. Our inward eye can range beyond the dome of visible stars to the unseen realm of the nebulae and galaxies.

*365 Starry Nights*  
Introduction (p. x)  
Prentice Hall Press. New York, New York, USA. 1982

Science is not a collection of facts, nor is science something that happens in the laboratory. Science is something that happens in the head; it is a flight of imagination beyond the constraints of ordinary imagination.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 1 (p. 3)  
The Viking Press. New York, New York, USA. 1991

**Reid, Thomas** 1710–96  
Scottish philosopher

It is genius, and not the want of it, that adulterates philosophy, and fills it with error and false theory. A creative imagination disdains the mean offices of digging for a foundation, of removing rubbish, and carrying materials; leaving these servile employments to the drudges in science, it plans a design, and raises a fabric. Invention supplies materials where they are wanting, and fancy adds colouring and every befitting ornament. The work pleases the eye, and wants nothing but solidity and a good foundation.

*The Works of Thomas Reid* (Volume 1)  
An Inquiry into the Human Mind, Chapter I, Section ii (p. 99)  
James Thin. Edinburgh, Scotland. 1895

**Richards, Mary Caroline**  
No biographical data available

The imagination equips us to perceive reality when it is not fully materialized.

*Centering in Pottery, Poetry, and the Person*  
Chapter III (p. 74)  
Wesleyan University Press. Middletown, Connecticut, USA. 1989

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...if you have a good scientific imagination you can think of all sorts of things that might be true, and that's the essence of science. You first think of something that might be true — then you look to see if it is, and it generally isn't.

*Bertrand Russell Speaks His Mind*  
What Is Philosophy? (p. 13)  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1960

**Schopenhauer, Arthur** 1788–1860  
German philosopher

Every man takes the limits of his own field of vision for the limits of the world.

*The Wisdom of Life, and Other Essays*  
Studies in Pessimism  
Psychological Observations (p. 255)  
M. W. Dunne. New York, New York, USA. 1901

**Serling, Rod** 1924–75  
American playwright

There is a fifth dimension beyond those known to man. It is a dimension vast as space and timeless as infinity. It is the middle ground between light and shadow, between the pit of his fears and the summit of his knowledge. This is the dimension of imagination. It is an area called the Twilight Zone.

*Twilight Zone*  
Preamble  
Television program (1959–1964)

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

DON JUAN: Stupidity has all the knowledge, and Imagination all the intelligence.

*Man and Superman: A Comedy and a Philosophy*

Act III (p. 83)

The Heritage Press. New York, New York, USA. No date

**Teall, J. J. Harris** 1849–1924

British geologist

...it is well to remember that there is a scientific, as well as an unscientific, use of the imagination.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

The Evolution of Petrological Ideas (p. 288)

Government Printing Office. Washington, D.C. 1903

**Thomson, Sir George** 1892–1975

English physicist

Science, like all arts, needs imagination.

*The Inspiration of Science*

Chapter II (p. 8)

Oxford University Press, Inc. London, England. 1961

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

...the imagination, give it the least license, dives deeper and soars higher than Nature goes.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter XVI (p. 441)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Tombaugh, Clyde** 1906–97

American astronomer

You have to have the imagination to recognize a discovery when you make one. When they examined Voyager images and saw for the first time the volcanic eruptions on Io, that called for some intuitive imagination. I would suggest that above everything else, in observing you have to be very alert to everything. You have to be able to recognize a discovery as such. There are so many people who don't seem to have that talent. A research astronomer cannot afford to be in such a rut. I might say that different types of personalities in astronomy make certain types of discoveries that are in line with their personalities.

In David H. Levy

*Clyde Tombaugh: Discoverer of Planet Pluto*

Chapter 5 (p. 61)

University of Arizona Press. Tucson, Arizona, USA. 1991

**Tyndall, John** 1820–93

Irish-born English physicist

With accurate experiment and observation to work upon... imagination becomes the architect of physical theory.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VI (p. 162)

Macmillan &amp; Company Ltd. London, England. 1918

**Velikovsky, Immanuel** 1895–1979

Russian author

Imagination coupled with skepticism and an ability to wonder — if you possess these, bountiful nature will hand you some of the secrets out of her inexhaustible store. The pleasure you will experience in discovering truth will repay you for your work; don't expect other compensation, because it may not come.

*Earth in Upheaval*

Supplement, Worlds in Collision in the Light of Recent Finds in

Archaeology, Geology, and Astronomy, Address, Princeton University, October 14, 1953 (p. 279)

Dell Publishing Company, Inc. New York, New York, USA. 1955

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

There is an astonishing imagination, even in the science of mathematics... We repeat, there was far more imagination in the head of Archimedes than in that of Homer.

*The Works of Voltaire* (Volume 10)

*Philosophical Dictionary* (Volume 10)

Imagination (p. 170)

The St. Hubert Guild. Akron, Ohio, USA. 1901

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

All our minds are made of memories. In our memories each of us has something that without any special training whatever will go back into the past and grip firmly and convincingly all sorts of workable facts, sometimes more convincingly than firmly. But the imagination, unless it is strengthened by a very sound training in the laws of causation, wanders like a lost child in the blankness of things to come and returns empty.

*The Discovery of the Future* (p. 21)

B.W. Huebsch. New York, New York, USA. 1913

**Wheeler, John Archibald** 1911–

American physicist and educator

The vision of the Universe that is so vivid in our minds is framed by a few iron posts of true observation — themselves resting on theory for their meaning — but most of all the walls and towers in the vision are of papier-mâché, plastered in between those posts by an immense labor of imagination and theory.

In John Archibald Wheeler and Wojciech Hubert Zurek (eds.)

*Quantum Theory and Measurement*

Law Without Law (p. 203)

Princeton University Press. Princeton, New Jersey, USA. 1983

**Whitrow, G. J.** 1912–2000

English mathematician

Our idea of the universe as a whole remains a product of the imagination.

*The Structure and Evolution of the Universe: An Introduction to Cosmology*  
Chapter 8 (p. 197)  
Hutchinson. London, England. 1959

**Wilson, Edmund** 1895–1972  
American writer and literary critic

The great scientists have been occupied with values — it is only their vulgar followers who think they are not. If scientists like Descartes, Newton, Einstein, Darwin, and Freud don't "look deeply into experience," what do they do? They have imaginations as powerful as any poet's and some of them were first-rate writers as well. How do you draw the line between Walden and *The Voyage of the Beagle*? The product of the scientific imagination is a new vision of relations — like that of the artistic imagination.

In Elena Wilson (ed.)  
*Letters on Literature and Politics, 1912–1972*  
Letter to Allen Tate, July 20, 1931 (p. 212)  
Farrar, Straus & Giroux. New York, New York, USA. 1977

## IMMORTALITY

**Plato** 428 BCE–347 BCE  
Greek philosopher

But he who has been earnest in the love of knowledge and of true wisdom, and has exercised his intellect more than any other part of him, must have thoughts immortal and divine, if he attain truth, and in so far as human nature is capable of sharing in immortality, he must altogether be immortal...

In *Great Books of the Western World* (Volume 7)  
*Timaeus*  
Section 90 (p. 476)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**von Braun, Wernher** 1912–77  
German-American rocket scientist

Nature does not know extinction: all it knows is transformation. Everything science has taught me, and continues to teach me, strengthens my belief in the continuity of our spiritual existence after death.

Immortality  
*This Week Magazine*, January 24, 1960 (p. 2)

## IMMUNITY

**Mechnikov, Ilya** 1845–1916  
Russian microbiologist

There is no need to be a doctor or a scientist to wonder why the human body is capable of resisting so many harmful agents in the course of everyday life. It is often

seen that in households where all members are exposed to the same danger, or again in schools or troops where everyone lives the same life, disease does not strike everyone indifferently. For some individuals who go down at the attack, there are others who have immunity to a greater or lesser extent.

*Nobel Lectures, Physiology or Medicine 1901–1921*  
Nobel lecture for award received in 1908  
On the Present State of the Question of Immunity in Infectious Diseases (p. 281)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## IMMUNOLOGICAL DEFENSE

**Chedd, Graham**  
No biographical data available

[I]t is possible to divide [immunological defenses] into two general classes, representing approximately the infantry and the heavy armor. The infantry consists of the well-known soluble antibodies, sent out into the blood in response to invasion by the great majority of the microbes to which we are susceptible. The heavy armour is made up of the cytotoxic lymphocytes, the class of white blood cells that attack and destroy many parasitic organisms, that are largely responsible for rejecting grafts of foreign tissue, and whose main job may be to patrol the body on the continual lookout for cancer cells.

Immunological Engineering  
*New Scientist and Science Journal*, May 13, 1971

**Thomas, Lewis** 1913–93  
American physician and biologist

Our arsenals for fighting off bacteria are so powerful and involve so many defense mechanisms, that we are more in danger from these than from the invaders. We live in the midst of explosive devices. We are mined.

*New England Journal of Medicine*, September 14, 1972

## IMPOSSIBILITY

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

It is impossible to import things into an infinite area, there being no outside to import things in from.

*The Original Hitchhiker Radio Script*  
Fit the Fifth (p. 101)  
Harmony Books. New York, New York, USA. 1983

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

In framing an ideal we may assume what we wish, but should avoid impossibilities.

In *Great Books of the Western World* (Volume 9)  
*Politics*

Book II, Chapter 6, 1265a [15]  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A likely impossibility is always preferable to an unconvincing possibility.

In *Great Books of the Western World* (Volume 8)

*On Poetics*

24, 1460a

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

To aim at such a distant object and hit it is of course impossible. But if one has the impudence to throw in that direction without aiming, and in addition to imagine something so absurd as that one might hit it, yes, then perhaps it can happen. The idea that something perhaps could happen can be stronger than practice and will.

In Timothy Ferris (ed.)

*The Whole Shebang: A State—of-the Universe's Report*

Quantum Weirdness (p. 273)

Simon & Schuster. New York, New York, USA. 1996

**Borel, Félix Edouard** 1871–1956

French mathematician

Events with a sufficiently small probability never occur, or at least we must act, in all circumstances, as if they were impossible.

Translated by Maurice Baudin

*Probabilities and Life*

Introduction (pp. 2–3)

Dover Publications. New York, New York, USA. 1962

**Braudel, Fernand** 1902–85

French historian

...intellectuals are always fascinated by the impossible.

Translated by Sarah Matthews

*On History*

Part II, History and the Social Science (p. 35)

University of Chicago Press. Chicago, Illinois, USA. 1980

**Card, Orson Scott** 1951–

Science fiction author

You can't rule out the impossible, because you never know which of your assumptions about what was possible might turn out in the real universe to be false.

*Ender's Shadow*

Chapter 22 (p. 348)

TOR. New York, New York, USA. 1999

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

Alice laughed. "There's no use trying," she said "one can't believe impossible things."

"I daresay you haven't had much practice," said the Queen. "When I was your age, I always did it for half-

an-hour a day. Why, sometimes I've believed as many as six impossible things before breakfast..."

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter V (p. 200)

The Modern Library. New York, New York, USA. 1936

**Chestov, Leon** 1866–1938

Russian philosopher

A round square or a wooden iron is an absurdity and consequently an impossibility...

Look Back and Struggle

*Forum Philosophicum*, Volume 1, Number 1, 1930 (p. 112)

**Clarke, Arthur C.** 1917–

English science and science fiction writer

The only way of finding the limits of the possible is by going beyond them into the impossible.

*The Lost Worlds of 2001*

Chapter 34 (p. 189, fn)

New American Library. New York, New York, USA. 1972

**Cromer, Alan** 1935–

American physicist and educator

Belief in impossibility is the starting point for logic, deductive mathematics, and natural science. It can originate in a mind that has freed itself from belief in its own omnipotence.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 4 (p. 78)

Oxford University Press, Inc. New York, New York, USA. 1993

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Holmes," I cried, "this is impossible."

"Admirable!" he said. "A most illuminating remark. It is impossible as I state it, and therefore I must in some respect have stated it wrong."

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of Priory School (p. 620)

Wings Books. New York, New York, USA. 1967

**Goddard, Robert H.** 1882–1945

American physicist

Often a science in its infancy, because it is unable to distinguish between path and barrier, falsely judges many things to be possible and others to be impossible...

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted

Graduation oration (p. 66)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Goldwyn, Samuel** 1882–1974

American film producer

I'll tell you in two words — im - possible.

Quoted in his obituary

*New York Times*, February 1, 1974



**Huxley, Aldous** 1894–1963  
English writer and critic

Except under controlled conditions, or in circumstances where it is possible to ignore individuals and consider only large numbers and the law of averages, any kind of accurate foresight is impossible.

*Time Must Have a Stop*  
Chapter XXX (p. 296)  
The Sun Dial Press. Garden City, New York, USA. 1944

**Juster, Norton** 1929–  
American architect and author

...so many things are possible just as long as you don't know they're impossible.

*The Phantom Tollbooth*  
Chapter 19 (p. 247)  
Alfred A. Knopf. New York, New York, USA. 1989

**Rubinstein, Anton** 1829–94  
Russian pianist, composer, and conductor

Do not forget to dare the impossible in order to achieve the possible.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneiersson  
Progress Publishers. Moscow, Russia. 1979

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Well, I'll have her: and if it be a match, as nothing is impossible —.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The Two Gentlemen of Verona  
Act III, Scene ii, l. 379  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Syngé, John L.** 1897–1995  
Irish mathematician and physicist

There is a fascination about the impossible... which is responsible for the dreams and fantasies with which we are all familiar. Everything which is possible becomes banal. Only the inaccessible is worthy of our passions.

*Kandelman's Krim*  
Chapter Eight (p. 115)  
Jonathan Cape. London, England. 1957

**Thurber, James** 1894–1961  
American writer and cartoonist

All things, as we know, are impossible in this most impossible of all impossible worlds.

*Lanterns and Lances*  
The Last Clock (p. 43)  
Time-Life Books, Inc. Alexandria, Virginia, USA. 1980

**von Braun, Wernher** 1912–77  
German-American rocket scientist

...the past few decades should have taught us to use the word "impossible" with utmost caution.

In Erik Bergaust  
*Wernher von Braun*  
Reaching for the Straws (p. 2)  
National Space Institute. Washington, D.C. 1976

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

Man can believe the impossible, but man can never believe the improbable.

*Epigrams: Phrases and Philosophies for the Use of the Young*  
Sebastian Melmoth  
A.R. Keller. London, England. 1907

## IMPRESSION

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The human understanding is most excited by that which strikes and enters the mind at once and suddenly, and by which the imagination is immediately filled and inflated. It then begins almost imperceptibly to conceive and suppose that everything is similar to the few objects which have taken impression on the mind.

In W.I.B. Beveridge  
*The Art of Scientific Investigation*  
Chapter Nine (p. 114)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

## IMPROBABILITY

**Dawkins, Richard** 1941–  
English ethologist, evolutionary biologist, and popular science writer

To "tame" chance means to break down the very improbable into less improbable small components arranged in series. No matter how improbable it is that an X could have arisen from Y in a single step, it is always possible to conceive of a series of infinitesimal graded intermediates between them. However improbable a large scale change may be, smaller changes are less improbable. And provided we postulate a sufficient series of sufficiently finely graded intermediates, we shall be able to derive anything from anything else, without astronomical improbabilities.

*The Blind Watchmaker*  
Chapter 11 (pp. 317–318)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

Physical theories must not introduce as many arbitrary constants as there are phenomena to be accounted for; they must establish connections among the various experimental facts and, above all, must lead to predictions.

In A. d'Abro  
*The Rise of the New Physics* (Volume One)  
 Chapter IV (p. 33)  
 Dover Publications, Inc. New York, New York, USA. 1951

## INADEQUACY

**Cannon, Walter Bradford** 1871–1945  
 American neurologist and physiologist

Training and practice may not lead to perfection, but they will surely compensate for early inadequacy.

*The Way of an Investigator: A Scientist's Experiences in Medical Research*  
 Chapter III (p. 43)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1945

## INCONCEIVABILITY

**Kelvin, Lord William Thomson** 1824–1907  
 Scottish engineer, mathematician, and physicist

Nothing that we can measure is inconceivably large or inconceivably small in physical science.

*Popular Lectures and Addresses* (Volume 1)  
 Lecture, Royal Institution of Great Britain  
 February 3, 1883 (p. 147)  
 Macmillan & Company Ltd. London, England. 1894

## INDEPENDENCE

**Koerner, Jon**  
 No biographical data available

The problem is that, in many cases for many systems, there may simply be no such thing as a truly independent variable. Out here in the real world, the phrase “independent” may often be oxymoronic. The very notion of independence reflects the world of Platonic idealism, a pure world populated by separate discrete things each with its essence, floating suspended in a sea of laws, rules governing the relations between these autonomous entities.

*Nontriviality of Nonlinear Dynamics in Psychology of Learning*  
 Doctoral dissertation, University of Minnesota, 1989 (p. 118)

## INDEX FOSSIL

**Shaw, Alan**  
 No biographical data available

It would be difficult to estimate how many nascent geologists have been turned aside from paleontology by being forced during the course of some dismal semester to learn hundreds of index fossils and the formations of which they are the index. Many geologists' sole memory of the whole discipline of paleontology is the unerasable fact that “*Spirifer frimesi* is the index fossil of the Burlington Limestone” or some such tidbit.

*Time in Stratigraphy*  
 Chapter 13 (p. 90)  
 McGraw-Hill Book Company. New York, New York, USA. 1964

## INDIGESTION

**Hugo, Victor** 1802–85  
 French author, lyric poet, and dramatist

Indigestion was sent into the world to read a lecture to our stomachs...

*Les Miserables*  
 Volume 1, Book III, Chapter 7 (p. 132)  
 The Heritage Press. New York, New York, USA. 1938

**Ingersoll, Robert G.** 1833–99  
 American orator and lawyer

...many people think they have religion when they are troubled with dyspepsia.

*The Ghosts: and Other Lectures*  
 The Liberty of Man, Woman and Child (p. 122)  
 C.P. Farrell, Publishers. New York, New York, USA. 1892

## INDIVIDUAL

**Einstein, Albert** 1879–1955  
 German-born physicist

The individual feels the nothingness of human desires and aims and the sublimity and marvelous order which reveal themselves both in Nature and in the world of thought. He looks upon individual existence as a sort of prison and wants to experience the universe as a single significant whole.

*The World as I See It* (p. 229)  
 Philosophical Library. New York, New York, USA. 1949

## INDIVIDUALITY

**Muir, John** 1838–1914  
 American naturalist

Indeed, every atom in creation may be said to be acquainted with and married to every other, but with universal union there is a division sufficient in degree for the purposes of the most intense individuality.

*Steep Trails*  
 Chapter I (p. 12)  
 Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

...no matter, therefore, what may be the note which any creature forms in the song of existence, it is made first for itself, then more and more remotely for all the world and worlds.

*Steep Trails*  
 Chapter I (p. 12)  
 Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**INDUCTION**

**Comte, Auguste** 1798–1857  
French philosopher

Induction for deduction, with a view to construction.

In J.A. Thomson

*Introduction to Science*

Chapter III (p. 58)

Williams & Norgate Ltd. London, England. 1916

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

Even in the mathematical sciences, our principal instruments to discover the truth are induction and analogy.

*Oeuvres complètes de Laplace*

Introduction, Volume 7 (p. v)

Gauthier-Villars. Paris, France. 1886

Analysis and natural philosophy owe their most important discoveries to this fruitful means, which is called induction. Newton was indebted to it for his theorem of the binomial and the principle of universal gravity.

*A Philosophical Essay on Probabilities*

Chapter XVII (p. 176)

Dover Publications, Inc. New York, New York, USA. 1951

**Lewis, C. S. (Clive Staples)** 1898–1963  
British author, scholar, and popular theologian

This is called the inductive method. Hypothesis, my dear young friend, establishes itself by a cumulative process: or, to use popular language, if you make the same guess often enough it ceases to be a guess and becomes a Scientific Fact.

*The Pilgrim's Regress: An Allegorical Apology for Christianity, Reason and Romanticism*

Wm. B. Eerdsman, Publishers. Grand Rapids. Michigan, USA. 1996

**Mendeleyev, Dmitry** 1834–1907  
Russian chemist

By investigating the universe by an inductive method (endeavoring from the much which is observable to arrive at a little which may be verified and is indubitable) the new science refuses to recognise dogma as truth, but through reason, by a slow and laborious method of investigation, strives for and attains to true deductions.

*Principles of Chemistry* (Volume 1)

Introduction (p. 2, fn 1)

Longmans, Green & Company. London, England. 1891

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

...the chief reason in favor of any theory on the principles of mathematics must always be inductive, i.e., it must lie in the fact that the theory in question enables us to deduce ordinary mathematics. In mathematics, the greatest

degree of self-evidence is usually not to be found quite at the beginning, but at some later point; hence the early deductions, until they reach this point, give reasons rather from them, than for believing the premises because true consequences follow from them, than for believing the consequences because they follow from the premises.

*Principia Mathematica* (Volume 1)

Preface (p. v)

At The University Press. Cambridge, England. 1950

**INERTIA**

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

Then it was found that the rules of motions of particles were incorrect. The mechanical rules of inertia and forces are wrong — Newton's laws are wrong — in the world of atoms. Instead, it was discovered that things on a small scale behave nothing like things on a larger scale.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2–3 (p. 2–6)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Leibniz, Gottfried Wilhelm** 1646–1716  
German philosopher and mathematician

It is one thing if something merely retains its state until some event happens to change it — a circumstance which may occur if the subject is completely indifferent with respect to either state; it is another thing and signifies much more if the subject is not indifferent but possesses a power, an inclination as it were, to retain its state and to resist the cause of change.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part II, Chapter I (p. 105)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Rothman, Milton A.** 1919–  
Experimental American nuclear physicist and science writer

There was once a government whose leaders decided that it would be nice to relieve the people of the effort of carrying their weight around. They reasoned that life would be much easier without the stresses and strains caused by the force of gravity. Therefore they convened their legislature and repealed the law of gravity. As soon as their president signed the bill, everything became weightless. Immediately all the air whizzed off into space. Likewise, all objects not tied down to the ground were flung away from the spinning earth — for, unfortunately, the legislature had forgotten to repeal the law of Inertia.

*The Laws of Physics*  
Chapter I (p. 5)  
Basic Books, Inc. New York, New York, USA. 1963

## INFECTION

### Voorhees, Irving Wilson

No biographical data available

Perpetual warfare ought to be waged against those who willfully cough and sneeze into the open without protecting the face with a handkerchief.

Colds: Their Cause and Cure  
*American Medicine*, Volume 12, 1917

## INFERENCE

### Deetz, James 1930–2000

American archaeologist

At the inferential level, the archaeologist is at least providing the flesh for the bare bones of his data, and, if done with care and imagination, such a procedure makes possible the delineation and ultimate understanding of past cultures.

*Invitation to Archaeology*  
Chapter I (p. 11)  
The Natural History Press. Garden City, New York, USA. 1967

### Deming, William Edwards 1900–93

American statistician, educator, and consultant

An inference, if it is to have scientific value, must constitute a prediction concerning future data. If the inference is to be made purely with the help of the distribution theory of statistics, the experiments that constitute evidence for the inference must arise from a state of statistical control; until that state is reached, there is no universe, normal or otherwise, and the statistician's calculations by themselves are an illusion if not a delusion. The fact is that when distribution theory is not applicable for lack of control, any inference, statistical or otherwise, is little better than a conjecture. The state of statistical control is therefore the goal of all experimentation.

*Statistical Method from the Viewpoint of Quality Control*  
Foreword from the Editor (p. iii)  
Washington: Department of Agriculture. 1939

### Priestley, Joseph 1733–1804

English theologian and scientist

I can only repeat that it is not my opinions on which I would be understood to lay any stress. Let the new facts, from which I deduce them, be considered as my discoveries, and let other persons draw better inferences from them if they can.

In F.W. Gibbs  
*Joseph Priestley: Adventurer in Science and Champion of Truth*

Chapter 9 (p. 117)  
Thomas Nelson & Sons Ltd. London, England. 1965

### Wiley, Gordon R. 1913–2002

American archaeologist and writer

Inference is the key or the methodological pivot of archaeology, for it is only through inference that inanimate objects are reassembled into the milieu of life. Inferences are drawn from analogies.

*An Introduction to American Archaeology* (Volume 1)  
North and Middle America (p. 3)  
Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1966

## INFINITE

### Anaxagoras ca. 500 BCE–428 BCE

Greek philosopher of nature

There is no smallest among the small and no largest among the large, But always something still smaller and something still larger.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 2)  
Birkhäuser. Boston, Massachusetts, USA. 1987

### Bailey, Philip James 1816–1902

English poet

God puts his finger in the other scale,  
And up we bounce, a bubble. Nought is great  
Nor small, with God; for none but he can make  
The atom imperceptible, and none  
But he can make a world; he counts the orbs,  
He counts the atoms of the universe,  
And makes both equal; both are infinite.

*Festus: A Poem*  
Scene IV (p. 83)  
George Routledge & Sons, Limited. London, England. 1893

### Bartlett, Elizabeth 1924–94

Because I longed  
to comprehend the infinite  
I drew a line  
between the known and unknown.

In Ernest Robson and Jet Wimp  
*Against Infinity*  
Because I Longed (p. 11)  
Primary Press, Parker Ford, Pennsylvania, USA. 1979

### Berkeley, George 1685–1753

Irish prelate and metaphysical philosopher

Of late the speculations about Infinities have run so high, and grown to such strange notions, as have occasioned no small scruples and disputes among the geometers of the present age. Some there are of great note who, not content with holding that finite lines may be divided into an infinite number of parts, do yet farther maintain that each of those infinitesimals is itself subdivisible into an

infinity of other parts or infinitesimals of a second order, and so on ad infinitum. These, I say, assert there are infinitesimals of infinitesimals of infinitesimals, & c., without ever coming to an end; so that according to them an inch does not barely contain an infinite number of parts, but an infinity of an infinity of an infinity ad infinitum of parts.

*The Principles of Human Knowledge*

Section 130

Hull, A. Brown & Sons, Ltd. London, England. 1937

**Blake, William** 1757–1827

English poet, painter, and engraver

If the doors of perception were cleansed, everything would appear to man as it is, infinite.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell

University of California Press. Berkeley, California, USA. 1982

**Borges, Jorge Luis** 1899–1986

Argentine writer

There is a concept which corrupts and upsets all others. I refer not to Evil, whose limited realm is that of ethics; I refer to the infinite.

In Donald A. Yates & James E. Irby (eds.)

*Labyrinths: Short Stories & Other Writings*

Avatars of the Tortoise (p. 202)

A New Direction Book. New York, New York, USA. 1964

The ignorant suppose that infinite number of drawings require an infinite amount of time; in reality it is quite enough that time to be infinitely subdivisible, as is the case in the famous parable of the Tortoise and the Hare. This infinitude harmonizes in an admirable manner with the sinuous numbers of Chance and of the Celestial Archetype of the Lottery, adored by the Platonists.

*Ficciones*

The Babylon Lottery (p. 70)

Grove Press. New York, New York, USA. 1962

**Camus, Albert** 1913–60

Algerian-French novelist, essayist, and playwright

Somebody has to have the last word. Otherwise, every reason can be met with another one and there would never be no end to it.

*The Fall* (p. 45)

Alfred A. Knopf. New York, New York, USA. 1958

**Carlyle, Thomas** 1795–1881

English historian and essayist

The moment of discovery, “spontaneous illumination...”  
The infinite is made to blend itself with the finite, to stand visible, as it were, attainable there.

In Roger A MacGowan and Frederick I Ordway, III

*Intelligence in the Universe* (p. 49)

Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1966

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

What is that thing which does not give itself, and which if it were to give itself would not exist?

It is the infinite...

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Mathematics (p. 612)

George Braziller. New York, New York, USA. 1958

**de Morgan, Augustus** 1806–71

English mathematician and logician

I had expressed my wish to have a thermometer of probability, with impossibility at one end, as 2 plus 2 makes 5, and necessity at the other as 2 plus 2 make 4.

*A Budget of Paradoxes*

Dr. Whewell's Letter (p. 416)

Longmans, Green & Company. London, England. 1872

Great fleas have little fleas upon their backs to bite 'em,  
And little fleas have lesser fleas, and so ad infinitum.

And the great fleas themselves, in turn have greater fleas to go on;

While these again have greater still, and greater still,  
and so on.

*A Budget of Paradoxes*

Are Atoms Worlds (p. 377)

Longmans, Green & Company. London, England. 1872

**Dell, J. H.**

No biographical data available

The wilder'd mind is tost and lost,

O sea in thy eternal tide;

The reeling brain essays in vain,

O stars, to grasp the vastness wide!

The terrible tremendous scheme

That glimmers in each glancing light,

O night, O stars, too rudely jars

The finite with the infinite!

In Alfred R. Wallace

*Man's Place in the Universe: A Study of the Results of Scientific*

*Research in Relation to the Unity or Plurality of Worlds* (p. x)

Chapman & Hall Ltd. London, England. 1903

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

We call infinite that thing whose limits we have not perceived, and so by that word we do not signify what we understand about a thing, but rather what we do not understand.

In P. Mancosu and E. Vailati

Torricelli's Infinitely Long Solid and Its Philosophical Reception in the

Seventeenth Century

*Isis*, Volume 82, Number 311, 1991 (p. 62)

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

For it is only the finite that has wrought and suffered; the infinite lies stretched in smiling repose.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Spiritual Laws (p. 305)

The Library of America. New York, New York, USA. 1983

...and thus ever, behind the coarse effect, is a fine cause, which, being narrowly seen, is itself the effect of a finer cause.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Circles (p. 404)

The Library of America. New York, New York, USA. 1983

### **Hawking, Stephen William** 1942–

English theoretical physicist

In an infinite number universe, every point can be regarded as the center, because every point has an infinity of stars on each side of it.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 1 (p. 5)

Bantam Books. Toronto, Ontario, Canada. 1988

### **Hilbert, David** 1862–1943

German mathematician

The infinite, like no other problem, has always deeply moved the soul of men. The infinite, like no other idea, has had a stimulating and fertile influence upon the mind. But the infinite is also more than any other concept, in need of clarification.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 66)

Princeton University Press. Princeton, New Jersey, USA. 1949

The infinite! No other question has ever moved so profoundly the spirit of man...

In E. T. Bell

*Men of Mathematics* (Address in memory of Weirstrass) (p. xxi)

Simon & Schuster. New York, New York, USA. 1937

From time immemorial the infinite has stirred men's emotions more than any other question. Hardly any other idea stimulated the mind so fruitfully. Yet no other concept needs clarification more that it does.

In H. B. Griffiths and A. G. Hawson

*Mathematics: Society and Curricula*

Exercises (p. 111)

Cambridge University Press. London, England. 1974

### **Hobbes, Thomas** 1588–1679

English philosopher and political theorist

When we say anything is infinite, we signify only that we are not able to conceive the ends and bounds of the thing named.

In *Great Books of the Western World* (Volume 23)

*Leviathan*

Part I, Chapter 3 (p. 54)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Huxley, Thomas Henry** 1825–95

English biologist

Truly it has been said, that to a clear eye the smallest fact is a window through which the Infinite may be seen.

*Discourses Biological and Geological*

The Study of Zoology (p. 209)

D. Appleton & Company. New York, New York, USA. 1897

### **Kant, Immanuel** 1724–1804

German philosopher

But the infinite is absolutely (not merely comparatively) great. In comparison with this all else (in the way of magnitudes of the same order) is small. But the point of capital importance is that the mere ability even to think it as a whole indicates a faculty of mind transcending every standard sense. For the latter would entail a comprehension yielding as unit a standard bearing to the infinite ratiion expressible in numbers, which is impossible.

*The Critique of Judgment*

First Part, The Mathematically Sublime, 26

Hafner Publishing Company. New York, New York, USA. 1951

### **Kasner, Edward** 1878–1955

American mathematician

### **Newman, James Roy** 1911–66

Mathematician and mathematical historian

The infinite in mathematics is always unruly unless it is properly treated.

*Mathematics and the Imagination*

Paradox Lost and Paradox Regained (p. 210)

Simon & Schuster. New York, New York, USA. 1940

### **Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

I say *finitude* is incomprehensible, the infinite in the universe *is* comprehensible. Now apply a little logic to this. Is the negation of infinitude comprehensible? What would you think of a universe in which you could travel one, ten, or a thousand miles, or even to California, and then find it come to an end? Even if you were to go millions and millions of miles, the idea of coming to an end is incomprehensible.

*Popular Lectures and Addresses* (Volume 1)

The Wave Theory of Light (pp. 314–315)

Macmillan & Company Ltd. London, England. 1894

### **Loomis, Elisha S.** 1852–1940

Teacher

In the use of this method (of infinities) the pupil must be awake and thinking, for when the infinite is employed in an argument by the unskilled, the conclusion is often most absurd.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 34)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

Again if for the moment all existing space be held to be bounded, supposing a man runs forward to its outside borders, and stands on the utmost verge and then throws a winged javelin, do you choose that when hurled with vigorous force it shall advance to the point to which it has been sent and fly to a distance, or do you decide that something can get in its way and stop it? for you must admit and adopt one of the two suppositions; either of which shuts you out from all escape and compels you to grant that the universe stretches without end.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book One, l. 968–980 (p. 13)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Maeterlinck, Maurice** 1862–1949  
Belgian playwright and poet

The infinite which our imagination seeks to embrace is nothing more than the indefinite.

Translated by Bernard Miall

*The Life of Space*

The Fourth Dimension, IV (p. 13)

Dodd, Mead & Company. New York, New York, USA. 1928

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

There are two great infinities, — the infinite in space and the infinite in time.

*Sketch-Book of Popular Geology*

Lecture Third (p. 120)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

**Mitchell, Maria** 1818–89  
American astronomer and educator

Do not forget the infinite in the infinitesimal.

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 164)

Macmillan & Company Ltd. New York, New York, USA. 1949

**Pascal, Blaise** 1623–62  
French mathematician and physicist

We know that there is an infinite, and we are ignorant of its nature.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section III, 233

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Proctor, Richard A.**  
No biographical data available

Inconceivable, doubtless, are these infinities of time and space, of matter, of motion, and of life. Inconceivable that the whole universe can be for all time the scene

of the operation of infinite power, omnipresent, all-knowing. Utterly incomprehensible how Infinite Purpose can be associated with endless material evolution. But it is no new thought, no modern discovery, that we are thus utterly powerless to conceive or comprehend the idea of an Infinite Being, Almighty, All-knowing, Omnipresent, and Eternal, of whose inscrutable purpose the material universe is the unexplained manifestation. Science is in presence of the old, old mystery; the old, old questions are asked of her — ‘Canst thou by searching find out God? Canst thou find out the Almighty unto perfection? It is as high as heaven; what canst thou do? deeper than hell; what canst thou know?’ And science answers these questions as they were answered of old — ‘As touching the Almighty we cannot find Him out.’

In Alfred R. Wallace

*Man's Place in the Universe: A Study of the Results of Scientific Research in Relation to the Unity or Plurality of Worlds* (p. x)

Chapter XVI (p. 324)

Chapman & Hall Limited. London, England. 1903

**Richardson, Lewis** 1881–1953  
English mathematician and physicist

Big whorls have little whorls

Which feed on their velocity,

And little whorls have lesser whorls,

And so on to viscosity.

In Ian Stewart

*Does God Play Dice: The New Mathematics of Chaos*

Chapter 10 (p. 184)

Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

**Royce, Josiah** 1855–1916  
American philosopher

...let us suppose, if you please, that a portion of the surface of England is very perfectly leveled and smoothed, and is the devoted to the production of our precise map of England. That in general, then, should be found upon the surface of England, map constructions which more or less roughly represent the whole of England, — all this has nothing puzzling about it.... But now suppose that this our resemblance is to be made absolutely exact.... A map of England, contained within England, is to represent, down to the minutest detail, every contour and marking, natural or artificial, that occurs upon the surface of England.... One who, with absolute exactness of perception, looked down upon the ideal map thus supposed to be constructed, would see lying upon the surface of England, and at a definite place thereon, a representation of England on as large of small a scale as you please.... This representation, which would repeat in the outer portions the details of the former, but upon a smaller space, would be seen to contain yet another England, and this another, and so on without limit.

*The World and the Individual*

Supplementary Essay, Section III (p. 504)  
The Macmillan Company. New York, New York, USA. 1900

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...I could be bounded in a nutshell and count myself a king of infinite space...

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Hamlet, Prince of Denmark  
Act II, Scene ii, l. 260–261  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Swift, Jonathan** 1667–1745

Irish-born English writer

So, Naturalists observe, a Flea

Hath smaller Fleas that on him prey,

And these have smaller Fleas to bite ‘em

And so proceed, ad infinitum.

*The Portable Swift*

On Nature

Penguin Books. New York, New York, USA. 1977

**Tolstoy, Leo** 1828–1910

Russian writer

And so to imagine the action of a man entirely subject to the law of inevitability without any freedom, we must assume the knowledge of an infinite number of space relations, an infinitely long period of time, and an infinite series of causes.

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
Second Epilogue, Chapter X (p. 693)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Arriving at infinitesimals, mathematics, the most exact of sciences, abandons the process of analysis and enters on the new process of the integration of unknown, infinitely small, quantities.

In *Great Books of the Western World* (Volume 51)  
*War and Peace*  
Second Epilogue, Chapter XI (p. 695)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**van Gogh, Vincent Willem** 1853–90

Dutch painter

If what one is doing looks out upon the infinite, and if one see that one’s work has its *raison d’être* and continuance in the future, then one works with more serenity.

*The Complete Letters of Vincent Van Gogh with Reproductions of all the Drawings in the Correspondence* (Volume Three)  
Letter 538 (p. 39)  
New York Graphic Society. Greenwich, Connecticut, USA. 1958

**von Haller, Albrecht** 1708–77

Swiss biologist

Infinity! What measures thee? Before the worlds as days, and men as moments flee!

In W. Hastie (ed.)

*Kant’s Cosmogony*

Seventh Chapter (p. 134)

Greenwood Publishing Corporation. New York, New York, USA. 1968

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

From what science has discovered about the infinitely small and the infinitely vast, the size of our bodies is almost totally irrelevant. In this little mahogany stand... may be civilizations as complex and diversified in scale as our own; and up there, the heavens, with all their vastness, may be only a minute strand of tissue in the body of a being in the scale of which all our universes are as a trifle.

In Lucien Price

*Dialogues of Alfred North Whitehead as Recorded by Lucien Price*

Dialogue XLIII, November 11, 1947 (pp. 367–368)

Little, Brown & Company. Boston, Massachusetts, USA. 1954

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Ought the word “infinite” to be avoided in mathematics?” Yes; where it appears to confer a meaning upon the calculus; instead of getting one from it.

*Remarks on the Foundations of Mathematics*

Appendix II, 17 (p. 63e)

The MIT Press. Cambridge, Massachusetts, USA. 1967

**Zebrowski, George** 1945–

Polish-American science fiction writer

Science, when it runs up against infinities, seeks to eliminate them, because a proliferation of entities is the enemy of explanation.

Time Is Nothing But A Clock

*OMNI Magazine*, Volume 17, Number 1, October 1994 (p. 144)

**INFINITESIMAL**

**Bing, Ilse** 1899–1998

German-born avant-garde photographer

Infinitesimal is the nearest to zero

infinitesimal is so small

that it is no longer something

but it is not yet nothing.

In Ernest Robson and Jet Wimp

*Against Infinity*

Infinitesimal (p. 12)

Primary Press, Parker Ford, Pennsylvania, USA. 1979

**Boethius** ca. 475–524

Roman philosopher and statesman

Thou has learnt from astronomical proofs that the whole earth compared with the universe is not greater than a point, that is, compared with the sphere of the heavens, it may be thought of as having no size at all. Then, of



this tiny corner, it is only one-quarter that, according to Ptolemy, is habitable to living things. Take away from this quarter the seas, marshes, and other desert places, and the space left for man hardly even deserves the name of infinitesimal.

Translated by W. V. Cooper  
*The Consolation of Philosophy*  
II, vii  
J.M. Dent. London, England. 1902

**Browning, Robert** 1812–89

English poet

Oh! The little more, and how much it is!  
And the little less, and what world's away!

*The Poetical Works of Robert Browning*  
By the Fireside  
Stanza XXXIX  
The Macmillan Company. New York, New York, USA. 1888–94

**Carus, Paul** 1852–1919

American philosopher

Infinity is the land of mathematical hocus pocus. There Zero the magician is king. When Zero divides any number he changes it without regard to its magnitude into the infinitely small: and inversely, when divided by any number he begets the infinitely great.

The Nature of Logical and Mathematical Thought  
*Monist*, Volume 20, Number 1, January 1910 (p. 69)

**Dantzig, Tobias** 1884–1956

Russian mathematician

They [the mathematicians of the Enlightenment] defined their terms vaguely and used their methods loosely, and the logic of their arguments was made to fit the dictates of their intuition. In short, they broke all the laws of rigor and of mathematical decorum. The veritable orgy which followed the introduction of the infinitesimals...was but a natural reaction. Intuition had too long been held imprisoned by the severe rigor of the Greeks. Now it broke loose, and there were no Euclids to keep its romantic flight in check.

In by W.M. Priestley  
*Calculus: A Liberal Art*  
Chapter 8 (p. 310)  
Springer-Verlag New York, Inc. New York, New York, USA. 1998

**Scott Cary**

Fictional character

I was continuing to shrink, to become...what? The infinitesimal? What was I? Still a human being? Or was I the man of the future? If there were other bursts of radiation, other clouds drifting across seas and continents, would other beings follow me into this vast new world? So close — the infinitesimal and the infinite. But suddenly, I knew they were really the two ends of the same concept. The unbelievably small and the unbelievably vast

eventually meet — like the closing of a gigantic circle. I looked up, as if somehow I would grasp the heavens. The universe, worlds beyond number, God's silver tapestry spread across the night. And in that moment, I knew the answer to the riddle of the infinite. I had thought in terms of man's own limited dimension. I had presumed upon nature.

*The Incredible Shrinking Man*  
Film (1957)  
Closing soliloquy narration

**INFINITY**

**Archytas of Tarentum** 428 BCE–350 BCE

Greek mathematician

If I am at the extremity of the heaven of the fixed stars, can I stretch outwards my hand or staff? It is absurd to suppose that I could not; and if I can, what is outside must be either body or space. We may then in the same way get to the outside of that again, and so on; and if there is always a new place to which the staff may be held out, this clearly involves extension without limit.

Quoted in  
*Essays in Honor of Gilbert Murray*  
The Invention of Space (p. 233)  
George Allen & Unwin Ltd. London, England. 1936

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Infinity is a fathomless gulf, into which all things vanish.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. vii)  
Birkhäuser. Boston, Massachusetts, USA. 1987

**Berbohm, Max** 1872–1956

English caricaturist and writer

The attempt to conceive Infinity had always been quite arduous enough for me.

*Mainly on the Air*  
A Note on the Einstein Theory (p. 77)  
Alfred A. Knopf, Inc. New York, New York, USA. 1947

**Blake, William** 1757–1827

English poet, painter, and engraver

Too see the world in a grain of sand,  
And a heaven in a wild flower:  
Hold infinity in the palm of your hand,  
And eternity in an hour.

*The Complete Poetry and Prose of William Blake*  
The Pickering Manuscript, Auguries of Innocence, l. 1–4  
University of California Press. Berkeley, California, USA. 1982

The nature of infinity is this:

That every thing has its  
Own Vortex, and when once a traveler thro' Eternity  
Has pass'd that Vortex,  
he perceives it roll backward behind

His path, into a globe itself unfolding like a sun;  
Or like a moon, or like a universe of starry majesty,  
While he keeps onwards in his wondrous journey on the  
earth,  
Or like a human form, a friend (with) whom he lived  
benevolent.

*The Complete Poetry and Prose of William Blake*

Milton, l. 21–7

University of California Press. Berkeley, California, USA. 1982

**Borland, Hal** 1900–78

American writer

Lift your eyes to the nighttime heavens now if you would  
see the lights of infinity.

*An American Year: Country Life and Landscapes Through the Seasons*

August (p. 81)

Simon & Schuster. New York, New York, USA. 1946

**Box, George E. P.** 1919–

English statistician

It is a pity, therefore, that the authors have confined their attention to the relatively simple problem of determining the approximate distribution of arbitrary criteria and have failed to produce any sort of justification for the tests they propose. In addition to those functions studied there are an infinity of others, and unless some principle of selection is introduced we have nothing to look forward to but an infinity of test criteria and an infinity of papers in which they are described.

Discussion

*Journal of the Royal Statistical Society, Ser. B.*, 18, 1956 (p. 29)

**Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

I saw, as one might see the transit of Venus... , a quantity passing through infinity and changing its sign from plus to minus. I saw exactly how it happened and why the tergiversation was inevitable.... But it was after dinner and I let it go!

*My Early Life: A Roving Commission*

A Roving Commission (p. 26)

Charles Scribner's Sons. New York, New York, USA. 1958

**Cousins, Norman** 1912–90

American editor and author

Infinity converts the possible into the inevitable.

Editor's Odyssey

*Saturday Review*, April 15, 1978 (p. 18)

**Crane, Hart** 1899–1932

American poet

But the star-glistened salver of infinity,  
The circle, blind crucible of endless space,  
Is sluiced by motion, — subjugated never.

*The Complete Poems and Selected Letters and Prose of Hart Crane*

The Bridge, Cape Hatteras

Anchor Books. Garden City, New York, USA. 1966

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

But how can finite grasp Infinity?

*The Poetical Works of Dryden*

Hind and the Panther, I

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

You cannot escape one infinity, I told myself, by fleeing to another; you cannot escape the revelation of the identical by taking refuge in the illusion of the multiple.

Translated by William Weaver

*Foucault's Pendulum*

Chapter I (pp. 6–7)

Harcourt, Brace Jovanovich, Publishers. San Diego, California, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

That queer quantity “infinity” is the very mischief, and no rational physicist should have anything to do with it. Perhaps that is why mathematicians represent it by a sign like a love-knot.

*New Pathways in Science*

Chapter X, Section III (p. 217)

The Macmillan Company. New York, New York, USA. 1935

**Eldridge, Paul** 1888–1982

American educator

Truth must be judged in terms of time and space; superstition in terms of eternity and infinity.

*Maxims for a Modern Man*

2533

T. Yoseloff. New York, New York, USA. 1965

**Froude, James Anthony** 1818–94

English historian and biographer

Large forms resolve themselves into parts, down so far as we can see into infinity.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 16)

Charles Scribner's Sons. New York, New York, USA. 1890

**Gamow, George** 1904–68

Russian-born American physicist

*One, Two, Three — Infinity*

Title of Book

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

Infinity is only a figure of speech, meaning a limit to which certain ratios may approach as closely as desired, when others are permitted to increase indefinitely.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. ix)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Gleick, James** 1954–  
American author, journalist, and essayist

In the mind's eye, a fractal is a way of seeing infinity.

*Chaos: Making a New Science*  
A Geometry of Nature (p. 98)  
The Viking Press. New York, New York, USA. 1987

**Greene, Brian** 1963–  
American physicist

Calculations that merge the equations of general relativity and those of quantum mechanic typically yield one and the same ridiculous answer: infinity. Like a sharp rap on the wrist from an old-time schoolteacher, an infinite answer is nature's way of telling us that we are doing something that is quite wrong.

*The Elegant Universe*  
Chapter 5 (p. 129)  
W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

Only a cosmic jester could perpetrate eternity and infinity...

*Masks of the Universe*  
Part II, Chapter 12 (p. 230)  
The Macmillan Company. New York, New York, USA. 1985

**Ionesco, Eugene** 1912–94  
French playwright

PROFESSOR: You know how to count? How far can you count up to?

PUPIL: I can count to...to infinity.

PROFESSOR: That's not possible, miss.

PUPIL: Well then, let's say to sixteen.

PROFESSOR: That is enough. One must know one's limits.

Translated by Donald M. Allen  
*Four Plays*  
The Lesson (p. 53)  
Grove Press, Inc. New York, New York, USA. 1958

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

Only if we know that what truly matters is the infinite can we avoid fixing our interests on futilities. In the final analysis we count for something only because of the essential we embody, and if we do not embody that life is wasted.

Memories, Dreams, Reflections  
Chapter XI (p. 325)  
Vintage Books. New York, New York, USA. 1963

**Kaplan, Robert** 1946–  
No biographical data available

**Kaplan, Ellen**  
No biographical data available

Is it ourself, our mind or spirit, that is infinity's proper home? Or might the infinite be neither out there nor in here but only in language, a pretty conceit of poetry?

*The Art of the Infinite*  
An Invitation (p. 1)  
Oxford University Press, Inc. Oxford, England. 2003

**Kasner, Edward** 1878–1955  
American mathematician

**Newman, James Roy** 1911–66  
Mathematician and mathematical historian

With the Hottentots, infinity begins at three.

*Mathematics and the Imagination*  
New Names for Old (p. 19)  
Simon & Schuster. New York, New York, USA. 1940

**Locke, John** 1632–1704  
English philosopher and political theorist

This further is observable in number, that it is that which the mind makes use of in measuring all things that by us are measurable, which principally are expansion and duration; and our idea of infinity, even when applied to those, seems to be nothing but the infinity of number. For what else are our ideas of Eternity and Immensity, but the repeated additions of certain ideas of imagined parts of duration and expansion, with the infinity of number; in which we can come to no end of addition.

In *Great Books of the Western World* (Volume 35)  
*An Essay Concerning Human Understanding*  
Book II, Chapter XVI, Section 8 (p. 167)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But of all other ideas, it is number, which I think furnishes us with the clearest and most distinct idea of infinity we are capable of.

In *Great Books of the Western World* (Volume 35)  
*An Essay Concerning Human Understanding*  
Book II, Chapter XVII, Section 9 (p. 170)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mathews, G. B.**  
No biographical data available

A great deal of misunderstanding is avoided if it be remembered that the term *infinity*, *infinite*, *zero*, *infinitesimal* must be interpreted in connexion with their context, and admit a variety of meanings according to the way in which they are defined.

*Theory of Numbers*  
Part I, Section 104 (p. 112)  
Chelsea Publishing Company. New York, New York, USA. 1980

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Unity joined to infinity adds nothing to it, no more than one foot to an infinite measure. The finite is annihilated in the presence of the infinite, and becomes a pure nothing.  
In *Great Books of the Western World* (Volume 33)

*Pensées*

Section III, 233

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Pierpont, James**

No biographical data available

...the notion of infinity is our greatest friend; it is also the greatest enemy of our peace of mind... Weirstrass taught us to believe that we had at last thoroughly tamed and domesticated this unruly element. Such however is not the case; it has broken loose again. Hilbert and Brouwer have set out to tame it once more. For how long? We wonder.

Mathematical Rigor, Past and Present

*Bulletin of the American Mathematical Society*, Volume 34,

January–February, 1928 (p. 47)

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

...without mathematical infinity, there would be no science at all, because there would be nothing general.

In H.B. Griffiths & A.G. Hawson

*Mathematics: Society and Curricula*

Exercises (p. 111)

Cambridge University Press. London, England. 1974

### **Rucker, Rudy** 1946–

Science and science fiction author

The study of infinity is much more than a dry academic game. The intellectual pursuit of the Absolute Infinite is, as Georg Cantor realized, a form of the souls quest for God. Whether or not the goal is ever reached, an awareness of the process brings enlightenment.

*Infinity and the Mind*

Preface (p. ix)

Princeton University Press. Princeton, New Jersey, USA. 1995

### **Shelley, Percy Bysshe** 1792–1822

English poet

...infinity within,

Infinity without...

*The Complete Poetical Works of Percy Bysshe Shelley*

Queen Mab, l. 22–23

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

### **Wolf, Fred Alan** 1934–

American theoretical physicist, writer, and lecturer

I like infinities. I believe that infinity is just another name for mother nature. Nature provides infinite possibility all the time.

*Parallel Universes*

Chapter 6 (p. 70)

Simon & Schuster. New York, New York, USA. 1988

Some scientists are also bothered by infinities, which seem to crop up at embarrassing places in our theories of the universe. A black hole...has an infinity at its very center.

*Parallel Universes*

Chapter 6 (p. 69)

Simon & Schuster. New York, New York, USA. 1988

I believe that the infinity of possibilities predicted to arise in quantum physics is the same infinity as the number of universe-possibilities predicted to arise in relativistic physics when, at the beginning of time, the universe, our home, and all of its sisters and brothers were created. As modest and troublesome as we often are, we too are never the less creatures of infinity.

*Parallel Universes*

Chapter 6 (p. 70)

Simon & Schuster. New York, New York, USA. 1988

Infinity is always one more than now.

*Parallel Universes*

Chapter 6 (p. 69)

Simon & Schuster. New York, New York, USA. 1988

...infinity is just another name for mother nature.

*Parallel Universes*

Chapter 6 (p. 70)

Simon & Schuster. New York, New York, USA. 1988

### **Ya Vilenkin, N.**

No biographical data available

In the Middle Ages the problem of infinity was of interest mainly in connection with arguments about whether the set of angels who could sit on the head of a pin was infinite or not.

*Stories about Sets*

Academic Press. New York, New York, USA. 1968

## INFORMATION

### **Bernal, John Desmond** 1901–71

Irish-born physicist and x-ray crystallographer

We should admit in theory what is already very largely a case in practice, that the main currency of scientific information is the secondary sources in the form of abstracts, reports, tables, etc., and that the primary sources are only for detailed reference by very few people. It is possible that the fate of most scientific papers will be not to be read by anyone who uses them, but with luck they will furnish an item, a number, some facts or data to such reports which may, but usually will not, lead to the original paper being consulted. This is very sad but it is the inevitable consequence of the growth of science.

The Supply of Information to the Scientist: Some Problems of the Present Day

*Journal of Documentation*, Volume 13, 1957

### **Brand, Stewart**

No biographical data available

Information wants to be free. Information also wants to be expensive.

*The Media Lab: Inventing the Future at MIT* (p. 202)

Penguin Books. New York, New York, USA. 1988

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

In other words, there is more to a message than merely its information content; there is also the value or quality of the information that has to be taken into account.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*  
Chapter 6 (p. 77)  
Simon & Schuster. New York, New York, USA. 1988

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

Where is the Life we have lost in living? Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?

*The Rock*  
Chapter I (p. )  
Harcourt, Brace & Company. New York, New York, USA. 1934

**Franklin, Benjamin** 1706–90  
American printer, scientist, and diplomat

I find a frank acknowledgment of one's ignorance is not only the easiest way to get rid of a difficulty, but the likeliest way to obtain information, and therefore I practice it: I think it an honest policy. Those who affect to be thought to know everything, and so undertake to explain everything, often remain long ignorant of many things that others could and would instruct them in, if they appeared less conceited.

*The Works of Benjamin Franklin* (Volume 1)  
Electricity (p. 307)  
Hillard, Gray & Company. Boston, Massachusetts, USA. 1836–40

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

...the sparks of information from time to time struck out, instead of glimmering for a moment, and dying away in oblivion, began to accumulate into a genial glow, and the flame was at length kindled which was speedily to acquire the strength and rapid spread of a conflagration.

*A Preliminary Discourse on the Study of Natural Philosophy*  
Part III, Chapter VI, Section 383 (p. 348)  
Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Hertz, Heinrich** 1857–94  
German physicist

...to get information for myself and for others direct from nature gives me so much more satisfaction than to be always learning it from others and for myself alone...

*Miscellaneous Papers*  
Introduction (p. xiii)  
Macmillan & Company Ltd. London, England. 1896

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

There may be thousands of relevant bits of information lying dormant in hundreds of technical journals on dusty library shelves which, if remembered, would act as Open Sesames.

*The Act of Creation*  
Book One, Part Two, Chapter X  
Notes (p. 254)  
The Macmillan Company. New York, New York, USA. 1964

**Lee, Stan** 1922–  
American writer and editor

Negative information is that which, immediately upon acquiring, causes the recipient to know less than he did before.

*Dunn's Conundrum*  
Trash Report: #85–10–9 (p. 156)  
Harper & Row, Publishers. New York, New York, USA. 1985

**Liebling, A. J.**  
No biographical data available

When information becomes unavailable, the expert comes into his own.

*New York Times Book Review*, 23 November 1997

**Mailer, Norman** 1923–  
American author

The only thing of which I could be certain was that everyone had information to offer, spoke in a voice that was full of authority, and contradicted what the last fellow had said.

*Ancient Evenings*  
Part IV, Chapter Seven (p. 312)  
Little, Brown & Company. Boston, Massachusetts, USA. 1983

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

The ballast of factual information, so far from being just about to sink us, is growing daily less. The factual burden of a science varies inversely with its degree of maturity. As a science advances, particular facts are comprehended within, and therefore in a sense annihilated by, general statements of steadily increasing explanatory power and compass — whereupon the facts need no longer be known explicitly, that is, spelled out and kept in mind. In all sciences we are being progressively relieved of the burden of singular instances, the tyranny of the particular. We need no longer record the fall of every apple.

*Two Conceptions of Science*  
*Encounter*, 143, August 1965

**Minot, George R.** 1885–1950  
American physician

As each bit of information is added to the sum of human knowledge it is evident that it is the little things that count; that give all the fertility and character; that give all the hope and happiness to human affairs. The concept of bigness is apt to be a delusion, and standardizing processes must not supplant creative impulses.

*Les Prix Nobel. The Nobel Prizes in 1934*

Nobel banquet speech for award received in 1934

Nobel Foundation. Stockholm, Sweden. 1935

### President's Science Advisory Committee

We shall cope with the information explosion, in the long run, only if some scientists and engineers are prepared to commit themselves deeply to the job of sifting, reviewing, and synthesizing information; i.e., to handling information with sophistication and meaning, not merely mechanically. Such scientists must create new science, not just shuffle documents: their activities of reviewing, writing books, criticizing, and synthesizing are as much a part of science as is traditional research.

*Science, Government and Information*

Summary and Major Recommendations

A.1 (p. 2)

The White House. Washington, D.C. January 10, 1963

### Schrödinger, Erwin 1887–1961

Austrian theoretical physicist

The scientific picture of the real world around me is very deficient. It gives me a lot of factual information, puts all our experience in a magnificently consistent order, but is ghastly silent about all and sundry that is really dear to our heart, that really matters to us.

In Ken Wilbur (ed.)

*Quantum Questions* (p. 81)

New Science Library. Boulder, Colorado, USA. 1984

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

I think it is best to put up with information the way you get it; and seem satisfied with it, and surprised at it, and grateful for it, and say, "My word!" and never let on. It was a wide space; I could tell you how wide, in chains and perches and furlongs and things, but that would not help you any. Those things sound well, but they are shadowy and indefinite, like troy weight and avoirdupois; nobody knows what they mean. When you buy a pound of a drug and the man asks you which you want, troy or avoirdupois, it is best to say "Yes," and shift the subject.

*Following the Equator* (Volume 1)

Chapter XXIII (p. 229)

Harper & Brothers. New York, New York, USA. 1899

## INGENUITY

### Johnson, Samuel 1696–1772

English critic, biographer, and essayist

It may sometimes happen, that the greatest efforts of ingenuity have been exerted in trifles; yet the same principles and expedients may be applied to more valuable purposes, and the movements, which put into action machines of no use but to raise the wonder of ignorance, may be employed to drain fens or manufacture metals, to assist the architect or preserve the sailor.

*The Rambler* (Volume 2)

No. 83, January 1, 1751 (pp. 184–185)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

## INHERITANCE

### Ardrey, Robert 1908–80

American anthropologist

...acquired characteristics cannot be inherited, and... within a species every member is born in the essential image of the first of its kind.

*African Genesis: A Personal Investigation into the Animal Origins and Nature of Man*

Chapter I, Section 2 (p. 12)

Athenaeum. New York, New York, USA. 1961

### Darwin, Charles Robert 1809–82

English naturalist

Any variation which is not inherited is unimportant for us.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter I (p. 11)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it varies however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Introduction (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## INNOVATION

### Fredrickson, G. 1932–

No biographical data available

The point is simply that if a technological innovation has a good side (as it almost always does), it will more than likely have a bad side as well.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 144)

**Gardner, John W.** 1912–2002  
American administrator

We may learn something about the renewal of societies if we look at the kind of men who contribute most to that outcome — the innovators.

*Self-Renewal: The Individual and the Innovative Society*

Chapter 4 (p. 27)

Harper & Rowe, Publishers, New York, New York, USA. 1964

Many of the major changes in history have come about through successive small innovations, most of them anonymous.

*Self-Renewal: The Individual and the Innovative Society*

Chapter 4 (p. 31)

Harper & Rowe, Publishers, New York, New York, USA. 1964

**Thagard, Paul**  
Profesor of philosophy

Whereas genetic variation in organisms is not induced by the environmental conditions in which the individual is struggling to survive, scientific innovations are designed by their creators to solve recognized problems; they therefore are correlated with solutions to problems... Scientists also commonly seek new hypotheses that will correct error in their previous trials...

*Computational Philosophy of Science*

Chapter 6 (p. 103)

MIT Press. Cambridge, Massachusetts, USA. 1988

## INORGANIC

**Shulman, Max**  
No biographical data available

Organic chemistry is the study of organs; inorganic chemistry is the study of the insides of organs.

In Evan Esar

*20,000 Quips and Quotes* (p. 127)

Doubleday. Garden City, New York, USA. 1968

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

In the concrete fullness of the world without, we distinguish by common consent the realm of organisms and the domain of the inorganic. Sun and stars, sky and sea, mountains and rivers, the air we breathe and the dust beneath our feet, crystals and precious stones, it seems like colour-blindness to sum this up in the negative and unattractive term “inorganic.” But better than use a question-begging word.

*The System of Animate Nature* (Volume 1)

Lecture II (p. 49)

William & Norgate. London, England. 1920

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

So far as we can see, inorganic entities are vehicles for receiving and storing in a napkin, and for restoring without gain or loss.

*Process and Reality* (p. 269)

Chapter VIII (p. 177)

The Free Press. New York, New York, USA. 1978

## INSANITY

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

At bottom we discover nothing new and unknown in the mentally ill; rather, we encounter the substratum of our own natures.

*Memories, Dreams, Reflections*

Chapter IV (p. 127)

Vintage Books. New York, New York, USA. 1970

## INSCRIPTION

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

We have been looking abroad on the old geological burying-grounds, and deciphering the strange inscriptions on their tombs; but there are other burying-grounds, and other tombs, — solitary church-yards among the hills, where the dust of the martyrs lies, and tombs that rise over the ashes of the wise and good; nor are there awaiting, on even the monuments of the perished races, frequent hieroglyphics, that while their burial-yards contain but the debris of the past, we are to regard the others as charged with the sown seed of the future.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture Second (p. 140)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

## INSIGHT

**Weaver, Warren** 1894–1978  
American mathematician

Sometimes when, for a time, we think hard about some subject and then “dismiss it from our minds,” this subject seems to reappear later, in an improved and expanded form, just as though it had descended to a subconscious level of the mind, and had there profited by association with an unrecognized mixture of other ideas in a sort of unconscious reverie.

*Lady Luck: A Theory of Probability*

Chapter 1 (p. 30)  
Dover Publications, Inc. New York, New York, USA. 1963

## INSOMNIAC

**Crichton-Browne, Sir James** 1840–1938  
English physician

A lady of my acquaintance, after a slight operation, suffered from insomnia [that] drugs failed to relieve. Her doctor, however, was very resourceful and on visiting her on the Sunday forenoon said: “I see there’s a sermon on the wireless at eight this evening...” There is no soporific better than a dry sermon.

*From the Doctor’s Notebook*  
Insomnia (p. 202)  
Duckworth. London, England. 1937

## INSPIRATION

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

One must fill oneself with human science. Above all and in spite of all, be a man. Do not fear to surcharge yourself with humanity. Ballast your mind with reality and then throw yourself into the sea — the sea of inspiration.

Translated by L. O’Rourke  
*Intellectual Autobiography* (pp. 124–125)  
Funk & Wagnalls Company. London, England. 1907

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

One need only open the eyes to see that the conquest of industry which have enriched so many practical men would never have seen the light, if these practical men alone had existed and if they had not been preceded by unselfish devotees who died poor, who never thought of utility, and yet had a guide far other than caprice.

*The Foundations of Science*  
Science and Method, Book I  
Chapter I (p. 363)  
The Science Press. New York, New York, USA. 1913

**Sand, George** 1804–76  
French novelist

We are of nature, in nature, by nature, and for nature. Talent, will, genius, are natural phenomena like the lake, the volcano, the mountain, the wind, the star, the cloud.

Translated by A.L. McKenzie  
*The George Sand–Gustave Flaubert Letters*  
Letter CCLXXX (p. 323)  
Duckworth & Company Ltd. London, England. 1922

## INSTINCT

**May, Rollo** 1909–94  
American psychologist

An instinct, Freud emphasizes, has as its goal the restoring of an earlier state. He borrows here from the second law of thermodynamics, that the energy of the universe is constantly running down. Since “...an instinct is an urge inherent in organic life to restore an earlier state of things...” and “inanimate things existed before living ones,” so our instincts push us back to the inanimate. The instincts move toward nirvana, which is complete absence of excitation. The “aim of all life is death.” And here we find ourselves at Freud’s most controversial theory termed the death instinct, or Thanatos.

*Love and Will*  
Chapter Three (p. 85)  
W.W. Norton & Company, Inc. New York, New York, USA. 1969

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

...obeying the living hand of the past which is within them.

*The Outline of Science* (Volume 1)  
Chapter VII (p. 220)  
G.P. Putnam’s Sons. New York, New York, USA. 1937

**White, Gilbert** 1720–93  
English naturalist and cleric

They who write on natural history cannot too frequently advert to instinct, that wonderful limited faculty, which, in some instances, raises the brute creation as it were above reason, and in others leaves them so far below it.

*The Natural History of Selborne*  
Letter LVI (p. 221)  
Robert M. McBride & Company. New York, New York, USA. 1925

To a thinking mind nothing is more wonderful than that early instinct which impresses young animals with the notion of the situation of their natural weapons, and of using them properly in their own defense, even before those weapons subsist or are formed.

*The Natural History of Selborne*  
Letter XXXI (p. 178)  
Robert M. McBride & Company. New York, New York, USA. 1925

## INSTRUMENT

**Abbott, Donald Putnam** 1920–86  
American marine biologist and professor

There’s no substitute for fine forceps. None.  
In Galen Howard Hilgard (ed.)  
*Observing Marine Invertebrates: Drawings from the Laboratory*  
Author’s Preface (p. xvi)  
Stanford University Press. Stanford, California, USA. 1987

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The unassisted hand and the understanding left to itself possess but little power. Effects are produced by the



means of instruments and helps, which the understanding requires no less than the hand; and as instruments either promote or regulate the motion of the hand, so those that are applied to the mind prompt or protect the understanding.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 2 (p. 107)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Baudrillard, Jean** 1929–

French cultural theorist

It is like the expanding universe. The more our instruments penetrate it, the further the limits recede.

Translated by Chris Turner

*Cool Memories*

October 1983 (p. 145)

Verso. London, England. 1990

**Bridgman, Percy Williams** 1882–1961

American physicist

Not only do we use instruments to give us fineness of detail inaccessible to direct sense perception, but we also use them to extend qualitatively the range of our senses into regions where our senses no longer operate...

*The Way Things Are*

Chapter V (p. 149)

Harvard University Press. Cambridge, Massachusetts, USA. 1959

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Men can construct a science with very few instruments, or with very plain instruments; but no one on earth could construct a science with unreliable instruments.

*Heretics*

Science and the Savages (p. 147)

Books for Libraries Press. Freeport, New York, USA. 1970

**Davy, Sir Humphry** 1778–1829

English chemist

...nothing tends so much to the advancement of knowledge as the application of a new instrument. The native intellectual powers of men in different times are not so much the causes of the different success of their labours, as the peculiar nature of the means and artificial resources in their possession.

In Thomas Hager

*Force of Nature: The Life of Linus Pauling*

Chapter 4 (p. 86)

Simon & Schuster. New York, New York, USA. 1995

**Egler, Frank E.** 1911–96

American botanist and ecologist

Dazed with this brightness of our technology, I wonder if some are not inclined to forget that the most important instrument in science must always be the mind of man.

*The Way of Science*

Methodology and Instrumentation (p. 59)

Hafner Publishing Company. New York, New York, USA. 1970

**Eisenhart, Churchill** 1913–94

Statistician

Of wonders of science and feats of design

Has many a scribe writ the praise;

And if I now mention the subject again

It's distinctly a relative phase.

For while science and gadgets are fine in their ways

One worries at times 'bout their clutch,

Especially when science, design, and math'matics

Combine to get us in Dutch.

Operational Aspects of Instrument Design

*Science*, Volume 110, October 7, 1949 (p. 343)

**Flexner, Abraham** 1866–1959

American educator

Science lies in the intellect, not in the instruments.

*Medical Education: A Comparative Study*

Chapter I (pp. 6–7)

The Macmillan Company. New York, New York, USA. 1925

**Foster, Bishop**

No biographical information available

Man, having one kind of an eye given him by his Maker, proceeds to construct two other kinds [of scopes]. He makes one that magnifies invisible objects thousands of times, so that a dull razor-edge appears as thick as three fingers, until the amazing beauty of color and form in infinitesimal objects is entrancingly apparent, and he knows that God's care of least things is infinite. Then he makes the other kind four or six feet in diameter, and penetrates the immensities of space thousands of times beyond where his natural eye can pierce, until he sees that God's immensities of worlds are infinite also.

In Henry Warren

*Recreations in Astronomy*

Chapter III (p. 43)

Chautauqua Press. New York, New York, USA. 1886

**Galison, Peter**

American physicist and historian

The modern history of instruments and the patterns of their use may lack the glamour of the history of our over arching theoretical constructs. Nonetheless, these bubbling, sparking, clanking devices remain the weft and the warp of physics.

In Peter Achinstein and Owen Hannaway

*Observation, Experiment and Hypothesis in Modern Physics*

Bubble Chambers and the Experimental Workplace (p. 359)

The MIT Press. Cambridge, Massachusetts, USA. 1985

**Giere, Ronald**

American philosopher of science

The overwhelming presence of machines and instrumentation must be one of the most salient features of the modern scientific laboratory.... The development of science depends at least as much on new machinery as it does on new ideas.

*Explaining Science: A Cognitive Approach*

Chapter 5 (p. 138)

The University of Chicago Press. Chicago, Illinois, USA. 1988

**Gogarty, Oliver St. John** 1878–1957

Irish author

The telescope, the microscope and the test-tube have made skeptics of us all. We have changed wisdom for an exact knowledge of stains, precipitants, reactions and refractions, and put it, for this generation at least, beyond recall.

*I Follow Saint Patrick*

Chapter 15

Reynal & Hitchcock. New York, New York, USA. 1938

**Hale, George Ellery** 1868–1938

American astronomer

We need the ideas of men from all parts of the world; we need the contributions they can make; and we need them more than we need larger instrumental means than we now possess.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Some Opportunities for Astronomical Work with Inexpensive Apparatus (p. 285)

Government Printing Office. Washington, D.C. 1908

**Kuhn, Thomas S.** 1922–96

American historian of science

...scientists see new and different things when looking with familiar instruments in places they have looked before.... It is as elementary prototypes for these transformations of the scientist's world that the familiar demonstrations of a switch in visual gestalt prove so suggestive. What were ducks in the scientist's world before the revolution are rabbits afterwards.

*The Structure of Scientific Revolutions*

Chapter X (p. 111)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Lavoisier, Antoine Laurent** 1743–94

French chemist

As the usefulness and accuracy of chemistry depend entirely upon the determination of the weights of the ingredients and products, too much precision cannot be employed in this part of the subject; and for this purpose, we must be provided with good instruments.

*Elements of Chemistry in a New Systematic Order*

Part III, Chapter I (p. 88)

Printed for William Creech. Edinburgh, Scotland. 1790

In the present advanced state of chemistry, very expensive and complicated instruments are become indispensably necessary for ascertaining the analysis and synthesis of bodies with the requisite precision as to quantity and proportion; it is certainly proper to endeavor to simplify these, and to render them less costly; but this ought by no means to be attempted at the expense of their convenience of application, and much less of their accuracy.

*Elements of Chemistry in a New Systematic Order*

Part III, Chapter I, Section II (p. 319)

W. Creech. Edinburgh, Scotland. 1790

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Ye instruments, ye surely jeer at me,  
With handle, wheel and cogs and cylinder.  
I stood beside the gate, ye were to be the key.  
True, intricate your ward, but no bolts do ye stir.  
Inscrutable upon a sunlit day,  
Her veil will Nature never let you steal,  
And what she will not to your mind reveal,  
You will not wrest from her with levers and with screws.

In *Great Books of the Western World* (Volume 47)

*Faust*

The First Part

Night, Faust in his Study, l. 668–675

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The reason why we are on a higher imaginative level is not because we have finer imagination, but because we have better instruments.

*Science and the Modern World*

Chapter VII (p. 166)

The Macmillan Company. New York, New York, USA. 1929

## INSULIN

**Banting, Frederick G.** 1891–1941

Canadian physiologist

Insulin is not a cure for diabetes; it is a treatment. It enables the diabetic to burn sufficient carbohydrates, so that proteins and fats may be added to the diet in sufficient quantities to provide energy for the economic burdens of life.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1923

Diabetes and Insulin (p. 68)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## INTEGER

**Hauffman, Paul**

No biographical data available

The trouble with integers is that we have examined only the small ones. Maybe all the exciting stuff happens at really big numbers, ones we can't get our hand on or even begin to think about in any very definite way. So maybe all the action is really inaccessible and we're just fiddling around. Our brains have evolved to get us out of the rain, find where the berries are, and keep us from getting killed. Our brains did not evolve to help us grasp really large numbers or to look at things in a hundred thousand dimensions.

The Man Who Loves Only Numbers  
*The Atlantic Magazine*, Volume 260, Number 5, November, 1987

**Minkowski, Hermann** 1864–09  
German mathematician

Integers are the fountainhead of all mathematics.  
*Diophantische Approximationen: eine einföhrung in die zahlen Theorie, von Hermann Minkowski*  
Preface  
Publisher undetermined

## INTEGRAL

**McReynolds, J. W.**  
No biographical information available

I am a mathematician to this extent: I can follow triple integrals if they are done slowly on a large blackboard by a personal friend.  
George's Problem  
*Scripta Mathematica*, Volume 15, 1949

**McShane, E. J.**  
No biographical information available

There are in this world optimists who feel that any symbol that starts off with an integral sign must necessarily denote something that will have every property that they should like an integral to possess.

This of course is quite annoying to us rigorous mathematicians; what is even more annoying is that by doing so they often come up with the right answer.  
*Bulletin of the American Mathematical Society*, Volume 69, 1963 (p. 611)

**Sylvester, James Joseph** 1814–97  
English mathematician

It seems to be expected of every pilgrim up the slopes of the mathematical Parnassus, that he will at some point or other of his journey sit down and invent a definite integral or two towards the increase of the common stock.  
*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
Notes to the Meditation on Poncelet's Theorem, Including a Valuation of the Two New Definite Integrals (p. 214, fn 2)  
University Press. Cambridge, England. 1904–1912

## INTEGRATION

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

"But no-one expected he'd ever get very far, because I don't suppose he could even integrate  $e$  to the  $x$ ." "Is such ignorance possible?" gasped someone.  
*Tales from the White Hart* (p. 5)  
Publisher undetermined

**de Morgan, Augustus** 1806–71  
English mathematician and logician

Common integration is only the memory of differentiation, the different artifices by which integration is effected are changes, not from the known to the unknown, but from forms in which memory will not serve us to those in which it will.  
*Transactions of the Cambridge Philosophical Society*, Volume 8, 1844 (p. 188)

**Kettering, Charles Franklin** 1876–1958  
American engineer and inventor

...the most highly satisfactory use of the reverse-curve sign of integration used in calculus is for those two S-openings in the top of a violin.  
In T.A. Boyd  
*Professional Amateur* (p. 209)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1957

**Rankine, William John Macquorn** 1820–72  
Scottish engineer and physicist

Now integrate  $L$  with respect to  $dt$ ,  
( $t$  Standing for time and persuasion);  
Then, between proper limits, 'tis easy to see,  
The definite integral Marriage must be —  
(A very concise demonstration).  
*Songs and Fables*  
The Mathematician in Love, Verse 7  
J. Maclehose. Glasgow, Scotland. 1874

**Schenck, Jr., Hilbert**  
No biographical data available  
"Oh, hast thou solved the integral?  
Here is a raise, my brainish boy!"  
He threw his time cards in the air  
And clapped his hands with joy.  
Wockyjabber  
*The Magazine of Fantasy and Science Fiction*, May 1960

## INTELLECT

**Bergson, Henri** 1859–1941  
French philosopher

The history of the evolution of life, incomplete as it yet is, already reveals to us how the intellect has been formed,

by an uninterrupted progress, along a line which ascends through the vertebrate series up to man. It shows us in the faculty of understanding an appendage of the faculty of acting, a more and more precise, more and more complex and supple adaptation of the consciousness of living beings to the conditions of existence that are made for them.

*Creative Evolution*

Introduction (p. xix)

The Modern Library. New York, New York, USA. 1944

**Bramah, Ernest** 1869–1942

Author

As the Book of Verses indicates, “The person who patiently awaits a sign from the clouds for many years, and fails to notice the earthquake at his feet, is devoid of intellect.”

*The Wallet of Kai Lung*

16

Grant Richards. London, England. 1911

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Intellect...sees an object as it stands in the light of science...

*The Complete Works of Ralph Waldo Emerson* (Volume 2)

Essays: First Series

Chapter XI (p. 326)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

We may insist as much as we like that the human intellect is weak in comparison with human instincts, and be right in doing so. But nevertheless there is something peculiar about this weakness. The voice of the intellect is a soft one, but it does not rest until it has gained a hearing. Ultimately, after endlessly repeated rebuffs, it succeeds. This is one of the few points in which one may be optimistic about the future of mankind.

In Jonathan Glover

*Humanity: A Moral History of the Twentieth Century*

The Future of An Illusion

Yale University Press. New Haven, Connecticut, USA. 2001

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Only in the course of the nineteenth century, when spirit began to degenerate into intellect, did a reaction set in against the unbearable dominance of intellectualism, and this led to the unpardonable mistake of confusing intellect with spirit and blaming the latter for the misdeeds of the former.

Translated by R.F.C. Hull

*Alchemical Studies*

Difficulties Encountered by a European in Trying to Understand the East (p. 9)

Princeton University Press. Princeton, New Jersey, USA. 1967

## INTELLECTUAL

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

In the modern world the celibacy of the medieval learned class has been replaced by a celibacy of the intellectual which is divorced from the concrete contemplation of the complete facts.

*Science and the Modern World*

Chapter XIII (p. 283)

The Macmillan Company. New York, New York, USA. 1929

## INTELLIGENCE

**Bradbury, Ray** 1920–

American writer

The universe is full of matter and force. Yet in all that force, amongst all the bulks and gravities, the rains of cosmic light, the bombardment of energy — how little spirit, how small the decimal points of intelligence.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Ray Bradbury (p. 133)

Harper & Row, Publishers. New York, New York, USA. 1973

**Grassé, Pierre P.** 1895–1985

French zoologist

Any living thing possesses an enormous amount of “intelligence...” Today, this “intelligence” is called “information,” but it is still the same thing... This “intelligence” is the sine qua non of life. If absent, no living being is imaginable. Where does it come from? This is a problem which concerns both biologists and philosophers, and, at present, science seems incapable of solving it.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*

An Introduction to the Study of Evolution (p. 2)

Academic Press. New York, New York, USA. 1977

**Lemon, Harvey Brace**

Physicist

In our recognition that order is universal, a fact confirmed by myriads of observations of patient, indefatigable, and devoted investigators, the old saying that “an irreverent astronomer is mad” can apply with equal force to the physicist. Man learns something of his own minute and colossal stature, and he comes to feel that his own intelligence, which enables him to make such sublime discoveries, is the supreme achievement of evolution.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Atomic Structure (p. 98)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Lilly, John**

No biographical data available

The highest intelligence on the planet probably exists in a sperm whale, who has a ten-thousand-gram brain, six times larger than ours.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Altered States (p. 165)

Ticknor & Fields. New York, New York, USA. 1984

**INTELLIGENT DESIGN****Darwin, Charles Robert** 1809–82

English naturalist

Your question what would convince me of Design is a poser. If I saw an angel come down to teach us good, and I was convinced from others seeing him that I was not mad, I should believe in design.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter III (p. 169)

Letter To Asa Gray, September 17, 1861

D. Appleton & Company. New York, New York, USA. 1887

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

I belong to the group of scientists who do not subscribe to a conventional religion but nevertheless deny that the universe is a purposeless accident.... [T]he physical universe is put together with an ingenuity so astonishing that I cannot accept it merely as a brute fact. There must... be a deeper level of explanation.

*The Mind of God: The Scientific Basis for a Rational World*

Preface (p. 16)

Simon & Schuster. New York, New York, USA. 1992

**Dembski, William A.** 1960–

American mathematician and philosopher

Scientists rightly resist invoking the supernatural in scientific explanations for fear of committing a god-of-the-gaps fallacy (the fallacy of using God as a stop-gap for ignorance). Yet without some restriction on the use of chance, scientists are in danger of committing a logically equivalent fallacy — one we may call the “chance-of-the-gaps fallacy.” Chance, like God, can become a stop-gap for ignorance.

*The Chance of the Gaps*

Paper presented at conference, Boulder, Colorado. Fall 2001

What has kept design outside the scientific mainstream these last 130 years is the absence of precise methods for distinguishing intelligently caused objects from unintelligently caused ones. For design to be a fruitful scientific theory, scientists have to be sure they can reliably determine whether something is designed.... This fear

of falsely attributing something to design only to have it overturned later has prevented design from entering science proper....

*Mere Creation: Science, Faith and Intelligent Design*

Introduction (p. 16)

InterVarsity Press. Downers Grove, Illinois, USA. 1998

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

...overpoweringly strong proofs of intelligent and benevolent design lie all round us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living beings depend on one ever-acting Creator and Ruler.

*Popular Lectures and Addresses* (Volume 2)

Presidential Address to the British Association, Edinburgh, 1871

(p. 205)

Macmillan & Company Ltd. London, England. 1894

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

You all know the argument from design: everything in the world is made just so that we can manage to live in the world, and if the world was ever so little different, we could not manage to live in it.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Why I Am Not a Christian (p. 9)

Watts. London, England. 1927

**INTERACTION****Hugo, Victor** 1802–85

French author, lyric poet and dramatist

Nothing, in fact, is small, and any one who is affected by the profound penetration of nature is aware of this fact. Although no absolute satisfaction is granted to philosophy, and though it can no more circumscribe the cause than limit the effect, the contemplator falls into unfathomable ecstasy when he watches all the decomposition of forces which result in unity. Everything labors for everything.

*Les Miserables*

Volume 4, Book III, Chapter 3 (p. 67)

The Heritage Press. New York, New York, USA. 1938

Algebra is applied to the clouds, the irradiation of the planet benefits the rose, and no thinker would dare to say that the perfume of the hawthorn is useless to the constellation.

*Les Miserables*

Volume 4, Book III, Chapter 3 (p. 67)

The Heritage Press. New York, New York, USA. 1938

## INTERDEPENDENCE

**Muir, John** 1838–1914  
American naturalist

To the dwellers of the plain, dependent on irrigation, the Big Tree, leaving all its higher uses out of the count, is a tree of life, a never failing spring, sending living water to the lowlands all through the hot, rainless summer.

*Our National Parks*  
Chapter IX (p. 329)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Plants, animals and stars are all kept in place, bridled along appointed way, with one another, and through the midst of one another killing and being killed, eating and being eaten, in harmonious proportions and quantities.

*Steep Trails*  
Chapter I (p. 13)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

...consumption of one another... is a kind of culture varying with the degree of directness with which it is carried out, but we should be careful not to ascribe to such culture any improving qualities upon those on whom it is brought to bear.

*Steep Trails*  
Chapter I (p. 13)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## INTERN

**Stone, John**  
No biographical data available

The old man asked, "Are you an Intern?" Hearing the young doctor's tired, "Yes," the old man followed with another question: "Do you know what it takes to be a good Intern? It takes the heart of a lion, the eye of an eagle, and the hand of a woman."

In D. Abse (ed.)  
*My Medical School* (p. 196)  
Robson Books. London, England. 1978

## INTERNIST

**Findley, Thomas**  
Physician

An internist has been defined as a man who is totally unable to answer either yes or no to any question.... If there is such a thing as a typical internist, he is a sedentary individual, curious, skeptical, reflective. He is accustomed to look at the patient as a unit rather than as a collection of separate organs and, if he had the fundamental scientific training he should have had, he is eager to distinguish between a fact and someone's opinion.

The Obligations of an Internist to a General Surgeon  
*Surgery*, Volume 16, 1944

Accustomed to legerdemain and quick results, [the surgeon] is apt to regard the diagnosis and treatment of a headache, for example, as a trivial matter, forgetting that the internist may require hours of probing before discovering that what the patient needs is not a new pair of glasses but a different mother-in-law.

The Obligations of an Internist to a General Surgeon  
*Surgery*, Volume 16, 1944

## INTERPRETATION

**Leakey, Mary** 1913–96  
English archaeologist

There is so much we do not know, and the more we do know, the more we realize that early interpretations were completely wrong. It is good mental exercise, but people get so hot and nasty about it, which I think is ridiculous.

Marguerite Holloway  
*Scientific American*, October 1994

## INTERSTELLAR MESSAGE

**Baron Munchausen**  
Fictional character

I immediately perceived the true descent of this people, which does not appear of terrestrial origin, but descended from some of the inhabitants of the moon, because the principal language spoken there, and in the centre of Africa, is very nearly the same. Their alphabet and method of writing are pretty much the same, and show the extreme antiquity of this people, and their exalted origin. I here give you a specimen of their writing...

*The Surprising Adventures of Baron Munchausen*  
Chapter XXV (p. 178)  
Thomas Y. Crowell Company, Publishers. New York, New York, USA. 1902

**Thomas, Lewis** 1913–93  
American physician and biologist

Perhaps the safest thing to do at the outset, if technology permits, is to send music...I would vote for Bach, all of Bach, streamed out into space, over and over again. We would be bragging, of course, but it is surely excusable for us to put the best possible face on at the beginning of such an acquaintance.

*The Lives of a Cell: Notes of a Biology Watcher*  
Ceti (p. 45)  
The Viking Press. New York, New York, USA. 1974

## INTESTINE

**Dunne, Finley Peter** 1867–1936  
American journalist and humorist

...though I have patches on me pantaloons, I've ne'er a wan on me intestines.

*Mr. Dooley's Opinions*

Thanksgiving (p. 127)

Harper. New York, New York, USA. 1906

## INTUITION

**Bruner, Jerome Seymour** 1915–

American psychologist

Intuition implies the act of grasping the meaning or significance or structure of a problem without explicit reliance on the analytical apparatus of one's craft. It is the intuitive mode that yields hypotheses quickly, that produces interesting combinations of ideas before their worth is known. It precedes proof: indeed, it is what the techniques of analysis and proof are designed to test and check. It is founded on a kind of combinatorial playfulness that is only possible when the consequences of error are not overpowering or sinful. Above all, it is a form of activity that depends upon confidence in the worthwhileness of the process of mathematical activity rather than upon the importance of right answers at all times.

On Learning Mathematics

*Mathematics Teacher*, Volume 53, December 1960 (p. 613)

**Einstein, Albert** 1879–1955

German-born physicist

To these elementary laws there leads no logical path, but only intuition, supported by being sympathetically in touch with experience.

In Gerald Holton

*Thematic Origins of Scientific Thought: Kepler to Einstein*

Chapter 10 (p. 357)

Harvard University Press. Cambridge, Massachusetts, USA. 1973

...there is no logical way to the discovery of these elemental laws. There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance...

In Max Planck

*Where Is Science Going?*

Prologue, (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Huxley, Aldous** 1894–1963

English writer and critic

...experience is not a matter of having actually swum the Hellespont, or danced with the dervishes, or slept in a doss-house. It is a matter of sensibility an intuition, of seeing and hearing the significant things, of paying attention at the right moments, of understanding and coordinating. Experience is not what happens to a man; it is what a man does with what happens to him.

*Texts and Pretexts: An Anthology with Commentaries*

Introduction (p. 5)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1933

**Klee, Paul** 1879–1940

Swiss painter

When intuition joins exact research, the progress of understanding will be accelerated astoundingly.

In Rolf Huisgen

*The Adventure Playground of Mechanisms and Novel Reactions*

Marginalia on Art and Science (p. 211)

American Chemical Society, Washington, D.C. 1994

## INVALID

**Yourcenar, Marguerite** 1903–87

French writer

Nothing seemed simpler: a man has the right to decide how long he may usefully live...sickness disgusts us with death, and we wish to get well, which is a way of wishing to live. But weakness and suffering, with manifold bodily woes, soon discourage the invalid from trying to regain ground: he tires of those respites which are but snares, of that faltering strength, those ardors cut short, and that perpetual lying in wait for the next attack.

*Memoirs of Hadrian*

Patentia (p. 278, 279)

Farrar, Straus & Company. New York, New York, USA. 1963

## INVARIANCE

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

It is now natural for us to try to derive the laws of nature and to test their validity by means of the laws of invariance, rather than to derive the laws of invariance from what we believe to be the laws of nature.

*Symmetries and Reflections*

Chapter 1 (p. 5)

Ox Bow Press. Woodbridge, Connecticut, USA. 1979

## INVARIANTS

**Sylvester, James Joseph** 1814–97

English mathematician

As all roads are said to lead to Rome, so I find, in my own case at least, that all algebraic inquiries sooner or later end at the Capitol of Modern Algebra over whose shining portal is inscribed "Theory of Invariants."

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

An Inquiry into Newton's Rule for the Discovery of Imaginary Roots

(p. 380, fn 1)

University Press. Cambridge, England. 1904–1912

## INVENTION

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The human mind is often so awkward and ill-regulated in the career of invention that is at first diffident, and then despises itself. For it appears at first incredible that any such discovery should be made, and when it has been made, it appears incredible that it should so long have escaped men's research. All which affords good reason for the hope that a vast mass of inventions yet remains, which may be deduced not only from the investigation of new modes of operation, but also from transferring, comparing and applying those already known, by the methods of what we have termed literate experience.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*

First Book, Aphorism 110 (p. 129)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Brecht, Bertolt** 1898–1956  
German writer

The more we can squeeze out of nature by inventions and discoveries and improved organization of labour, the more uncertain our existence seems to be. It's not we who lord it over things, it seems, but things which lord it over us.

*The Messingkauf Dialogues*

The Second Night, the Philosopher's Speech About Our Period (p. 42)  
Methuen. London, England. 1965

**D'Israeli, Isaac** 1766–1848  
English critic and historian

The golden hour of invention must terminate like other hours, and when the man of genius returns to the cares, the duties, the vexations, and the amusements of life, his companions behold him as one of themselves — the creature of habits and infirmities.

*Literary Character: Or, the History of Men of Genius*

Chapter XVI (p. 183)  
Routledge, Warnes & Routledge. London, England. 1859

**Drachmann, A. G.** 1810–92  
Historian of technology

I should prefer not to seek for the cause of the failure of an invention in the social conditions till I was quite sure that it was to be found in the technical possibilities of the time.

*The Mechanical Technology of Greek and Roman Antiquity*

Survey of Results (p. 206)  
Munksgaard. Copenhagen, Denmark. 1963

**Dyer, Frank Lewis** 1870–1941  
No biographical data available

**Martin, Thomas Commerford**  
No biographical data available

All persons who make inventions will necessarily be more or less original in character, but to the man who chooses to become an inventor by profession must be conceded a mind more than ordinarily replete with virility and originality.

*Edison: His Life and Inventions* (Volume 2)

Chapter XXIV (p. 597)

Harper & Brothers. New York, New York, USA. 1929

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

In America, the geography is sublime, but the men are not; the inventions are excellent, but the inventors one is sometimes ashamed of.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Considerations by the way (p. 1084)

The Library of America. New York, New York, USA. 1983

**Invention breeds invention.**

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Society and Solitude

Works and Days (p. 161)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Feleki, László**

No biographical data available

With the invention of the steam engine the hell of science broke loose.

Keeping Up with Science

*Impact of Science on Society*, Volume 19, 1969 (p. 279)

**Galbraith, John Kenneth** 1908–2006  
Canadian-American economist

Inventions that are not made, like babies that are not born, are rarely missed.

*The Affluent Society*

Chapter 9, Section III (p. 122)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1969

**Hamilton, Walton**

No biographical data available

**Till, Irene**

No biographical data available

Most discoveries patented today can be anticipated...

For the most part, technicians are not self starters. The bulk of them in fact are captives; those in corporate employ are told by business executives what problems to work on... The solo inventor's real opportunity is to seize or blunder upon a pioneer idea; as a technology foliates from its base, his self reliance is hardly a match for a bevy of experts who can be kept on the job.... A captive technology offers no chance to invent except to those already in control, or to others on such terms as those in control dictate.

*Law and Contemporary Problems*, Volume 13, 1948 (p. 252)



**Hubbard, Elbert** 1856–1915  
American editor, publisher, and author

The brains of a thousand inventors have seethed, dreamed, contrived, thought, so as to bring me to my present form.

*Notebook of Elbert Hubbard* (p. 116)  
Publisher undetermined

In an inventor's work there is required something similar to that which the artist brings to bear.

*Notebook of Elbert Hubbard* (p. 194)  
Publisher undetermined

**Kettering, Charles Franklin** 1876–1958  
American engineer and inventor

The lack of ideas and inventions in one generation can easily mean the loss of Freedom in the next.

*Short Stories of Science and Invention: A Collection of Radio Talks by C.F. Kettering*  
The Silent Service (p. 35)  
General Motors. Detroit, Michigan, USA. 1955

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

But for the unattainable ideal of perfect conquest of Nature, we should not have the marvels of modern Invention and Empirical Science.

*Mole Philosophy and Other Essays*  
Chapter I (p. 3)  
E.P. Dutton & Company. New York, New York, USA. 1927

**King, Blake**  
No biographical data available

...if your conclusion is that the operator should be able to make daily adjustments on your invention by hitting it with a rock, say so.

Object: Creativity  
*Mechanical Engineering*, November 1963 (p. 41)

**Lemelson, Jerome** 1923–97  
American inventor

...an important part of invention today is being able to discover the problem.

In Kenneth A Brown  
*Inventors at Work: Interviews with 16 Notable American Inventors*  
Jerome Lemelson (p. 126)  
Tempus Books of Microsoft Press, Redmond, Washington, USA. 1988

**Maclaurin, W. R.**  
No biographical data available

We have now reached a stage in many fields where inventions are almost made to order, and where there can be a definite correlation between the number of applied scientists employed (and the funds at their disposal) and the inventive results. But one really gifted inventor is likely to be more productive than half a dozen men of lesser stature.

The Sequence from Invention to Innovation  
*Quarterly Journal of Economics*, February 1953

**Marcellus**  
No biographical data available

The principle reasons which have been assigned for the slow progress of the useful arts, are drawn from the wide separation which has been made between science and art, and the fact that many of the greatest inventions have resulted from accident rather than superior knowledge. These considerations have tended to give to these pursuits the character of unintellectual employments.

Essay on the Mechanic Arts  
*Young Mechanic*, Volume 1, Number III, March 1832 (p. 36)

**Marconi, Guglielmo** 1874–1937  
Italian physicist and inventor

Necessity is the cause of many inventions but the best ones are born of desire.

Every Man His Own Inventor  
*Colliers*, Volume 70, 1922

**Marshall, Alfred** 1842–1924  
English economist

The full importance of an epoch-making idea is often not perceived in the generation in which it is made... The mechanical inventions of every age are apt to be underrated relatively to those of earlier times. For a new discovery is seldom fully effective for practical purposes till many minor improvements and subsidiary discoveries have gathered themselves around it.

*Principles of Economics* (8<sup>th</sup> edition)  
Book IV, Chapter VI, I (p. 205, fn)  
Macmillan & Company Ltd. London, England. 1920

**McArthur, Peter** 1866–1924  
Canadian poet

It was a mere detail that my invention was no good.

*The Best of Peter McArthur*  
The Great Experiment (p. 26)  
Vancouver, Clarke, Irwin. Toronto, Ontario, Canada. 1967

**Middendorf, W. H.**  
No biographical data available

**Brown, Jr., G. T.**  
No biographical data available

The romantic theory that an invention will appear in full bloom without conscious effort on the part of the gifted inventor has been deprecated.

Orderly Creative Inventing  
*Electrical Engineering*, October 1957 (p. 861)

A full storehouse of knowledge is a necessary but not sufficient condition for invention. To this, one must add an organized method of attack.

Orderly Creative Inventing  
*Electrical Engineering*, October 1957 (p. 867)

**Mumford, Lewis** 1895–1990

American social philosopher

By his very success in inventing labor-saving devices, modern man has manufactured an abyss of boredom that only the privileged classes in earlier civilizations have ever fathomed. . .

*The Conduct of Life*

Chapter I (p. 14)

Harcourt, Brace & Company. New York, New York, USA. 1951

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Manifestly not every finding leads straight to invention; but it is hard to think of major discoveries about nature; major advances in science, which have not had large and ramified practical consequences.

In Dael Wolffe (ed.)

*Symposium on Basic Research*

Casper Auditorium of the Rockefeller Institute, May, 1959, The Need for New Knowledge (p. 6)

American Association for the Advancement of Science. Washington, D.C. 1959

**Sprat, Thomas** 1635–1713

English historian

Invention is an Heroic thing and plac'd above the reach of a low, and vulgar Genius. It requires an active, a bold, a nimble, a restless mind: a thousand difficulties must be contemn'd, with which a mean heart would be broken: many attempts must be made to no purpose: much Treasure must be scattered without any return: much violence and vigor of thought must attend it: some irregularities and excesses must be granted it that would hardly be pardon'd by the severe Rules of Prudence.

*The History of the Royal Society of London for the Improving of Natural Knowledge*

Section XXXI (p. 392)

Printed by T.R. London, England. 1667

**Swift, Jonathan** 1667–1745

Irish-born English writer

The greatest Inventions were produced in the Times of Ignorance; as the Use of the Compass, Gunpowder, and Printing; and by the dullest Nations, as the Germans.

*Satires and Personal Writings*

Thoughts on Various Subjects (p. 407)

Oxford University Press, Inc. New York, New York, USA. 1965

**Sylvester, James Joseph** 1814–97

English mathematician

As the prerogative of Natural Science is to cultivate a taste for observation, so that of Mathematics is, almost from the starting point, to stimulate the faculty of invention.

A Plea for the Mathematician

*Nature*, Volume 1 Thursday, January 6, 1870 (p. 261, fn)

**Twain, Mark (Clemens, Samuel**

**Langhorne)** 1835–1910

American author and humorist

A man invents a thing which could revolutionize the arts, produce mountains of money, and bless the earth, and who will bother with it or show any interest in it? — and so you are just as poor as you were before. But you invent some worthless thing to amuse yourself with, and would throw it away if let alone, and all of a sudden the whole world makes a snatch for it and out crops a fortune.

*The American Claimant*

Chapter XXIV (p. 164)

Chatto & Windus. London, England. 1892

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The greatest invention of the nineteenth century was the invention of the method of invention.

*Science and the Modern World*

Chapter VI (p. 96)

The Macmillan Company. New York, New York, USA. 1929

...inventive genius requires pleasurable mental activity as a condition for its vigorous exercise. “Necessity is the mother of invention” is a silly proverb. “Necessity is the mother of futile dodges” is much nearer to the truth. The basis of the growth of modern invention is science, and science is almost wholly the outgrowth of pleasurable intellectual curiosity.

*The Aims of Education and Other Essays*

Chapter IV (p. 69)

The Macmillan Company. New York, New York, USA. 1959

## INVENTOR

**Burdon-Sanderson, J.**

No biographical data available

...the human inventor is but a blunderer as compared with the unknown Master of the animal creation.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

Ludwig and Modern Physiology (p. 368)

Government Printing Office. Washington, D.C. 1898

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Man is a shrewd inventor, and is ever taking the hint of a new machine from his own structure, adapting some secret of his own anatomy in iron, wood, and leather, to some required function in the work of the world.

*Ralph Waldo Emerson: Essays and Lectures*

English Traits

Wealth (p. 857)

The Library of America. New York, New York, USA. 1983

**Milton, John** 1608–74

English poet

Th' invention all admir'd, and each how hee  
To be th' inventor miss'd; so easy it seem'd,

Once found, which yet unfound most would have  
thought

Impossible...

In *Great Books of the Western World* (Volume 32)*Paradise Lost*

Book VI, l. 498–501

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Rabinow, Jacob** 1910–99

Inventor

This is the penalty of being an inventor. If you invent something when everybody wants it, it is too late; it's been thought of by everybody else. If you invent too early, nobody wants it because it is too early. If you invent very late, after the need has passed, then it is just a mental exercise. I assure you that it is very hard to invent just at the right time.

In Daniel V. DeSimone

*Education for Innovation*

The Process of Invention (p. 75)

Pergamon Press. New York, New York, USA. 1968

The job of the inventors is to provide the lead for a lagging system.

In Daniel V. DeSimone

*Education for Innovation*

The Process of Invention (p. 75)

Pergamon Press. New York, New York, USA. 1968

**Redfield, Casper L.**

No biographical data available

A man's capacity as an inventor depends upon his faculty of making guesses which have some semblance of possibility...

In Joseph Rossman

*Industrial Creativity: The Psychology of the Inventor*

Chapter XI (p. 111)

University Books. New Hyde Park, New York, USA. 1964

**Rossman, Joseph**

Inventor

The inventor experiences a need which he wishes to satisfy.

*Industrial Creativity: The Psychology of the Inventor*

Chapter VI (p. 81)

University Books. New Hyde Park, New York, USA. 1964

Inventors are unconscious social changers.

*Industrial Creativity: The Psychology of the Inventor*

Chapter I (p. 6)

University Books. New Hyde Park, New York, USA. 1964

**Swann, William Francis Gray** 1884–1962

Anglo-American physicist

The inventor walks in the territory which the man of science has mapped out into regions of assured fertility, dubious fertility, and almost certain sterility. The man of science, and indeed the engineer, are inclined to conserve their efforts by walking in the rather limited realm which, on the basis of the laws with which they operate, represent regions of assured fertility. However, the inventor walks with courage everywhere. He sees a pasture which he thinks has promise. The physicist would explain to him that his reasons for expecting something from that region are invalid, and in 90 per cent of the cases they are, but the inventor walks nevertheless.

In Lenox R. Lohr

*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*

The Engineer and the Scientist (p. 260)

Centennial of Engineering. Chicago, Illinois. 1952

**Taylor, Calvin W.**

No biographical data available

...practically all of the mighty rivers of industry spring from the headwaters of lone wolf inventors or creators.

In Daniel V. DeSimone

*Education for Innovation*

Factors influencing Creativity (p. 49)

Pergamon Press. New York, New York, USA. 1968

**Taylor, Isaac**

No biographical data available

The great inventor is one who has walked forth upon the industrial world, not from universities, but from hovels; not as clad in silks and decked with honours, but as clad in fustian and grimed with soot and oil.

In Tyrone Edwards

*The New Dictionary of Thoughts*

J.G. Ferguson Publishing Company. Chicago, Illinois, USA. 1969

**Twain, Mark (Clemens, Samuel****Langhorne)** 1835–1910

American author and humorist

Name the greatest of all the inventors: Accident.

In Albert Bigelow Paine (ed.)

*Mark Twain's Notebook*

Chapter XXXIII (p. 374)

Harper &amp; Brothers. New York, New York, USA. 1899

**INVESTIGATION****Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

No amount of learning from books or of listening to the words of authority can be substituted for the spade-work of investigation.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 42)

Macmillan &amp; Company Ltd. London, England. 1918

**Herrick, Robert** 1591–1674

English poet

Attempt the end and never stand to doubt;  
Nothing's so hard, but search will find it out.

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

Seeke and Finde

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1968

**Sagan, Carl** 1934–96

American astronomer and author

Hidden within every astronomical investigation, sometimes so deeply buried that the researcher himself is unaware of its presence, lies a kernel of awe.

*Cosmos*

Chapter IX (p. 243)

Random House, Inc. New York, New York, USA. 1980

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

Many discoveries are reserved for ages still to be, when our memory shall have perished. The world is a poor affair if it do not contain matter for investigation for the whole world in every age.

*Physical Science in the Time of Nero, Being a Translation of the Quaestiones Naturales of Seneca*

Book VII, Chapter XXXI (pp. 305–306)

Macmillan &amp; Company Ltd. London, England. 1910

**INVESTIGATOR****Caldwell, G. C.**

No biographical data available

Great investigators like great poets, like men great in anything, are born not made; born, may we not truly say, out of the spirit of the country and the period in which their great works are done.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1893*

The American Chemist (p. 252)

Government Printing Office. Washington, D.C. 1894

**Shapley, Harlow** 1885–1972

American astronomer

...man's role as an investigator and would-be interpreter of the universe is surpassingly fascinating, whether or not it is cosmically significant.

*Starlight*

Part III, Chapter XV (p. 143)

George H. Doran Company. New York, New York, USA 1926

**ION****Hendrick, Ellwood**

No biographical data available

I used to think theology  
Was rather rough on doubt,  
But chemistry with ions, beats  
Theology all out.

So you'd better get your Bible down before you're well begun,

For you're going to need the exercise the art of faith,  
my son.

The Present Status of Ionization Theory

*Journal of Chemical Education*, Volume 2, Number 5, May 1925 (p. 376)**Kunin, Robert**

No biographical data available

**Myers, Robert J.**

No biographical data available

A recent interpretation of the miracle supposedly performed by Moses as he led the Israelites safely through the wilderness suggests the possibility of the application of ion exchange. In order to make the "bitter" water at Matah potable during their journey, Moses found a tree "which when he had cast it into the waters, the waters were made sweet." It has been suggested that the oxidized cellulose of the tree entered into an exchange reaction with the bitter electrolytes of the water, rendering the water potable.

*Ion Exchange Resins*

Chapter 1 (p. 1)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1950

**IRRATIONALITY****Laudan, Larry** 1945–

American philosopher of science

If rationality consists in believing only what we can reasonably presume to be true, and if we define "truth" in its classical nonpragmatic sense, then science is (and will forever remain) irrational.

*Progress and Its Problems: Toward a Theory of Scientific Growth*

Chapter Four (p. 125)

University of California Press. Berkeley, California, USA. 1977

...when a thinker does what it is rational to do, we need inquire no further into the causes of his actions; whereas, when he does what is in fact irrational — even if he believes it to be rational — we require some further explanation.

*Progress and Its Problems: Toward a Theory of Scientific Growth*

Chapter Six (pp. 188–189)

University of California Press. Berkeley, California, USA. 1977

**Mannheim, Karl** 1893–1947

Austria-Hungarian sociologist

Anyone who wants to drag in the irrational where the lucidity and acuity of reason still must rule by right merely shows that he is afraid to face the mystery at its legitimate place.

*Essays on the Sociology of Knowledge*

Chapter V (p. 229)

Routledge & Kegan Paul Ltd. London, England. 1952

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

**CHILTERN:** You think science cannot grapple with the problem of women?

**CHEVELEY:** Science can never grapple with the irrational. That is why it has no future before it, in this world.

**CHILTERN:** And women represent the irrational.

*Complete Writings of Oscar Wilde*

An Ideal Husband

Act I

The Nottingham Society. New York, New York, USA. 1907

## IRREVERSABILITY

**Planck, Max** 1858–1947

German physicist

A process which in no manner can be completely reversed I called a “natural” one. The term for it in universal use today is: “Irreversible.”

*Scientific Autobiography and Other Papers*

A Scientific Autobiography (p. 17)

Philosophical Library. New York, New York, USA. 1949

## ISOMERISM

**van’t Hoff, Jacobus Henricus** 1852–1911

Dutch physical and organic chemist

I desire to introduce some remarks which may lead to discussion and hope to avail myself of the discussion to give my ideas more definiteness and breadth. Since the starting point for the following communication is found in the chemistry of the carbon compounds, I shall for the present do nothing more than state the points having reference to it. It appears more and more that the present constitutional formulas are incapable of explaining certain cases of isomerism; the reason for this is perhaps

the fact that we need a more definite statement about the actual positions of the atoms.

Formulas at Present Used in Chemistry and a Note on the Relation of Optical Activity and the Chemical Constitution of Organic Compounds *Archives neerlandaises des sciences exactes et naturelles*, Volume 9, September 1874

## ISOSTASY

**Chamberlain, Rollin T.**

American geologist

The keynote to isostasy is a working toward equilibrium. Isostasy is not a process which upsets equilibrium, but one which restores equilibrium.

*Journal of the Washington Academy of Sciences*, Volume 20, 1932 (p. 455)

## IT

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

...the patriotic archbishop of Canterbury, found it advisable —

“Found *what?*” said the Duck.

“Found *it,*” the Mouse replied, rather crossly: “of course you know what ‘it’ means.”

“I know what ‘it’ means well enough, when *I* find a thing,” said the Duck: “it’s generally a frog, or a worm. The question is, what did the archbishop find?”

*The Complete Works of Lewis Carroll*

Alice’s Adventures in Wonderland

Chapter III (p. 36)

The Modern Library. New York, New York, USA. 1936

**Weingarten, Violet**

Writer

...report for a routine checkup feeling like a hypochondriac because obviously you’re in perfect health, and the doctor mumbles something about “it” having to come out, no rush, next week will be plenty of time.

*Intimations of Mortality* (p. 3)

Alfred A. Knopf. New York, New York, USA. 1978

## J

### JAW

#### Maisey, John

American paleontologist

It is hard to imagine life without jaws: giant killer sharks, carnivorous dinosaurs, saber-toothed tigers, and that talkative neighbor just would not be the same without them. The acquisition of jaws is perhaps the most profound and radical evolutionary step in craniate history, after the development of the head itself.

*Discovering Fossil Fishes*

Chapter 5 (p. 59)

Henry Holt & Company. New York, New York, USA. 1996

### JEALOUSY

#### Jung, Carl G. 1875–1961

Swiss psychiatrist and founder of analytical psychology

The kernel of all jealousy is lack of love.

*Memories, Dreams, Reflections*

Chapter IV (p. 137)

Vintage Books. New York, New York, USA. 1963

### JOURNAL

#### Stuart, Copans A.

Why, dear colleagues, must our findings

Now be put in sterile bindings?

Once physicians wrote for recreation.

Our great teachers through the ages,

Fracastro, and other sages,

Found writing could be fun, like fornication...

*Perspectives in Biology and Medicine*

Winter 1973 (p. 232)

### JOURNEY

#### Abbey, Edward 1927–89

American environmentalist and nature writer

That's the best thing about walking, the journey itself. It doesn't matter much whether you get where you're going or not. You'll get there anyway. Every good hike brings you eventually back home. Right where you started.

*The Journey Home: Some Words in Defense of the American West*

Chapter 18 (p. 205)

E.P. Dutton. New York, New York, USA. 1977

The longest journey begins with a single step, not with the turn of an ignition key.

*The Journey Home: Some Words in Defense of the American West*

Chapter 18 (p. 205)

E.P. Dutton. New York, New York, USA. 1977

#### Muir, John 1838–1914

American naturalist

One bird, a thrush, embroidered the silence with cheery notes, making the solitude familiar and sweet, while the solemn monotone of the stream sifting through the woods seemed like the very voice of God, humanized, terrestrialized, end entering one's heart as to a home prepared for it. Go where we will, all the world over, we seem to have been there before.

*All the World Over: Notes from Alaska*

First page

Sierra Club Books. San Francisco, California, USA. 1996

### JUDGMENT

#### Drinker, Henry 1850–1937

...in regard to all civil engineering, the first requisite is good judgment, the second requisite is good judgment, and the final requisite is GOOD JUDGMENT.

In Henry Drinker

*Tunneling, Explosive Compounds, and Rock Drilling* (p. 1005)

John Wiley & Sons, Inc. New York, New York, USA. 1878

#### Sagan, Carl 1934–96

American astronomer and author

It is of interest to note that while some dolphins are reported to have learned English — up to fifty words used in correct context — no human being has been reported to have learned dolphinese. Prejudice is making a judgment before you have looked at the facts. Postjudice is making a judgment afterwards. Prejudice is terrible, in the sense that you commit injustices and you make serious mistakes. Postjudice is not terrible. You can't be perfect of course; you may make mistakes also. But it is permissible to make a judgment after you have examined the evidence. In some circles it is even encouraged.

The Burden of Skepticism

*Skeptical Enquirer*, Volume 12, Fall 1987 (p. 46)

### JUSTIFICATION

#### Kelvin, Lord William Thomson 1824–1907

Scottish engineer, mathematician, and physicist

These somewhat pedantic words are justifiable, because “infinitesimal satellite” is nine syllables to express three or four sentences; that is our justification.

*Popular Lectures and Addresses* (Volume 1)

Lecture, Institution of Civil Engineers, May 3, 1883 (p. 100)

Macmillan & Company Ltd. London, England. 1894

## K

### KEY

**Mayr, Ernst** 1904–2005  
German-born American biologist

The use of keys in identification is old indeed. Much of Aristotle's classifications of animals was presented in the form of simple dichotomous alternatives.

*Principles of Systematic Zoology*  
Chapter 11B.3 (p. 276)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

### Quicke, D. L.

No biographical data available

The purpose of a key is to enable identifications, and it should not be a vehicle for expressing systematic opinions. First, good systematic characters are very often poor or even unusable key characters, and second, classifications are all too frequently subject to modification.

*Principles and Techniques of Contemporary Taxonomy* (p. 99)  
Blackie Academic & Professional. London, England. 1993

### KINGDOM

### Whittaker, R. H.

No biographical data available

There are those who consider questions in science which have no unequivocal experimentally determined answer scarcely worth discussing. Such feeling, along with conservatism, may have been responsible for the long and almost unchallenged dominance of the system of two kingdoms — plants and animals — in the broad classification of organisms. The unchallenged position of these kingdoms has ended, however; alternative systems are being widely considered.

*New Concepts of Kingdoms of Organisms*  
*Science*, Volume 163, Number 3863, 10 January 1969 (p. 150)

### KNOT

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer & mathematician

“A knot!” said Alice, always ready to make herself useful, and looking anxiously about her. “Oh, do let me help undo it!”

*The Complete Works of Lewis Carroll*  
Alice's Adventures in Wonderland  
Chapter III (p. 41)

The Modern Library. New York, New York, USA. 1936

## KNOWING

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

“Protect me from knowing what I don't need to know. Protect me from even knowing that I decided not to know about the things that I decided not to know about. Amen.” That's it. It's what you pray silently inside yourself anyway, so you may as well have it out in the open.

*The Ultimate Hitchhiker's Guide to the Galaxy*

Mostly Harmless  
Chapter 9 (p. 704)

The Ballantine Book Company. New York, New York, USA. 2002

**Nietzsche, Friedrich** 1844–1900

German philosopher

Once upon a time, in some out of the way corner of that universe which is dispersed into numberless twinkling solar systems, there was a star upon which clever beasts invented knowing. That was the most arrogant and mendacious minute of “world history,” but nevertheless, it was only a minute. After nature had drawn a few breaths, the star cooled and congealed, and the clever beasts had to die.

*The Portable Nietzsche*

On Truth and Lie in an Extra-Moral Sense (p. 42)  
Penguin Books. New York, New York, USA. 1976

**Williamson, Marianne** 1952–

American spiritual activist

There's a collective knowing that a dimension of reality exists beyond the material plane, and that sense of knowing is causing a mystical resurgence on the planet today. It's not just children who are looking for a missing piece. It is a very mature outlook to question the nature of our reality.

*Everyday Grace: Having Hope, Finding Forgiveness, and Making Miracles*

Introduction: Reclaiming Our Magic  
Penguin Putnam Inc. New York, New York, USA. 2002

### KNOWLEDGE

**Adams, George** 1750–95  
English instrument maker

The principles of all knowledge are founded in mind; the mind of man, either animated by desire or pressed by necessity, puts in action it's various energies, and unfolds the seeds of knowledge.

*Lectures on Natural and Experimental Philosophy* (Volume 3)

Chapter XXXIII (p. 369)

Printed by R. Hindmarsh. London, England. 1794

...mankind...for more than a thousand years, looked up to Aristotle as an oracle in philosophy. His authority was

the test of truth; it was a philosophy, says Lord Bacon, fruitful of words, but barren or works; admirably contrived to draw a veil over ignorance, and put a stop to the progress of knowledge, by filling men with a conceit that they knew every thing: a philosophy, that instead of accounting for any of the phenomena of nature, contrived to give learned names to their unknown causes, and fed men with hulks of barbarous terms, instead of the fruits of real knowledge.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (pp. 30–31)

Printed by R. Hindmarsh. London, England. 1794

**Addison, Joseph** 1672–1719

English essayist, poet, and statesman

The utmost extent of man’s knowledge is to know that he knows nothing.

*Interesting Anecdotes, Memoirs, Allegories, Essays, and Poetical Fragments*

Volume 3 & 4, Essay on Pride (p. 230)

Printed for T. N. Longman. London, England. 1796

**Alighieri, Dante** 1265–1321

Italian poet and writer

...to have heard without retaining does not make knowledge.

In *Great Books of the Western World* (Volume 21)

*The Divine Comedy of Dante Alighieri*

Paradise, Canto V, l. 41–42

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Arbuthnot, John** 1667–1735

Scottish mathematician and physician

Mathematical knowledge adds vigor to the mind, frees it from prejudice, credulity, and superstition.

*An Essay on the Usefulness of Mathematical Learning*

Printed at the Theater. Oxford, England. 1701

**Aristotle** 384 BCE–322

Greek philosopher

Yet it does not appear to be true in all cases that correlatives come into existence simultaneously. The object of knowledge would appear to exist before knowledge itself for it is usually the case that we acquire knowledge of objects already existing; it may be difficult, if not impossible, to find a branch of knowledge the beginning of the existence of which was contemporaneous with that of its object.

In *Great Books of the Western World* (Volume 8)

*Categories*

Chapter 7, 7b [20]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 19

All men by nature desire to know.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book I, Chapter 1 (p. 499)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...knowledge of any kind is a thing to be honored and prized...

In *Great Books of the Western World* (Volume 8)

*On the Soul*

Book I, Chapter I, 402a

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...knowledge is the object of our enquiry and men do not think they know a thing till they have grasped the “why” of it.

In *Great Books of the Western World* (Volume 8)

*Physics*

Book II, Chapter 2, 194b [15]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 19

**Asimov, Isaac** 1920–92

American author and biochemist

I believe that scientific knowledge has fractal properties; that no matter how much we learn, whatever is left, however small it may seem, is just as infinitely complex as the whole was to start with. That, I think, is the secret of the Universe.

Essay 400 — A Way of Thinking

*The Magazine of Fantasy and Science Fiction*, December 1994

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

...he who is desirous of instruction ought not to disdain listening to any one, who has knowledge to communicate, however humble may be his lot, or however limited his talents...

*Ornithological Biography* (Volume 1)

The Cougar (p. 205)

Adam Black. Edinburgh, Scotland. 1831

**Bach, Richard** 1936–

American writer

Isn’t it strange how much we know if only we ask ourselves instead of somebody else.

*Illusions: The Adventures of a Reluctant Messiah*

Chapter 8 (p. 82)

Delacorte Press. New York, New York, USA. 1977

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

To conclude therefore, let no man upon a weak conceit of sobriety or an ill-applied moderation think or maintain that a man can search too far, or be too well studied in the book of God’s words, or in the book of God’s work, divinity, or philosophy; but rather let men endeavor an endless progress or proficiency in both.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

First Book, Chapter I, Section 3 (p. 4)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The lame...in the path outstrip the swift who wander from it, and it is clear that the very skill and swiftness



of him who runs not in the right direction must increase his aberration.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 61 (p. 113)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

If any man makes it his delight and care — not so much to cling to and use past discoveries, as to penetrate to what is beyond them — not to conquer Nature by talk, but by toil — in short, not to have elegant and plausible theories, but to gain sure and demonstrable knowledge; let such men (if it shall seem to them right), as true children of knowledge, unite themselves with us.

In J.W. Gregory

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Geology of the Inner Earth — Igneous Ores (p. 312)

Government Printing Office. Washington, D.C. 1908

...that knowledge hath in it somewhat of the serpent, and therefore where it entereth into a man it makes him swell...

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

First Book, Chapter I, Section 2 (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Barfield, Owen** 1898–1997

British philosopher, critic, and anthroposophist

There is no “science of sciences”; no unity of knowledge. There is only an accelerating increase in that pigeon-holed knowledge by individuals of more and more about less and less, which, if persisted in indefinitely, can only lead mankind to a sort of “idiocy” (in the original sense of the word) — a state of affairs, in which fewer and fewer representations will be collective, and more and more will be private, with the result that there will in the end be no means of communication between one intelligence and another.

*Saving the Appearances: A Study in Idolatry*

Chapter XXI (p. 145)

Faber & Faber. London, England. 1957

### **Barrie, Sir James M.** 1860–1937

Scottish journalist, writer, and dramatist

ERNEST. ...I'm not young enough to know everything.

*The Admirable Crichton*

Act I (p. 16)

Hodder & Stoughton. London, England. 1961

### **Barry, Frederick** 1876–1943

Historian of science

It is clear, for instance, that we classify business management, pugilism and medicine together as science because, though as occupations they are only incidentally related, they are all characterized by the practical, methodical, and so far as is humanly possible, the rational utilization of knowledge for the attainment of definite goals.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge*

Chapter I (p. 5)

Columbia University Press. New York, New York, USA. 1927

### **Becker, Carl L.** 1873–1945

American historian

There is nothing new in heaven or earth not dreamt of in our laboratories; and we should be amazed indeed if tomorrow and tomorrow and tomorrow failed to offer us something new to challenge our capacity for readjustment.

*The Heavenly City of the Eighteenth Century Philosophers*

Chapter I (p. 23)

Yale University Press. New Haven, Connecticut, USA. 1932

### **Bernard, Claude** 1813–78

French physiologist

The fact that knowledge endlessly recedes as the investigator is about to grasp it is what constitutes at the same time his torment and happiness.

In René Dubos

*The Dreams of Reason*

Chapter 6 (p. 138)

Columbia University Press. New York, New York, USA. 1961

One of the greatest obstacles to the free and universal movement of human knowledge is the tendency that leads different kinds of knowledge to separate into systems.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter III, Section iv (p. 223)

Henry Schuman, Inc. New York, New York, USA. 1927

### **Billings, Josh (Henry Wheeler Shaw)** 1818–85

American writer and humorist

It is better to know less, than to know so much, that aint so.

*Old Probability: Perhaps Rain — Perhaps Not*

A Remark (Beginning of book)

G.W. Carleton & Company, Publishers. New York, New York, USA.

1879

### **Bloch, Marc** 1905–83

American physicist and educator

Each science, taken by itself, represents but a fragment of the universal march toward knowledge.

*The Historian's Craft*

Introduction (p. 15)

Manchester University Press. Manchester, England. 2004

### **Bloor, David**

No biographical data available

Like many features of a landscape, knowledge looks different from different angles. Approach it from an unexpected route, glimpse it from an unusual vantage point, and at first it may not be recognizable.

*Knowledge and Social Imagery*

Chapter Eight (p. 160)

The University of Chicago Press. Chicago, Illinois, USA. 1991

All knowledge, the sociologist could say, is conjectural and theoretical. Nothing is absolute and final. Therefore all knowledge is relative to the local situation of the thinkers who produce it: the ideas and conjectures that they are capable of producing; the problems that bother them; the interplay of assumptions and criticism in their milieu; their purposes and aims; the experiences they have and the standards and meanings they apply.

*Knowledge and Social Imagery*

Chapter Eight (p. 159)

The University of Chicago Press. Chicago, Illinois, USA. 1991

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

In our time, when increasing knowledge and ability more than ever link the fate of all peoples, international collaboration in science has far-reaching tasks which may be furthered not least by an awareness of the general conditions for human knowledge.

*Atomic Physics and Human Knowledge*

Atoms and Human Knowledge (p. 93)

John Wiley & Sons, Inc. New York, New York, USA. 1958

**Borel, Félix Edouard** 1871–1956

French mathematician

Incomplete knowledge must be considered as perfectly normal in probability theory; we might even say that, if we knew all the circumstances of a phenomenon, there would be no place for probability, and we would know the outcome with certainty.

Translated by Douglas Scott

*Probability and Certainty*

Chapter 1 (p. 13)

Walker & Company. New York, New York, USA. 1963

**Boulding, Kenneth E.** 1910–93

English economist and social scientist

The carbon atom, for instance, knows how to join with four hydrogen atoms or with two oxygen atoms. It also mysteriously enough knows how to join with one oxygen atom to form carbon monoxide. It is little more than a figure of speech, however, to regard this ability as knowledge.

*The Image*

Chapter 3 (p. 32)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1956

**Bulfinch, Thomas** 1796–1867

American writer

If no other knowledge deserves to be called useful but that which helps to enlarge our possessions or to raise our station in society, then mythology has no claim to the appellation. But if that which tends to make us happier and better can be called useful then we claim that epithet for our subject.

*The Age of Fable* (p. 1)

The Modern Library. New York, New York, USA. 1934

**Brecht, Bertolt** 1898–1956

German writer

GALILEO:...Knowledge will become a passion and research an ecstasy.

Translated by John Willett

*Life of Galileo*

Scene 9 (p. 77)

Arcade Publishing. New York, New York, USA. 1994

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

There is no absolute knowledge. And those who lay claim to it, whether they are scientists or dogmatists, open the door to tragedy.

*The Ascent of Man*

Chapter 11 (p. 353)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Bube, Richard H.**

American materials scientist

Science has become a particular kind of knowledge obtained in a particular way: knowledge of the natural world obtained by sense interaction with that world.

*The Encounter Between Christianity and Science*

Chapter 1 (p. 17)

W.B. Eerdmans Publishing Company. Grand Rapids, Iowa, USA. 1968

**Bullock, Theodore Holmes** 1915–2005

Comparative neuroscientist

The road is long and branching, distractions and obstacles are many, the goal is hazy and far away, pilgrims speak in many tongues. But we can look back and see progress, or look up and see some exciting peaks.

In John C. Fentress (ed.)

*Simpler Networks and Behavior*

In Search of Principles in Neural Integration

Sinauer Associates, Inc. Sunderland, Massachusetts, USA. 1976

**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

The process by which the boundaries of knowledge are advanced, and the structure of organised science is built, is a complex process indeed. It corresponds fairly well with the exploitation of a difficult quarry for its building materials and the fitting of these into an edifice; but there are very significant differences. First, the material itself is exceedingly varied, hidden and overlaid with relatively worthless rubble.... Second, the whole effort is highly unorganised. There are no direct orders from architect or quarrymaster. Individuals and small bands proceed about their business unimpeded and uncontrolled, digging where they will, working over their material, and tucking it into place in the edifice.

*Endless Horizons*

Chapter 17 (p. 179)

Public Affairs Press. Washington, D.C. 1946

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

It is far safer to know too little than too much. People will condemn the one, though they will resent being called upon to exert themselves to follow the other.

*The Way of All Flesh*

Chapter V (p. 18)

Rinehart & Company, Inc. New York, New York, USA. 1955

**Butlerov, Aleksandr Mikhailovich** 1828–86  
Russian chemist

As speech is composed of sets of words and as images are composed of aggregates of shades, so from the mass of apprehended facts connected with one another there arises knowledge in its loftiest and finest sense.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

That knowledge is not happiness, and science  
But an exchange of ignorance for that  
Which is another kind of ignorance.

*The Complete Poetical Works of Byron*

Manfred

Act II, Scene V, l. 431–433

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Cajori, Florian** 1859–1930  
Swiss-born American educator and mathematician

The contemplation of the various steps by which mankind has come into possession of the vast stock of mathematical knowledge can hardly fail to interest the mathematician. He takes pride in the fact that his science, more than any other, is an exact science, and that hardly anything ever done in mathematics has proved to be useless.

*A History of Mathematics*

Introduction (p. 1)

Macmillan & Company Ltd. London, England. 1919

**Cannon, Walter Bradford** 1871–1945  
American neurologist and physiologist

The boundary of knowledge, however, is pushed forward with painful slowness, and always, as an advance is achieved, further territory to be explored is revealed.

*The Way of an Investigator: A Scientist's Experiences in Medical Research*

Chapter II (p. 28)

W.W. Norton & Company. New York, New York, USA. 1945

**Carnap, Rudolf** 1891–1970  
American philosopher

When we say that scientific knowledge is unlimited, we mean “there is no question whose answer is in principle unattainable by science.”

In Mary Midgley

Can Science Save Its Soul?

*New Scientist*, Volume 135, Number 1832, 1 August 1992 (p. 24)

**Carroll, J. E.**

No biographical data available

Collecting fresh fruits becomes even harder as the tree of knowledge grows higher and wider. However, there are certain branches that provide surer footholds to the new growths, and teachers must search these out.

*Rate Equations in Semiconductor Electronics* (p. vi)

Cambridge University Press. Cambridge, England. 1985

**Charlie Chan**

Fictional character

Small investigation sometimes bring large amount of knowledge.

*The Golden Eye*

Film (1948)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

Illuminated darkness is not light.

*Heracleitean Fire: Sketches from a Life before Nature*

Part II

In the Light of Darkness (p. 109)

Rockefeller University Press. New York, New York, USA. 1978

**Clarke, J. M.**

No biographical data available

Knowledge is the only instrument of production that is not subject to diminishing returns.

Overhead Costs in Modern Industry

*Journal of Political Economy*, October 1927

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

...our knowledge will, we are easily persuaded, appear in turn the merest ignorance to those who come after us. Yet it is not to be despised, since by it we reach up groping fingers to touch the hem of the garment of the Most High.

*A Popular History of Astronomy During the Nineteenth Century*

Part II, Chapter XIII (p. 442)

A. & C. Black. London, England. 1908

**Coleridge, Mary** 1861–1907

English poet

The fruits of the tree of Knowledge are various; he must be strong indeed who can digest all of them.

*Gathered Leaves*

Mary Coleridge (pp. 8–9)

Constable & Company. London, England. 1910

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

Questioning is the cutting edge of knowledge; assertion is the dead weight behind the edge that gives it driving force.

*Speculum Mentis*

Chapter III, Section 5 (p. 78)

At The Clarendon Press. Oxford, England. 1946

**Collins, Wilkie** 1824–89  
English novelist

... what is scientific knowledge now may be scientific ignorance in some years more.

*Heart and Science*

LIV (p. 285)

Chatto & Windus. London, England. 1899

**Commoner, Barry** 1917–  
American biologist, ecologist, and educator

Nature is the same everywhere and what men everywhere have learned about nature, taken together, leads to knowledge far deeper than that which each man alone can learn.

*Science and Survival*

Chapter 4 (p. 57)

The Viking Press. New York, New York, USA. 1966

**Conant, James Bryant** 1893–1978  
American educator and scientist

The stumbling way in which even the ablest of the scientists in every generation have had to fight through thickets of erroneous observations, misleading generalizations, inadequate formulations, and unconscious prejudice is rarely appreciated by those who obtain their scientific knowledge from textbooks.

*Science and Common Sense*

Chapter Three (p. 44)

Yale University Press. New Haven, Connecticut, USA. 1951

**Confucius** 551 BCE–479 BCE  
Chinese philosopher and reformer

When you know a thing, to hold that you know it; and when you do not know a thing, to allow that you do not know it; — this is knowledge.

In James Legge

*The Chinese Classics* (Volume 1)

The Confucian Analects, book 2:17

At The Clarendon Press. Oxford, England. 1893–95

**Cooke, Josiah Parsons** 1827–94

Honor those who seek Knowledge for her own sake, and remember they are the great heroes of the world, who work in faith, and leave the result with God!

*The New Chemistry*

Lecture XIII (p. 326)

D. Appleton & Company. New York, New York, USA. 1876

**Cooper, Thomas** 1759–1839  
American educationalist and political philosopher

... knowledge is a plant of slow growth.

*The Introductory Lecture of Thomas Cooper, Esq.*

Introductory Lecture (p. 4)

Printed by Archibald Loudon. Carlisle, Pennsylvania, USA. 1812

**Cowper, William** 1731–1800  
English poet

Knowledge and Wisdom, far from being one,  
Have oft-times no connexion. Knowledge dwells  
In heads replete with thoughts of other men;  
Wisdom in minds attentive to their own.  
Knowledge, a rude unprofitable mass,  
The mere materials with which wisdom builds...  
Knowledge is proud that he has learn'd so much;  
Wisdom is humble that he knows no more.

*The Poetical Works of William Cowper*

The Task, Book VI, l. 88–93, 96, 97

John W. Lovell Company. New York, New York, USA. No date

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

The acquisition of any knowledge whatever is always useful to the intellect, because it will be able to banish the useless things and retain those which are good. For nothing can be either loved or hated unless it is first known.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Aphorisms (p. 88)

George Braziller. New York, New York, USA. 1958

All our knowledge originates in opinion.

In Edward MacCurdy

*Leonardo Da Vinci's Note-Books*

Book I (p. 53)

Duckworth & Company. London, England. 1906

**Darwin, Charles Robert** 1809–82  
English naturalist

The more one thinks, the more one feels the hopeless immensity of man's ignorance.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 1)

Letter 307, Darwin to Farrar, August 28, 1881 (p. 394)

D. Appleton & Company. New York, New York, USA. 1903

**Daumal, Rene** 1908–44  
French surrealist writer

You cannot stay on the summit forever; you have to come down again. So why bother in the first place? Just this: What is above knows what is below, but what is below does not know what is above. In climbing, take careful note of the difficulties along your way; for as you go up, you can observe them. Coming down, you will no longer see them, but you will know they are there if you have observed them well. There is an art of finding one's

direction in the lower regions by the memory of what one saw higher up. When one can no longer see, one can at least still know.

Translated by Roger Shattuck

*Mount Analogue*

Editor's Note (p. 110)

Shambhala. Boston, Massachusetts, USA. 1986

**Davy, Sir Humphry** 1778–1829

English chemist

The love of knowledge and of intellectual power is a faculty belonging to the human mind in every state of society; and it is one by which it is most justly characterized — one the most worthy of being cultivated and extended.

In Robert Siegfried and Robert H. Dott, Jr. (eds.)

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Introductory Lecture for the Courses of 1805 (p. 3)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

All human knowledge is necessarily imperfect; but the further it extends, the better are its effects.

In Robert Siegfried and Robert H. Dott, Jr. (eds.)

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Introductory Lecture for the Courses of 1805 (p. 9)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

**Dickens, Charles** 1812–70

English novelist

But wot's that, you're a-doin' of? Pursuit of knowledge under difficulties, Sammy?

*The Posthumous Papers of the Pickwick Club*

Chapter XXXIII (p. 387)

Dodd, Mead & Company. New York, New York, USA. 1944

**Dingle, Herbert** 1890–1978

English astrophysicist

No generation that is in the true line of advance can properly know what it is doing. It works in the dark, building better than it knows, by the blind understanding which directs its actions towards the final achievement. We can at least learn from our experience not to despise the work of those on whose shoulders we stand, as we hope for charitable judgment from those who will succeed us.

*Through Science to Philosophy*

Chapter XV (p. 354)

At The Clarendon Press. Oxford, England. 1937

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

What can we know? What are we all? Poor silly half-brained things peering out at the infinite, with the aspirations of angels and the instincts of beasts.

*The Stark Munro Letters*

Letter V (p. 94)

D. Appleton & Company. New York, New York, USA. 1895

Some eighty thousand years are supposed to have existed between paleolithic and neolithic man. Yet in all that time he only learned to grind his flint stones instead of chipping them. But within our father's lives what changes have there not been? The railway and the telegraph, chloroform and applied electricity. Ten years now go further than a thousand then, not so much on account of our finer intellects as because the light we have shows us the way to more. Primeval man stumbled along with peering eyes, and slow, uncertain footsteps. Now we walk briskly towards our unknown goal.

*The Stark Munro Letters*

Letter XIV (p. 320)

D. Appleton & Company. New York, New York, USA. 1895

I consider that a man's brain originally is like a little empty attic, and you have to stock it with such furniture as you choose. A fool takes in all the lumber of every sort that he comes across, so that the knowledge which might be useful to him gets crowded out, or at best is jumbled up with a lot of other things, so that he has a difficulty in laying his hands upon it. Now the skilful workman is very careful indeed as to what he takes into his brain-attic. He will have nothing but the tools which may help him in doing his work, but of these he has a large assortment, and all in the most perfect order. It is a mistake to think that that little room has elastic walls and can distend to any extent. Depend upon it — there comes a time when for every addition of knowledge you forget something that you knew before. It is of the highest importance, therefore, not to have useless facts elbowing out the useful ones.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 2 (p. 154)

Wings Books. New York, New York, USA. 1967

Is it not? Is it not? Breadth of view, my dear Mr. Mac, is one of the essentials of our profession. The interplay of ideas and the oblique uses of knowledge are often of extraordinary interest.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Valley of Fear

Part I, Chapter 7 (p. 512)

Wings Books. New York, New York, USA. 1967

A man should keep his little brain-attic stocked with all the furniture that he is likely to use, and the rest he can put away in the lumber-room of his library, where he can get it if he wants it.

*The Complete Sherlock Holmes*

The Five Orange Pips (p. 225)

Doubleday & Company, Inc. Garden City, New York, USA. 1930

**Drexler, K. Eric** 1955–

American nanotechnology engineer and researcher, and futurist

People who confuse science with technology tend to become confused about limits...they imagine that new

knowledge always means new know-how; some even imagine that knowing everything would let us do anything.

*Engines of Creation*

Chapter 10 (p. 148)

Anchor Press/Doubleday. Garden City, New York, USA. 1986

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

We have discovered that it is actually an aid in the search for knowledge to understand the nature of the knowledge we seek.

*The Philosophy of Physical Science*

Chapter I, Section II (p. 5)

The Macmillan Company. New York, New York, USA. 1939

...the road to a knowledge of the stars leads through the atom; and important knowledge of the atom has been reached through the stars.

*Stars and Atoms*

Lecture I (pp. 9–10)

Yale University Press. London, England. 1927

**Egler, Frank E.** 1911–96

American botanist and ecologist

Knowledge is not wisdom; wisdom is knowledge when it is tempered by judgment.

*The Way of Science*

The Nature of Science (p. 1)

Hafner Publishing Company. New York, New York, USA. 1970

**Einstein, Albert** 1879–1955

German-born physicist

Yet it is equally clear that knowledge of what is does not open the door directly to what should be.

*Out of My Later Years* (p. 22)

Thames & Hudson. London, England. 1950

In the light of finally obtained knowledge the deductions seem almost self-evident and can be understood with no great difficulty by any intelligent student. But the foreboding search in the dark, with its intense yearnings, its alternation from confidence to despondence and then the ultimate break-through to final clarity, can only be perceived by someone who has experienced it himself.

In Cornelius Lanczos

*Albert Einstein and the Cosmic World Order*

Chapter 5 (p. 85)

Interscience Publishers. New York, New York, USA. 1965

It is my inner conviction that the development of science seeks in the main to satisfy the longing for pure knowledge.

In Alexander Moszkowski

*Conversations with Einstein*

Chapter VIII (p. 173)

Horizon Press. New York, New York, USA. 1970

In every true searcher of Nature there is a kind of religious reverence; for he finds it impossible to imagine that he is the first to have thought out the exceedingly delicate threads that connect his perceptions. The aspect of knowledge which had not yet been laid bare gives the investigator a feeling akin to that experienced by a child who seeks to grasp the masterly way in which elders manipulate things.

In Alexander Moszkowski

*Conversations with Einstein*

Chapter III (p. 46)

Horizon Press. New York, New York, USA. 1970

...knowledge cannot spring from experience alone but only from the comparison of the inventions of the intellect with observed fact.

Translated by Alan Harris

*Essays in Science*

Johannes Kepler (p. 27)

Philosophical Library. New York, New York, USA. 1934

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

We in the modern world have turned more stones, listened to more buried voices, than any culture before us. There should be a kind of pity that comes with time, when one grows truly conscious and looks behind as well as forward, for nothing is more brutally savage than the man who is not aware that he is a shadow.

*The Night Country*

Chapter 6 (p. 85)

Charles Scribner's Sons. New York, New York, USA. 1971

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Yet things are knowable! They are knowable, because, being from one, things correspond. There is a scale; and the correspondence of heaven to earth, of matter to mind, of the part to the whole, is our guide. As there is a science of stars, called astronomy; and science of quantities, called mathematics; a science of qualities, called chemistry; so there is a science of sciences, — I call it Dialectic, — which is the Intellect discriminating the false and the true.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

Representative Men

Plato; or, the Philosopher (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Our knowledge is the amassed thought and experience of innumerable minds.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Quotations and Originality (p. 200)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

All our progress is an unfolding, like the vegetable bud. You have first an instinct, then an opinion, then a knowledge.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

Intellect (p. 419)

The Library of America. New York, New York, USA. 1983

**Everett, Edward** 1794–1865

American statesman, educator, and orator

...the great object of all knowledge is to enlarge and purify the soul, to fill the mind with noble contemplations, to furnish a refined pleasure, and to lead our feeble reason from the works of nature up to its great Author and Sustainer.

*An Oration*

The Uses of Astronomy, Albany, New York, 28 July 1856 (p. 36)

Ross & Tousey. New York, New York, USA. 1856

**Faber, Harold**

No biographical data available

New scientific knowledge is like wine in the wedding of Cana: it cannot be used up; the same idea can serve many users simultaneously; and as the number of customers increases, no one need be getting less of it because the others are getting more.

*The Book of Laws*

The Laws of Economics, Leontief's Law (p. 57)

Times Books. New York, New York, USA. 1979

**Fischer, Martin H.** 1879–1962

German-American physician

Knowledge is a process of piling up facts; wisdom lies in their simplification.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 2)

C.C. Thomas. Springfield, Illinois, USA. 1944

**Feynman, Richard P.** 1918–88

American theoretical physicist

I don't know what's the matter with people: they don't learn by understanding; they learn by some other way — by rote, or something. Their knowledge is so fragile!

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*

Who Stole the Door (pp. 36–37)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

A great deal more can be known than can be proved.

*Chicago Tribune*, 318:4, Section 7, November 14, 1993

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

The principle of science, the definition, almost, is the following: The test of all knowledge is experiment. Experiment is the sole judgment of scientific "truth."

*The Feynman Lectures on Physics* (Volume 1)

Chapter 1–1 (p. 1–1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1983

**Fischer, Robert B.**

No biographical data available

Thus, the scientist must recognize the statistical aspect of much of his knowledge, not, on the one hand, unduly hesitating to accept it as true if the probability is reasonably high, but, on the other hand, maintaining an alertness to the possibility that what may for good appear to be highly improbable may indeed occur or be true.

*Science, Man and Society*

Chapter 3 (p. 37)

W.B. Saunders Company. Philadelphia, Pennsylvania, USA. 1971

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

Inductive inference is the only process known to us by which essential new knowledge comes into the world.

*The Design of Experiments*

I, 4 (p. 7)

Hafner Publishing Company. New York, New York, USA. 1971

**Fleck, Ludwik** 1896–1961

Physician and epistemologist

Certainty, simplicity, vividness originate in popular knowledge. That is where the expert obtains his faith in this triad as the ideal of knowledge. Therein lies the general epistemological significance of popular science.

*Genesis and Development of a Scientific Fact*

Chapter Four, Section 4 (p. 115)

The University of Chicago Press. Chicago, Illinois, USA. 1979

**Forsyth, A. R.**

No biographical data available

...let me plead...for the highest consideration to be given to the pursuit of pure knowledge as well as technical training, not neglecting mathematics, once called the Queen of the Sciences. The wind bloweth where it listeth, and the spirit of knowledge does not follow the quest for wealth and power; but the creation of new knowledge makes for the high repute of a nation, alike in the days when its influence is dominant and more in the distant days when its doings shall have been recorded on the scroll of time.

*Gateway to the Great Books — Mathematics*

Mathematics in Life and Thought (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1963

**Foster, Sir Michael** 1836–1907

English physiologist and educator

What we know and what we think is not a new fountain gushing fresh from the barren rock of the unknown at the stroke of the rod of our own intellect, it is a stream which

flows by us and through us, fed by the far-off rivulets of long ago.

*Lectures on the History of Physiology*

Lecture I (p. 1)

University Press. Cambridge, England. 1901

Every experiment, every observation has, besides its immediate result, effects which, in proportion to its value, spread always on all sides into ever distant parts of knowledge.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*

Recent Advances in Science, and Their Bearing on Medicine and Surgery (pp. 350–351)

Government Printing Office. Washington, D.C. 1899

As the loom which is weaving that ever-spreading garment takes in new warp and new woof, such threads only of each are taken in as can be fitly joined to those which have come in before; each thread as it is twisted in becomes a hold for other threads to be caught up later on. No single observation, no single experiment stands alone by itself, nor can its worth be rightly judged by itself alone.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*

Recent Advances in Science, and their Bearing on Medicine and Surgery (p. 350)

Government Printing Office. Washington, D.C. 1899

**Fuller, Thomas** 1608–61

English clergyman and author

Knowledge is a Treasure, but Practice is the Key to it.

*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings. Ancient and Modern, Foreign and British*

No. 3139

Printed for Thomas and Joseph Allman. London, England. 1816

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

The knowledge whose content makes up astronomy is the gain from more than 2,000 years' work on one of the most abundant objects of human knowledge, in which the foremost minds of all times have summoned up all the resources of genius and diligence.

In G. Waldo Dunnington (ed.)

*Inaugural Lecture on Astronomy and Papers on the Foundations of Mathematics*

Inaugural Lecture on Astronomy (p. 49)

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1937

**Gell, Alfred** 1945–97

English social anthropologist

There are no closed frontiers between intellectual approaches. Only closed minds which refuse to cross them.

*The Anthropology of Time: Cultural Constructions of Temporal Maps and Images*

Chapter 31 (p. 322)

Berg. Oxford, England. 1996

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

No man can reveal to you aught but that which already lies half asleep in the dawning of your knowledge.

*The Prophet*

On Teaching (p. 56)

Alfred A. Knopf. New York, New York, USA. 1969

Knowledge and understanding are life's faithful companions who will never prove untrue to you. For knowledge is your crown, and understanding your staff; and when they are with you, you possess no greater treasures.

Translated by Anthony Ferris

*The Treasured Writing of Kahlil Gibran*

The Voice of the Master, Wisdom, viii (p. 488)

The Citadel Press. New York, New York, USA. 1958

**Gilbert, G. K.** 1843–1918

American geologist

Knowledge of Nature is an account at bank, where each dividend is added to the principle and the interest is ever compounded; and hence it is that human progress, founded on natural knowledge, advances with ever increasing speed.

The Origin of Hypotheses, Illustrated by the Discussion of a Topographic Problem

*Science*, Volume 3, Number 53, January 3, 1896 (p. 13)

In the domain of the world's knowledge there is no infallibility.

The Origin of Hypotheses, Illustrated by the Discussion of a Topographic Problem

*Science*, Volume 3, Number 53, January 3, 1896 (p. 12)

**Gore, George** 1826–1909

Electrochemist and scientific writer

New knowledge is not like a cistern, soon emptied, but is a fountain of almost unlimited power and duration...

*The Art of Scientific Discovery*

Part I, Chapter III (p. 27)

Longmans, Green & Company. London, England. 1878

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The less a man knows, the more content he is with his intellectual capacity and outlook: it requires a great man to realise the imperfections of his knowledge.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 20)

Macmillan & Company Ltd. London, England. 1918

The gospel of work is the gospel of science. Go into the fields of Nature and labour if you would become a disciple of science; for not otherwise can the kingdom of natural knowledge be gained.

*Discovery; or, The Spirit and Service of Science*

Chapter III (pp. 41–42)

Macmillan & Company Ltd. London, England. 1918



New treasures can never be secured from Nature without effort; “tribulation, not undisturbed progress gives life and soul, and leads to success when success can be reached, in the struggle for natural knowledge.”

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 42)

Macmillan & Company Limited. London, England. 1918

Success in science means the birth of new knowledge.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 42)

Macmillan & Company Ltd. London, England. 1918

**Hall, Alfred Rupert** 1920–

English historian of science

...the grain of real knowledge is concealed in a vast deal of esoteric chaff.

*The Scientific Revolution, 1500–1800*

Chapter XI (p. 307)

Longmans, Green & Company. London, England. 1954

**Harris, Sydney J.**

Our current annoyance at the long hair affected by young men is both trivial and parochial; what matters is the amount of substance inside the head, not outside.

*Leaving the Surface* (p. 329)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1968

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

...the first law of knowledge is the conservation of ignorance. Take any subject, no matter how simple; have you noticed, after study and thought, how the more we know of that subject the more aware we become of what we do not know? For some outlandish reason greater knowledge leads unavoidably to an awareness of greater ignorance. Learned ignorance (awareness of ignorance) replaces unlearned ignorance (unawareness of ignorance), and total ignorance as a consequence remains unchanged. Learned ignorance always increases with knowledge. “This is the second law of knowledge. Happy is the person who knowing nothing thinks he knows everything!...”

A Twinkle in the Eye of the Universe

*Quarterly Journal of the Royal Astronomical Society*, Volume 25, Number 4, December 1984 (p. 423)

**Harth, Erich**

No biographical data

I have no possessions that are truly my own. I am like a stranger at a rich man’s gate. What I have is borrowed, and even my knowledge is nothing but hand-me-downs, and an occasional oddity I pick up by chance. I pass it on to others like me.

*The Creative Loop: How the Brain Makes a Mind*

Chapter 1 (p. 6)

Addison-Wesley. Reading, Massachusetts, USA. 1993

**Harvey, William** 1578–1657

English physician

What shall I deliver in these my Exercises on Animal Generation I am anxious to make publicly known, not merely that posterity may there perceive the sure and obvious truth, but further, and especially, that by exhibiting the method of investigation which I have followed, I may propose to the studios a new and unless I am mistaken a safer way to the attainment of knowledge.

In *Great Books of the Western World* (Volume 28)

*Anatomical Exercises on the Generation of Animals*

Introduction (p. 231)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hele-Shaw, H. S.** 1854–1941

Naval architect

If I have assumed too little knowledge on your part, it is because of the difficulties I have found in the subject myself. If I have left more obscure than I have been able to make clear, it is consoling to think how many centuries were required to discover even what is known at the present time, and we may well be forgiven if we can not grasp at once results which represent the life work of some of the greatest men.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*

The Motions of a Perfect Liquid

Government Printing Office. Washington, D.C. 1901

**Herbert, Frank** 1920–86

American science fiction writer

Every judgment teeters on the brink of error. To claim absolute knowledge is to become monstrous. Knowledge is an unending adventure at the edge of uncertainty.

*Children of Dune* (p. 268)

Penguin Putnam Inc. New York, New York, USA. 1976

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...it happens that great masses of knowledge are daily perishing before our eyes without the possibility of recovery, because, in fact, our eyes are not open to them, and we have nothing to awaken our attention to their transient display.

*Essays From the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Terrestrial Magnetism (pp. 65–66)

Longman, Brown, Green, Longmans & Robert. London, England. 1857

**Hill, Archibald V.** 1886–1977

English physiologist

The pursuit of natural knowledge, the investigation of the world — mental and material — in which we live, is not a dull and spiritless affair: rather is it a voyage of adventure of the human mind, a holiday for reckless and imaginative souls.

*Les Prix Nobel. The Nobel Prizes in 1922*  
Nobel banquet speech for award received in 1922  
Nobel Foundation. Stockholm, Sweden. 1923

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

This is an inquisitive age, and if we insist on piling up beyond a certain height knowledge which is in itself mere trash and lumber to a man whose life is to be one long fight with death and disease, there will be some sharp questions asked by and by.

*Scholastic and Bedside Teaching*  
Lecture  
Harvard University  
November 6, 1867

The air we breathe is made up of four elements, at least: oxygen, nitrogen, carbonic acid gas, and knowledge.

*Over the Teacups*  
Chapter VI (pp. 132–133)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

The best part of our knowledge is that which teaches us where knowledge leaves off and ignorance begins.

*Medical Essays*  
Border Lines in Medical Science (p. 211)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The traveler who would not drink of the Nile until he had tracked it to its parent lakes, would be like to die of thirst; and the medical practitioner who would not use the results of many laborers in other departments without sharing their special toils, would find life far too short and art immeasurably too long.

*Medical Essays*  
Scholastic and Bedside Teaching (p. 274)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Knowledge and timber shouldn't be much used till they are seasoned.

*The Autocrat of the Breakfast-Table*  
Chapter VI (p. 134)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

It is the province of knowledge to speak and it is the privilege of wisdom to listen.

*The Poet at the Breakfast-Table*  
Chapter X (p. 264)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Holton, Gerald** 1922–  
Research professor of physics and science history

**Roller, Duane H. D.** ?–1994  
Science historian

Knowledge is like a net; if one were to cut out the part which is labeled science, the rest of the net would be useless.

*Foundations of Modern Physical Science*  
Chapter 14 (p. 247)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**Hopkinson, John** 1849–98  
English physicist and electrical engineer

Our knowledge must always be limited, but the knowable is limitless. The greater the sphere of our knowledge the greater the surface of contact with our infinite ignorance.

The Relation of Mathematics to Engineering  
*Nature*, Volume 50, Number 1280, May 10, 1894 (p. 47)

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

The aim is to bite good and hard on the fruit of the tree of knowledge.

*Ten Faces of the Universe*  
The Mathematician's Universe (p. 52)  
W.H. Freeman & Company. San Francisco, California, USA. 1977

**Hubble, Edwin Powell** 1889–1953  
American astronomer

The laws of science are the permanent contribution to knowledge — the individual pieces which are fitted together attempt to form a picture of the physical universe in action.

*The Nature of Science and Other Lectures*  
Part I, Experiment and Experience (p. 40)  
The Huntington Library. San Marino, California, USA. 1954

The history of astronomy is a history of receding horizons. Knowledge has spread in successive waves, each wave representing the exploitation of some new clew to the interpretation of observational data.

*The Realm of the Nebulae*  
Chapter I (p. 21)  
Dover Publications, Inc. New York, New York, USA. 1958

Science acquires knowledge but has no interest in its practical applications. The applications are the work of engineers.

*The Nature of Science and Other Lectures*  
Part II, Scientists at War (p. 63)  
The Huntington Library, San Marino, California, USA. 1954

Knowledge stirs the imagination, drives away the nightmares of superstition.

*The Nature of Science and Other Lectures*  
Part I, Science and Technology (pp. 24–25)  
The Huntington Library. San Marino, California, USA. 1954

**Huxley, Aldous** 1894–1963  
English writer and critic

Knowledge is the highest good, truth the supreme value, all the rest is secondary and subordinate.

*Brave New World*  
Chapter Sixteen (p. 273)  
Harper & Brothers. New York, New York, USA. 1950

**Huxley, Thomas Henry** 1825–95  
English biologist

So far as that limited revelation of the nature of things, which we call scientific knowledge, has yet gone, it tends, with constantly increasing emphasis, to the belief that, not merely the world of plants, but that of animals; not merely living things, but the whole fabric of the earth; not merely our planet, but the whole solar system; not merely our star and its satellites, but the millions of similar bodies which bear witness to the order which pervades boundless space, and has endured through boundless time; are all working out their predestined courses of evolution.

*Evolution and Ethics and Other Essays*

Prolegomena (p.6)

Macmillan & Company Ltd. London, England. 1894

Indeed, if a little knowledge is dangerous, where is the man who has so much as to be out of danger?

*Collected Essays* (Volume 3)

*Science and Education*

On Elementary Instruction in Physiology (p. 300)

Macmillan & Company Ltd. London, England. 1904

It is given to few to add to the store of knowledge, to strike new springs of thought, or to shape new forms of beauty. But so sure as it is that men live not by bread, but by ideas, so sure is it that the future of the world lies in the hands of those who are able to carry the interpretation of nature a step further than their predecessors.

*Collected Essays* (Volume 3)

*Science and Education*

Address on University Education (p. 254)

Macmillan & Company Ltd. London, England. 1904

...in science, as in life, learning and knowledge are distinct, and the study of things, and not of books, is the source of the latter.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 218)

Macmillan & Company Ltd. London, England. 1904

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

For my part, I shall be very well contented, and shall count I have done a great matter, if I can but come to any knowledge of the nature of things, as they now are, never troubling my head about their beginning, or how they were made, knowing that to be out of the reach of human Knowledge, or even Conjecture.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Book the Second, Every Sun has a Vortex round it, very different from those of Cartes (p. 160)

Printed for T. Childe. London, England. 1698

**Ingle, Dwight J.** 1907–78

Biologist and endocrinologist

To gain knowledge is not always simple. The search for truth, however, is one of man's most thrilling adventures. It is a search that requires patience, caution, and persistence.

*Is It Really So?: A Guide to Clear Thinking*

Chapter 9 (p. 76)

The West Minster Press. Philadelphia, Pennsylvania, USA. 1976

**James, William** 1842–1910

American philosopher and psychologist

...our science is a drop, our ignorance a sea. Whatever else be certain, this at least is certain — that the world of our present natural knowledge is enveloped in a larger world of some sort of whose residual properties we at present can frame no positive idea.

*The Will to Believe and Other Essays in Popular Philosophy*

Is Life Worth Living? (p. 54)

Dover Publications, Inc. New York, New York, USA. 1956

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

We of the present age know very little — almost nothing; we are rather pioneers setting out to explore a new country. We have the thrill of ever-changing views, now and again we reach a ridge or summit which opens up new and unexpected vistas — of necessity our point of view must continually change.

*Living Philosophies*

Chapter VIII (p. 119)

Simon & Schuster. New York, New York, USA. 1931

...our knowledge of the external world must always consist of numbers, and our picture of the universe — the synthesis of our knowledge — must necessarily be mathematical in form. All the concrete details of the picture, the apples, the pears and bananas, the ether and atoms and electrons, are mere clothing that we ourselves drape over our mathematical symbols — they do not belong to Nature, but to the parables by which we try to make Nature comprehensible. It was, I think, Kronecker who said that in arithmetic God made the integers and man made the rest; in the same spirit, we may add that in physics God made the rest.

*The New World-Picture of Modern Physics*

*Supplement to Nature*, Volume 134, Number 3384, September 1934 (p. 356)

...science should leave off making pronouncements: the river of knowledge has too often turned back on itself.

*The Mysterious Universe*

Chapter V (p. 188)

The Macmillan Company. New York, New York, USA. 1932

...to many it is not knowledge but the quest for knowledge that gives the greater interest to thought — to travel hopefully is better than to arrive.

*Physics and Philosophy*

Chapter VII (p. 217)

Dover Publications, Inc. New York, New York, USA. 1981

**Jefferson, Thomas** 1743–1826

3<sup>rd</sup> president of the United States

A patient pursuit of facts, and cautious combination and comparison of them, is the drudgery to which man is subjected by his Master, if he wishes to attain sure knowledge.

*Notes on the State of Virginia* (p. 71, n)

Printed by Samuel H Smith. Philadelphia, Pennsylvania, USA. 1800

**Jevons, William Stanley** 1835–82

English economist and logician

I am convinced that it is impossible to expound the methods of induction in a sound manner, without resting them on the theory of probability. Perfect knowledge alone can give certainty, and in nature perfect knowledge would be infinite knowledge, which is clearly beyond our capacities. We have, therefore, to content ourselves with partial knowledge, — knowledge mingled with ignorance, producing doubt.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book II, Chapter X (p. 197)

Macmillan & Company Ltd. London, England. 1887

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Integrity without knowledge is weak and useless and knowledge without integrity is dangerous and dreadful.

*The History of Rasselas: Prince of Abyssinia*

Chapter XLI (p. 100)

Oxford University Press. Oxford, England. 1988

**Jordan, David Starr** 1851–1931

American scientist and educator

We know nothing until we find it out...

Reason, Reverence and Love

*Science Monthly*, Volume XXI, Number 6, December 1925 (p. 587)

**Kerry, John** 1943–

United States senator

It is wrong to tell scientists that they can't cross the frontiers of new knowledge...

*CNN*

Kerry Promotes Science, Technology as Job Engines

Friday, October 22, 2004

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

We have only begun to knock a few chips from the great quarry of knowledge that has been given us to dig out and use. We know almost nothing about everything. That is why, with all conviction, I say that the future is boundless.

In James Kip Finch

*Engineering and Western Civilization*

Chapter 20 (p. 306)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

Knowledge is an immense power. Men must know. But we already know much! What if that knowledge — and only that — should become the possession of all? Would not science itself progress in leaps and cause mankind to make strides in production, invention, and social creation, or [in] which we are hardly in a condition now to measure the speed?

*Memoirs of a Revolutionist*

Part IV, III (p. 21)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Kusch, Polykarp** 1911–93

German-American physicist

The increase of scientific knowledge lies not only in the occasional milestones of science, but in the efforts of the very large body of men who with love and devotion observe and study nature.

*Les Prix Nobel. The Nobel Prizes in 1955*

Nobel banquet speech for award received in 1955

Nobel Foundation. Stockholm, Sweden. 1956

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

Men who strive in their works to push back the limits of human knowledge know well that it is not enough to discover and prove a useful truth previously unknown, but that it is necessary also to be able to propagate it and get it recognized...

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VIII (p. 404)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

That which we know is a little thing; that which we do not know is immense.

In Will and Ariel Durant

*The Story of Civilization: The Age of Napoleon* (p. 324)

Simon & Schuster. New York, New York, USA. 1975

**Larrabee, Harold A.** 1894–1979

No biographical data available

The great prizes of science go to the successful discoverers, not to those who follow behind and carefully explore the new land that has been opened up.

*Reliable Knowledge*

Chapter 3 (p. 72)

Cambridge University Press. Cambridge, England. 1978

**Latham, Peter Mere** 1789–1875

English physician

There is nothing so captivating as NEW knowledge.

In William B. Bean

*Aphorisms from Latham* (p. 38)

Prairie Press. Iowa City, Iowa, USA. 1962

**LeConte, John** 1818–91

American physician and physicist

...the lofty aspirations of humanity and not delusions; they are realities. They link us to a purer order of existence, which makes us heirs of immortality. We repose order a confident and unwavering assurance that, in God's own time, these earth-mists will be dispersed, and the dim twilight of conjecture will yield to the glorious, unclouded noonday of knowledge.

The Nebular Hypothesis

*The Popular Science Monthly*, Volume 2, April 1873 (p. 660)**Lemon, Harvey Brace**

Physicist

Quite characteristic is it of the acquisition of knowledge that as one learns a little, the horizon widens and what lies ahead to be learned is seen to cover a much vaster area. It is with our eyes on these horizons that we climb. What has been surmounted and overcome seems small and insignificant. How small and insignificant it is, fortunately we shall probably never be aware.

*Galileo to Cosmic Rays: A Look at Physics*

Chapter 40 (p. 440)

The University of Chicago Press. Chicago, Illinois, USA. 1934

**Levi, Primo** 1919–87

Italian writer and chemist

The future of humanity is uncertain, even in the most prosperous countries, and the quality of life deteriorates; and yet I believe that what is being discovered about the infinitely large and the infinitely small is sufficient to absolve this end of the century and millennium. What a very few are acquiring in knowledge of the physical world will perhaps cause this period not to be judged as a pure return to barbarism.

*Other People's Trades*

News from the Sky (pp. 23–24)

Summit Books. New York, New York, USA. 1989

**Lewis, Clarence Irving** 1883–1964

American philosopher

...interest in truth for its own sake — the pure and undistracted purpose to know — is not the characteristic final purpose of knowing. Knowledge for its own sake, and the contemplative life, represent an esthetic or near-esthetic ideal rather than one normally attributable to cognition. It is merely a professional fallacy of the scholar to impute his own peculiar interest in finding out the truth to human cognizing in general, as if that were the aim which rules or should rule it. He who is disinterestedly interested in finding out and knowing; who subordinates the desires and interests of action to discovery of truth, and to contemplation of it; likewise divests knowledge of its natural and pragmatic significance. By the same token, the ideal

of the contemplative life is mildly abnormal, however valid and indubitable the values to which it is addressed. The Ivory tower is characteristically the refuge of the practically defeated and of those who become disillusioned of the utilities of action.

*An Analysis of Knowledge and Valuation*

Chapter XIV (p. 442)

The Open Court Publishing Company. La Salle, Illinois, USA. 1946

There is no knowledge without interpretation.

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter VII (p. 195)

Dover Publications, Inc. New York, New York, USA. 1956

...if there is any knowledge at all, *some* knowledge must be apriori.

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter VII (p. 196)

Dover Publications, Inc. New York, New York, USA. 1956

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

I made the journey to knowledge like dogs who go for walks with their masters, a hundred times forward and backward over the same territory; and when I arrived I was tired.

*Lichtenberg: Aphorisms & Letters*

Aphorisms (p. 58)

Jonathan Cape. London, England. 1969

**Loehle, Craig**

Mathematical ecologist

A major obstacle to science is not ignorance but knowledge.

A Guide to Increased Creativity in Research — Inspiration or Perspiration?

*BioScience*, Volume 40, Number 2, February 1990 (p. 123)**Macaulay, Thomas Babington** 1800–59

English historian and author

Knowledge advances by steps, and not by leaps.

On History

*Edinburgh Review*, May 1828, Volume XLVII, 1828**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Not every physicist is an epistemologist, and not every one must or can be one. Special investigation claims a whole man, so does the theory of knowledge.

*History and Root of the Principle of the Conservation of Energy*

Author's Preface (p. 12)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

Every candid person will confess that there are many branches of knowledge about which he had better be silent.

*Popular Scientific Lectures*

On Instruction in the Classics and the Sciences (p. 345)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

It is a peculiar property of instinctive knowledge that it is predominantly of a negative nature. We cannot so well say what must happen as we can what cannot happen, since the latter alone stands in glaring contrast to the obscure mass of experience in us in which single characters are not distinguished.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter I, Part II, Section 2 (p. 36)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Maclaurin, Colin** 1698–1746

Scottish mathematician and natural philosopher

Those who have not imbibed the prejudices of philosophers, are easily convinced that natural knowledge is to be founded on experiment and observation.

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books* (p. 24)

Printed for the Author's Children. London, England. 1748

By proceeding with due care, every age will add to the common stock of knowledge; the mysteries that still lie concealed in nature may be gradually opened, arts will flourish and increase, mankind will improve, and appear more worthy of their situation in the universe, as they approach more towards a perfect knowledge of nature.

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books* (p.91)

Printed for the Author's Children. London, England. 1748

**Marlowe, Christopher** 1564–93

Renaissance English playwright and poet

Our souls, whose faculties can comprehend  
The wondrous architecture of the world,  
And measure every wandering planet's course,  
Still climbing after knowledge infinite.

*Tamburlaine the Great*

Part the First, Act II, Scene 7, l. 20–23

The Hesperides Press. London, England. 1930

**Mather, Kirtley F.** 1888–1978

American geologist

The expanding horizon of knowledge has simply lengthened the line of contact between man and the unknown elements in the cosmos.

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (pp. 3–4)

Thomas Y. Crowell Company. New York, New York, USA. 1931

**McEwan, Ian** 1948–

English author

Shakespeare would have grasped wave functions, Donne would have understood complementarity and relative time. They would have been excited. What richness! They would have plundered this new science for their imagery. And they would have educated their audiences

too. But you “arts” people, you’re not only ignorant of these magnificent things, You’re rather proud of knowing nothing.

*The Child in Time*

Chapter 2

Houghton Mifflin Company. Boston, Massachusetts, USA. 1987

**Milton, John** 1608–74

English poet

O Sacred, Wise, and Wisdom-giving Plant,  
Mother of Science...

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Chapter IX, l. 679–680

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Minot, George R.** 1885–1950

American physician

Thus, upon the foundations laid by previous investigators, do medical art and science build a structure which will in its turn be the foundation of future knowledge.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1934

The Development of Liver Therapy in Pernicious Anemia (p. 366)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Minto, Walter** 1753–96

Scottish-American mathematician

The progress of the human mind, from ignorance to knowledge, has generally been slow, and not by the most obvious and easy path.

*An Inaugural Oration on the Progress and Importance of the Mathematical Sciences.*

Princeton, preceding the Annual Commencement 1788 (p. 10)

Printed by Isaac Collins, 1788

**Mitchell, Maria** 1818–89

American astronomer and educator

...we have a hunger of the mind which asks for knowledge of all around us, and the more we gain, the more is our desire; the more we see, the more we are capable of seeing.

In Eve Merriam

*Growing Up Female in America*

Maria Mitchell (p. 88)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Monod, Jacques** 1910–76

French biochemist

Any mingling of knowledge with values is unlawful, forbidden.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*

Vintage Books. New York, New York, USA. 1972

**Montgomery, Lucy Maud** 1874–1942

Canadian author

Isn't it splendid to think of all the things there are to find out about? It just makes me feel glad to be alive — it's such an interesting world. It wouldn't be half so interesting if we knew all about everything, would it? There'd be no scope for imagination then, would there?

*Anne of Green Gables*

Chapter II (p. 19)

Page & Company. Boston, Massachusetts, USA. 1908

**Morgan, Charles** 1894–1958

English playwright and novelist

...as knowledge increases, wonder deepens...

*The Fountain*

The Bond

Chapter Ten (p. 383)

Alfred A. Knopf. New York, New York, USA. 1932

**Mumford, Lewis** 1895–1990

American social philosopher

The belief that science developed solely out of a pursuit of knowledge for its own sake is at best only a half truth, and at worst, mere self-flattery or self-deception on the part of scientists.

*The Myth of the Machine: The Pentagon of Power* (p. 106)

Chapter V (p. 106)

Harcourt Brace Jovanovich, Inc. New York, New York, USA. 1970

**Myers, Frederic William Henry** 1843–1901

English poet and essayist

...the method which our race has found most effective in acquiring knowledge is by this time familiar to all men. It is the method of modern Science — that process which consists in an interrogation of Nature entirely dispassionate, patient, systematic; such careful experiment and cumulative record as can often elicit from her slightest indications her deepest truths. That method is now dominant throughout the civilised world; and although in many directions experiments may be difficult and dubious, facts, rare and elusive, Science works slowly on and bides her time, — refusing to fall back upon tradition or to launch into speculation, merely because straight is the gate which leads to valid discovery, indisputable truth.

*Human Personality and Its Survival of Bodily Death* (Volume 1)

Introduction (p. 1)

Longmans, Green & Company. London, England. 1903

**Myrdal, Gunnar** 1898–1987

Swedish economist and sociologist

All ignorance, like all knowledge, tends thus to be opportunistic.

*Objectivity in Social Research*

Chapter III (p. 19)

Pantheon Books. New York, New York, USA. 1969

**Newcomb, Simon** 1835–1909

Canadian-born American astronomer

The fact is that our knowledge of the universe has been in the nature of a slow and gradual evolution, commencing at a very early period in human history, and destined to go forward without stop, as we hope, so long as civilization shall endure.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Problems of Astronomy (p. 83)

Government Printing Office. Washington, D.C. 1898

**Noble, Edmund**

No biographical data available

For knowledge is not a solvent for the whole of reality; all it can reach are those characters of existence which, in our capacity as self-maintainers, it is useful or may become useful for us to know.

*Purposive Evolution: The Link Between Science and Religion*

Chapter IV (p. 42)

Henry Holt & Company. New York, New York, USA. 1926

**Oparin, Alexander Ivanovich** 1894–1980

Russian biochemist

One can only understand the essence of things when one knows their origin and development.

*Life, Its Nature, Origin and Development*

Chapter I (p. 37)

Oliver & Boyd. Edinburgh, Scotland. 1961

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

...knowledge rests on knowledge; what is new is meaningful because it departs slightly from what was known before; this is a world of frontiers, where even the liveliest of actors or observers will be absent most of the time from most of them.

*Science and the Common Understanding*

Chapter 6 (p. 90)

Simon & Schuster. New York, New York, USA. 1954

A great discovery is a thing of beauty; and our faith — our binding, quiet faith — is that knowledge is good and good in itself.

*Science and the Common Understanding*

Chapter 6 (p. 98)

Simon & Schuster. New York, New York, USA. 1954

**Oreskes, Naomi**

No biographical data available

...if new knowledge is to be made, old knowledge has to be unmade.

*The Rejection of Continental Drift*

Epilogue (p. 316)

Oxford University Press, Inc. New York, New York, USA. 1999

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Science is organized knowledge, and knowledge is of things we see. Now the things that are seen are temporal; of the things that are unseen science knows nothing and has at present no means of knowing anything.

*Science and Immortality*

The Teresians (pp. 40–41)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1905

### **Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

From the very beginning of your work, school yourselves to severe gradualness in the accumulation of knowledge.

Bequest of Pavlov to the Academic Youth of His Country

*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

### **Petit, Jean-Pierre**

French astrophysicist

I'VE UNDERSTOOD IT! Well, that is...I'm not exactly sure WHAT I've understood, but I have the impression I've understood SOMETHING.

*Euclid Rules. OK?* (p. 44)

Publisher undetermined

### **Phillips, John**

All human knowledge is limited; but who has reached the boundary in any direction?

*A Treatise on Geology*

Geology, Progress of Geology (p. 4)

A. & C. Black. Edinburgh, Scotland. 1837

### **Philpotts, Eden** 1862–1960

English novelist, poet, and dramatist

Knowledge is all scientific researchers are after — new knowledge and discovery.

*A Shadow Passes*

Chapter IX (p. 140)

The Macmillan Company. New York, New York, USA. 1934

### **Platt, John R.**

No biographical data available

We are like men coming out of the dark house of the past into a world of dazzling sunlight. We have climbed up out of the dark cellar where we have been trapped for centuries, isolated, ignorant, selfish, combative, and helpless. Suddenly, we find ourselves standing on the threshold of a doorway through which we can see a vista of almost incredible knowledge, abundance, and well-being.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1968*

The New Biology and the Shaping of the Future (p. 122)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

We have bitten into the apple of knowledge and our eyes are opened. We have been driven out of the Eden of irresponsibility into the world of decision.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1968*

The New Biology and the Shaping of the Future (p. 169)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

### **Popper, Karl R.** 1902–94

Austrian/British philosopher of science

From the amoeba to Einstein, the growth of knowledge is always the same: we try to solve our problems, and to obtain, by a process of elimination, something approaching adequacy in our tentative solutions.

*Objective Knowledge: An Evolutionary Approach*

Chapter 7 (p. 261)

Clarendon Press. Oxford, England. 1972

The more we learn about the world, and the deeper our learning, the more conscious, specific, and articulate will be our knowledge of what we do not know, our knowledge of our ignorance. For this, indeed, is the main source of our ignorance — the fact that our knowledge can only be finite, while our ignorance must be infinite.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Introduction (p. 28)

Harper & Row, Publishers. New York, New York, USA. 1963

The way in which knowledge progresses, and especially our scientific knowledge, is by unjustified (and unjustifiable) anticipations, by guesses, by tentative solutions to our problems, by conjectures. These conjectures are controlled by criticism; that is, by attempted refutations, which include severely critical tests. They may survive these tests; but they can never be positively justified: they can neither be established as certainly true nor as “probable” (in the sense of probability calculus). Criticism of our conjectures is of decisive importance: by bringing out our mistakes it makes us understand the difficulties of the problem which we are trying to solve. This is how we become better acquainted with our problems, and able to propose more mature solutions: the very refutation of a theory — that is, of any serious tentative solution to our problem — is always a step forward that takes us nearer to the truth. And this is how we can learn from our mistakes.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Preface (p. vii)

Harper & Row, Publishers. New York, New York, USA. 1963

The theory of knowledge which I wish to propose is a largely Darwinian theory of the growth of knowledge. From the amoeba to Einstein, the growth of knowledge is always the same: we try to solve our problems, and to obtain, by a process of elimination, something approaching adequacy in our tentative solutions.

*Objective Knowledge: An Evolutionary Approach*

Chapter 7 (p. 261)

Clarendon Press. Oxford, England. 1972

...we should have to represent the tree of knowledge as springing from countless roots which grow up into the air rather than down, and which ultimately, high up, tend to unite into one common stem.



*Objective Knowledge: An Evolutionary Approach*  
Chapter 7 (pp. 262–263)  
Clarendon Press. Oxford, England. 1972

**Poynting, John Henry** 1852–1914  
English physicist

Molecules, atoms and corpuscles are at the present day the letters of the alphabet in which we write our knowledge of Physical Nature.

*Collected Scientific Papers*  
Molecules, Atoms and Corpuscles, 1902 (p. 664)  
At The University Press. Cambridge. 1920

**Preston, Thomas** 1860–1900  
Irish scientist

The great lessons of history are not to be found in the records of battles or in the details of infamous amours and massacres, nor in the memory of dates, but rather in the full knowledge of the inner meaning of events, and a deep appreciation of their general bearing on the social development of mankind. So also in science, that knowledge which is power is not the mere memory of facts, but the comprehension of their whole meaning in the story of nature.

*The Theory of Heat*  
Preface to the First Edition (p. 4)  
Macmillan & Company Ltd. London, England. 1904

**Price, C.**  
No biographical data available

As new knowledge develops, it has increasingly provided natural explanations for facts and phenomena formerly ascribed to the supernatural. Perhaps an understanding of chemical evolution and biological function can develop a philosophy of man more unified, less divisive, less of a major breeding ground for man's inhumanity to man than the many religious dogmas now so much used to inflame feelings of hatred, suspicion and prejudice in human society.

In D. Fohlfing and A. Oparin (eds.)  
*Molecular Evolution: Prebiological and Biological*  
Some Social and Philosophical Implications of Progress on the Origin and Synthesis of Life (p. 462)  
Plenum Press. New York, New York, USA. 1972

**Priestley, Joseph** 1733–1804  
English theologian and scientist

The greater is the circle of light, the greater is the boundary of the darkness by which it is confined.

*Experiments and Observations on Different Kinds of Air* (Volume 1)  
The Preface (p. xix)  
Thomas Pearson. Birmingham, England. 1790

Could I imagine that the knowledge of nature would ever be exhausted, and that we were approaching to a termination of our enquiries, I could more contentedly shut my eyes on a scene in which nothing more was to be seen,

or done. But to quit the stage at present (and I believe the aspect of things will be exactly similar in any future period of our existence) without the hope of re-visiting it, would fill me with the deepest regret.

*Experiments and Observations on Different Kinds of Air* (Volume 1)  
The Preface (p. xli)  
Thomas Pearson. Birmingham, England. 1790

...the increase of knowledge is like the increase of a city. The buildings of some of the first streets make a great figure, is much talked of, and known to everybody; whereas the addition of, perhaps, twice as much building, after it has been swelled to a considerable size, is not so much as taken notice of, and may really be unknown to many of the inhabitants.

*The History and Present State of Electricity*  
Preface (pp. vi–vii)  
Printed for J. Dodsley. London, England. 1767

**Pryanishnikov, D. N.**  
No biographical data available

Knowledge is not consummate, crystalised, and petrified; it is being eternally created and is eternally in motion.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

We are the inheritors of a great scientific tradition and of a beautiful structure of knowledge. It is the duty of our generation to add to the perfection of this structure and to pass on to the next generation the best traditions of our science for the edification and entertainment of all mankind.

The Physicist Returns from the War  
*The Atlantic Monthly*, Volume 176, Number 4, October 1945 (p. 114)

**Ramón y Cajal, Santiago** 1852–1934  
Spanish neuropathologist

We render a tribute of respect to those who add original work to a library, and withhold it from those who carry a library around in their head.

Translated by Neely Swanson and Larry W. Swanson  
*Advice for a Young Investigator*  
Chapter 5 (p. 78)  
The MIT Press. Cambridge, Massachusetts, USA. 1999

**Ramsay, Sir William** 1852–1916  
English chemist

The young student, when he learns what is known, is too apt to think that little is left to be discovered; yet all our progress since the time of Sir Isaac Newton has not falsified the saying of that great man — that we are but children picking up here and there a pebble from the shore of knowledge, while a whole unknown ocean stretches

before our eyes. Nothing can be more certain than this: that we are just beginning to learn something of the wonders of the world on which we live and move and have our being.

*Essays Biographical and Chemical*

Chemical Essays

What Is an Element? (p. 160)

Archibald Constable & Company Ltd. London, England. 1908

### **Raymo, Chet** 1936–

American physicist and science writer

Knowledge is an island in a sea of mystery. The metaphor takes its power from a firmly held fact: We live in a universe that is infinite, or effectively so. Our brains are finite, a mere 100 billion nerve cells. Our mental maps of the world are therefore necessarily finite. As time passes, the scale and detail of our maps increase, but they no more exhaust the worldscape they describe than a map of the Grand Canyon depletes the power of that natural chasm to astonish and surprise.

*Skeptics and True Believers: The Exhilarating Connection Between*

*Science and Religion*

Chapter Three (pp. 47–48)

Walker & Company. New York, New York, USA. 1998

### **Reichenbach, Hans** 1891–1953

German philosopher of science

The urge to knowledge is so deeply rooted in man that it can scarcely be omitted from a list of life's important needs.

*Atom and Cosmos*

Introduction (p. 18)

The Macmillan Company. New York, New York, USA. 1933

### **Richet, Charles** 1850–1935

French physiologist

The aim of science is knowledge about phenomena.

*The Natural History of a Savant*

Chapter VI (p. 42)

J.M. Dent & Sons Limited. London, England. 1927

### **Ritchie, Arthur David**

Scottish philosopher and science history writer

It is natural for anybody of a sanguine temperament who is impressed by the dependence of life on physical circumstances...to think that he is only a short way from the solution of every problem. He thinks he is delivering a final assault on the very citadel of Life itself; then, when the heat of the combat is over and he can look round at what he has accomplished, he finds that it is only an insignificant and almost undefended out-work that he has taken, and the citadel is as far off as ever.

*Scientific Method: An Inquiry into the Character and Validity of Natural Laws*

Chapter VI (pp. 176–177)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1923

### **Robinson, James Harvey** 1863–1936

American historian

Of all human ambitions an open mind eagerly expectant of new discoveries and ready to remold convictions in the light of added knowledge and dispelled ignorances and misapprehensions, is the noblest, the rarest and the most difficult to achieve.

*The Humanizing of Knowledge*

Chapter V (p. 61)

George H. Doran Company. New York, New York, USA. 1923

### **Rossman, Joseph**

Inventor

However, knowledge alone...never gives rise to new inventions or industries. It is usually left to the inventor to utilize the facts and principles of science, and to apply them for practical purposes.

*Industrial Creativity: The Psychology of the Inventor*

Chapter II (p. 19)

University Books. New Hyde Park, New York, USA. 1964

### **Rothman, Milton A.** 1919–

Experimental American nuclear physicist and science writer

It takes very little imagination to believe naively that anything is possible. Any ten-year-old child can believe this. It takes a great deal of knowledge to know what things are possible and what things are impossible.

*The Science Gap: Dispelling the Myths and Understanding the Reality of Science*

Myth 8 (p. 142)

Prometheus Books. Amherst, New York, USA. 2003

### **Royce, Josiah** 1855–1916

American philosopher

Science is never merely knowledge; it is orderly knowledge.

*Logical Essays* (p. 317)

W.C. Brown Company. Dubuque, Iowa, USA. 1951

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Unless we can know something without knowing everything, it is obvious that we can never know something.

In John E. Leffler

*Rates and Equilibria of Organic Reactions as Treated by Statistical,*

*Thermodynamic, and Extrathermodynamic Methods* (p. v)

John Wiley & Sons, Inc. New York, New York, USA. 1963

Whatever knowledge we possess is either knowledge of particular facts or scientific knowledge.

*The Scientific Outlook*

Chapter III (p. 73)

George Allen & Unwin Ltd. London, England. 1931

With equal passion I have sought knowledge. I have wished to understand the hearts of men. I have wished to know why the stars shine. And I have tried to

apprehend the Pythagorean power by which numbers holds sway above the flux. A little of this, but not much, I have achieved.

*The Autobiography of Bertrand Russell*

Prologue (pp. 3–4)

Little, Brown & Company, Boston, Massachusetts, USA. 1967

Science, as its name implies, is primarily knowledge; by convention it is knowledge of a certain kind, the kind, namely, which seeks general laws connecting a number of particular facts.

*The Scientific Outlook*

Introduction (p. 10)

George Allen & Unwin Ltd, London, England. 1931

The world as we perceive it is full of a rich variety: some of it is beautiful, some of it is ugly; parts seem to us good, parts bad. But all this has nothing to do with the purely causal properties of things, and it is the properties with which science is concerned. I am not suggesting that if we knew these properties completely we should have a complete knowledge of the world, for its concrete variety is an equally legitimate object of knowledge. What I am saying is that science is that sort of knowledge which gives causal understanding, and that this sort of knowledge can in all likelihood be completed, even where living bodies are concerned, without taking account of anything but their physical and chemical properties.

*The Scientific Outlook*

Chapter V (p. 133)

George Allen & Unwin Ltd, London, England. 1931

Knowledge, everywhere, is coming to be regarded not as a good in itself, or as a means of creating a broad and humane outlook on life in general, but as merely an ingredient in technical skill.

*The Will to Doubt*

“Useless” Knowledge (p. 72)

The Wisdom Library, New York, New York, USA. 1958

### **Sagan, Carl** 1934–96

American astronomer and author

In science it often happens that scientists say, “You know that’s a really good argument; my position is mistaken,” and then they would actually change their minds and you never hear that old view from them again. They really do it. It doesn’t happen as often as it should, because scientists are human and change is sometimes painful. But it happens every day. I cannot recall the last time something like that happened in politics or religion.

*1987 Committee for Scientific Investigation of Claims of the Paranormal*  
Keynote Address

In a way, science might be described as paranoid thinking applied to Nature: we are looking for natural conspiracies, for connections among apparently disparate data.

*The Dragons of Eden: Speculations on the Evolution of Human Intelligence*

Chapter 7 (p. 183)

Random House, Inc. New York, New York, USA. 1977

### **Saint Avvaiyar**

No biographical data available

What we have learnt is like a handful of Earth,  
While what we have yet to learn is like the whole  
World.

In an article by M. Blumer

*Angewandete Chemie International Edition in English*

Volume 14, 1975 (p. 507)

### **Samuelson, Bengt, I.** 1934–

Swedish physiological chemist

We are just in the beginning of gathering knowledge about man and his environment. We can hardly comprehend the enormous possibilities that are inherent in discovering the structure and function of nature from the inner space of particles and atoms to the cells of the human body as well as the outer space of stars and galaxies. To use the new knowledge in technical and medical developments to combat poverty and disease throughout the world is indeed a challenge.

*Les Prix Nobel. The Nobel Prizes in 1982*

Nobel banquet speech for award received in 1982

Nobel Foundation, Stockholm, Sweden. 1983

### **Santayana, George (Jorge Augustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

Science, then is the alternative consideration of common experience; it is common knowledge extended and refined.

*The Life of Reason or The Phases of Human Progress*

Part V, Chapter I (p. 393)

Charles Scribner’s Sons, New York, New York, USA. 1953

### **Seton, Ernest Thompson** 1860–1946

Naturalist and writer

A knowledge of animals doubles the interest of an ordinary country ramble — and the more we learn their ways, the more glimpses we will likely get of them!

In William H. Carr

*The Stir of Nature*

Chapter Two (p. 27)

Oxford University Press, Inc. New York, New York, USA. 1930

### **Severinus, Petrus** 1540–1602

Swedish anatomist

...sell your lands, your house, your clothes and your jewelry; burn up your books. On the other hand, buy yourselves stout shoes, travel to the mountains, search the valleys, the deserts, the shores of the sea, and the deepest depressions of the earth; note with care the distinctions between animals, the differences of plants, the various

kinds of minerals, the properties and mode of origin of everything that exists. Be not ashamed to study diligently the astronomy and terrestrial philosophy of the peasantry. Lastly, purchase coal, build furnaces, watch and operate with the fire without wearying. In this way and no other, you will arrive at a knowledge of things and their properties.

In Allen G. Debus

*The French Paracelsians*

Chapter 1 (p. 8)

Cambridge University Press. Cambridge, England. 1991

### Seward, John

No biographical data available

Let us have the mind and the mind's-workings, not the remains of earnest thought which has been frittered away by a long dreary course of preparatory study, by which all life has been evaporated. Never forget that there is in the wide river of nature something which every body who has a rod and line may catch, precious things which every one may dive for.

The Purpose and Tendency of Early Italian Art

*The Germ*, Volume 2, February 1850 (p. 60)

### Shelley, Mary 1797–1851

English Romantic writer

Oh what a strange nature is knowledge! It clings to the mind, when it has once seized on it, like a lichen on the rock.

*The Novels and Selected Works of Mary Shelly* (Volume 1)

Frankenstein, Volume 2, Chapter V (p. 90)

William Pickering. London, England. 1996

### Shermer, Michael 1954–

American science writer

Science is not the affirmation of a set of beliefs but a process of inquiry aimed at building a testable body of knowledge constantly open to rejection or confirmation. In science, knowledge is fluid and certainty fleeting. That is at the heart of its limitations. It is also its greatest strength.

*Why People Believe Weird Things: Pseudoscience, Superstition, and*

*Other Confusions of Our Time*

Part 2, Chapter 8 (p. 124)

Henry Holt & Company. New York, New York, USA. 2002

### Sillman, Benjamin 1779–1864

American chemist and geologist

Knowledge is nothing but the just and full comprehension of the real nature of things, physical, intellectual, and moral; it is co-existence with the universe of being; reaching back to the dawn of time, and forward to its consummation.

*An Introductory Lecture* (p. 47)

Printed by Hezekiah Howe. New Haven, Connecticut, USA. 1828

### Silver, Brian L.

Israeli professor of physical chemistry

...at the borders of our knowledge we run into real complexity, into questions that challenge our ability to define the nature of reality.

*The Ascent of Science*

Preface (p. xiv)

Solomon Press Book. New York, New York, USA. 1998

### Smith, Logan Pearsall 1865–1946

American author

I know too much; I have stuffed too many of the facts of History and Science into my intellectuals. My eyes have grown dim over books; believing in geological periods, cave dwellers, Chinese Dynasties, and the fixed stars has prematurely aged me.

*Trivia*

Book II, The Burden (p. 156)

Doubleday, Page & Company. Garden City, New York, USA. 1917

### Smith, Theobald 1859–1934

American pathologist

It is incumbent upon us to keep training and pruning the tree of knowledge without looking to the right or the left.

Obituary Notice of Deceased Member

*Journal of Pathology and Bacteriology*, Volume 40, Number 3, May

1935 (p. 630)

### Snyder, Carl H.

No biographical data available

...the difference between "magic" and "science" is knowledge.

*The Extraordinary Chemistry of Ordinary Things*

Preface (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1995

### Sockman, Ralph W. 1889–1970

American minister

...the field of knowledge which even the best of us can master is like an island surrounded by a limitless ocean of mystery. And the larger the island of knowledge, the longer the shoreline of wonder.

*Now to Live!*

The Dog and the Manger (p. 202)

Abington-Cokesbury Press. New York, New York, USA. 1946

### Soddy, Frederick 1877–1956

English chemist

...before you can apply knowledge you must discover it...

*Science and Life*

Science and the State (p. 55)

J. Murray. London, England. 1920

### Spencer, Herbert 1820–1903

English social philosopher

Science is organized knowledge...

*Education: Intellectual, Moral, and Physical*

Chapter II (p. 119)

A.L. Fowle. New York, New York, USA. 1860

**Steinbeck, John** 1902–68

American novelist

...knowledge is a sacred thing, not to be questioned or even inspected.

*Sea of Cortez*

Chapter 21 (p. 209)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Stenger, Victor J.** 1935–

American physicist

I have learned that obtaining new knowledge is not easy and that we shouldn't expect it to be easy. All the easy stuff was discovered a long time ago. Today, new knowledge is accumulated only through the greatest effort and concentration of resources, often by teams of hundreds of scientists.

*Physics and Psychics: The Search for a World Beyond the Senses*

Preface (p. 10)

Prometheus Books. Buffalo, New York, USA. 1990

**Sterne, Laurence** 1713–68

English novelist and humorist

Knowledge, like matter, he would affirm, was divisible in infinitum; — that the grains and scruples were as much a part of it as the gravitation of the whole world.

*The Life and Opinions of Tristram Shandy, Gentleman and a Sentimental Journey Through France and Italy* (Volume 1)

Chapter XIX (p. 130)

Macmillan & Company Ltd. London, England. 1900

**Stewart, Ian** 1945–

English mathematician and science writer

I may not understand it, but it sure looks important to me.

*Does God Play Dice?* (2<sup>nd</sup> edition)

Chapter 6 (p. 109)

Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

**Sullivan, John William Navin** 1886–1937

Irish mathematician

Knowledge for the sake of knowledge, as the history of science proves, is an aim with an irresistible fascination for mankind, and which needs no defense. The mere fact that science does, to a great extent, gratify our intellectual curiosity, is a sufficient reason for its existence.

*The Limitations of Science*

Chapter 7, Section 3 (p. 164)

New American Library. New York, New York, USA. 1956

**Swift, Jonathan** 1667–1745

Irish-born English writer

Erect your schemes with as much method and skill as

you please; yet if the materials be...spun out of your own entrails...the edifice will conclude at last in cobwebs.... As for us the ancients, we are content with the bee to pretend to nothing of our own, beyond our wings and our voice, that is to say, our flights and our language. For the rest, whatever we have got, has been by infinite labour and search, and ranging through every corner of nature.

*Gulliver's Travels, the Tale of a Tub, Battle of the Books, etc.*

The Battle of the Books (p. 554)

Oxford University Press, Inc. London, England. 1929

**Syngé, John L.** 1897–1995

Irish mathematician and physicist

Knowledge is alive. It creeps, it grows, it crawls, it jumps. It never stays quite still. We add to it. We tear it in pieces. We put it together again, and then it is a different knowledge.

*Kandelman's Krim*

Chapter Four (p. 85)

Jonathan Cape. London, England. 1957

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

Knowledge is a sacred cow, and my problem will be how we can milk her while keeping clear of her horns.

Teaching and the Expanding Knowledge

*Science*, Volume 146, Number 3649, 4 December 1964 (p. 1278)

**Tennyson, Alfred (Lord)** 1809–92

English poet

Knowledge comes, but wisdom lingers.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 72

Oxford University Press, Inc. London, England. 1953

And this grey spirit yearning in desire,  
To follow knowledge like a sinking star, beyond the  
utmost bound of human thought.

*Alfred Tennyson's Poetical Works*

Ulysses, l. 30–31

Oxford University Press, Inc. London, England. 1953

**Thomson, Sir George** 1892–1975

English physicist

Science is knowledge which, in principle at least, is public in the sense that it may be shared by many, unlike private personal experiences such as dreams or pain. This suggests a preference for statements which can be made in a form valid for large classes of possible observers.

*The Inspiration of Science*

Introduction (p. 6)

Oxford University Press, Inc. London, England. 1961

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The knowledge of an unlearned man is living & luxuriant

like a forest — but covered with mosses & lichens and for the most part inaccessible & going to waste — the knowledge of the man of science is like timber collected in yards for public works, which still supports a green sprout here & there — but even this is liable to dry rot.

*Journal (Volume 3: 1848–1851)*

January 7, 1851 (p. 174)

Princeton University Press. Princeton, New Jersey, USA. 1981

Such is always the pursuit of knowledge. The celestial fruits, the golden apples of the Hesperides, are ever guarded by a hundred-headed dragon which never sleeps, so that it is an Herculean labor to pluck them.

*The Writings of Henry David Thoreau (Volume 9)*

Wild Apples (p. 377)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

My desire for knowledge is intermittent; but my desire to bathe my head in atmospheres unknown to my feet is perennial and constant. The highest that we can attain to is not Knowledge, but Sympathy with Intelligence. I do not know that this higher knowledge amounts to anything more definite than a novel and grand surprise on a sudden revelation of the insufficiency of all that we called Knowledge before — a discovery that there are more things in heaven and earth than are dreamed of in our philosophy. It is the lighting up of the mist by the sun.

*The Writings of Henry David Thoreau (Volume 9)*

Walking (p. 294)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### **Timiryazev, K. A.**

No biographical data available

The select who engage in science must look upon knowledge as a treasure entrusted to their care, but belonging to the whole people.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierman

Progress Publishers. Moscow, Russia. 1979

### **Trotter, William** 1872–1939

Surgeon and sociologist

Knowledge comes from noticing resemblances and recurrences in the events that happen around us.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eight (p. 92)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **Tucker, Wallace**

No biographical data available

### **Tucker, Karen**

No biographical data available

As the circle of knowledge expands into the unknown, the boundary between the known and unknown also expands.... Speculating and predicting what lies beyond

the boundary is fascinating. Finding out is even more fascinating.

*Revealing the Universe*

Chapter 26 (p. 262)

Harvard University Press. Cambridge, Massachusetts, USA. 2001

### **van Leeuwenhoek, Antony** 1632–1723

Dutch biology researcher and microscope developer

...my work, which I've done for a long time, was not pursued in order to gain the praise I now enjoy, but chiefly from a craving after knowledge, which I notice resides in me more than in most other men. And therewithal, whenever I found out anything remarkable, I have thought it my duty to put down my discovery on paper, so that all ingenious people might be informed thereof.

In Julia A Ribes, Kay Elder and Doris J. Baker

*Infections, Infertility, and Assisted Reproduction*

Letter of June 12, 1716 (p. 3)

Cambridge University Press. Cambridge, England. 2004

### **von Baeyer, Hans Christian** 1938–

German-born physicist and author

Field guides are instruments of the pleasure of pure knowledge.

Rainbows, Whirlpools, and Clouds

*The Sciences*, Volume 24, Number 4, July/August 1984 (p. 24)

### **von Buch, L.**

No biographical data available

It is hard to say when knowledge of any particular natural body began and to whom this knowledge must be ascribed. Is it the one who first raised the body from the mass of the unknown or he who first perceived the special nature and individuality of this body or he who first coined a special name for it? Obviously, one would not opt for the finder nor for he who gave it its name but for the naturalist who first showed how its special characteristic might be recognized and whereby the creature is to be essentially separated and distinguished from all similar ones. But this knowledge only emerges very slowly and gradually and is obscured by many other things which, in the course of time, have to state at which point in time the first discovery of a product of nature is to be sited.

In Rudolf Daber and Jochen Helms (eds.)

*Fossils: The Oldest Treasures that Ever Lived*

Only a Slab of Transitional Limestone (p. 40)

T.H.F. Publications, Inc., Neptune City, New Jersey, USA. 1985

### **von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

...the fine thread, which wafts and woofs through the web of knowledge, through the sciences in all periods, even through the darkest and most confusing ones, is drawn by individuals.

In Karl J. Fink

*Goethe's History of Science*

Chapter 7 (p. 93)

Cambridge University Press. Cambridge, England. 1991

...how one gropes and falters when one wants to dedicate himself to knowledge, how in the sciences one tends to take the back for the front and the bottom for the top, this is to be presented in the history of color theory, which by treating a specific realm, must present symbolically the destiny of many other human efforts.

In Karl J. Fink

*Goethe's History of Science*

Chapter 6 (p. 85)

Cambridge University Press. Cambridge, England. 1991

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

...our knowledge is not to lie dormant in the shape of catalogues. The very fact that we must carry it about in black and white shows that our intellectual mastery of it is incomplete. It is not enough to be acquainted with the facts; scientific knowledge begins only when their laws and their causes are unveiled.

In David Cahan (ed.)

*Science and Culture: Popular and Philosophical Essays*

On the Relation of Natural Science to Science in General

Academical Discourse, November 22, 1862 (p. 83)

The University of Chicago Press. Chicago, Illinois, USA. 1995

**Waddington, Conrad Hal** 1905–75

British biologist and paleontologist

Scientific knowledge and understanding is a communal achievement, the sum of a multitude of contributions from many different people. Any individual may feel a certain justifiable pride if he knows that he has added one brick to the structure.

*The Scientific Attitude*

Science's Failure and Success (p. 62)

Penguin Books. Middlesex, England. 1941

**Walker, John** 1731–1803

English minister and educator

The objects of nature themselves must be sedulously examined in their native state, the fields and the mountains must be traversed, the woods and the waters must be explored, the ocean must be fathomed and its shores scrutinized by everyone that would become proficient in natural knowledge.... The way to knowledge of natural history is to go to the fields, the mountains, the oceans, and to observe, collect, identify, experiment and study.

*Lectures on Geology: Including Hydrography, Mineralogy, and Meteorology with an Introduction to Biology*

Biographical Introduction (p. xvii)

The University of Chicago Press. Chicago, Illinois, USA. 1966

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

Can we believe that we are fulfilling the purpose of our existence while so many of the wonders and beauties of the creation remain unnoticed around us? While so much of the mystery which man has been able to penetrate, however imperfectly, is still all dark to us? While so many of the laws which govern the universe and which influence our lives are, by us, unknown and uncared for? And this not because we want the power, but the will, to acquaint ourselves with them. Can we think it right that, with the key to so much that we ought to know, and that we should be the better for knowing, in our possession, we seek not to open the door, but allow this great store of mental wealth to lie unused, producing no return to us, while our highest powers and capacities rust for want of use?

*My Life*

Chapter XIV (p. 203)

Chapman & Hall. London, England. 1905

How little should we know had the knowledge acquired by each preceding age died with it! How blindly should we grope our way in the same obscurity as did our ancestors, pursue the same phantoms, make the same fatal blunders, encounter the same perils, in order to purchase the same truths which had been already acquired by the same process, and lost again and again in bygone ages!

*My Life*

Chapter XIV (p. 204)

Chapman & Hall. London, England. 1905

He who has extended his inquiries into the varied phenomena of nature learns to despise no fact, however small, and to consider the most apparently insignificant and common occurrences as much in need of explanation as those of a grander and more imposing character.

*My Life*

Chapter XIV (p. 202)

Chapman & Hall. London, England. 1905

Is it not fitting that, as intellectual beings with such high powers, we should each of us acquire a knowledge of what past generations have taught us, so that, should the opportunity occur, we may be able to add somewhat, however small, to the fund of instruction for posterity?

*My Life*

Chapter XIV (p. 204)

Chapman & Hall. London, England. 1905

...can any reflecting mind have a doubt that, by improving to the utmost the nobler faculties of our nature in this world, we shall be the better fitted to enter upon and enjoy whatever new state of being the future may have in store for us?

*My Life*

Chapter XIV (p. 204)

Chapman & Hall. London, England. 1905

...our horizon ever widens, the limits to our advance seem more distant than ever, and there seems nothing too

noble, too exalted, too marvelous, for the ever-increasing knowledge of future generations to attain to.

*My Life*

Chapter XIV (p. 204)

Chapman & Hall. London, England. 1905

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

Knowledge has to be sucked into the brain, not pushed into it.

*The Privilege of Being a Physicist*

Chapter 4 (p. 31)

W.H. Freeman & Company. New York, New York, USA. 1989

**Whewell, William** 1794–1866

English philosopher and historian

The Senses place before us the Characters of the Book of Nature; but these convey no knowledge to us, till we have discovered the Alphabet by which they are to be read.

*The Philosophy of the Inductive Sciences Founded Upon their History* (Volume 2)

Aphorisms, Aphorisms Concerning Ideas, II (p. 443)

John W. Parker. London, England. 1847

**White, J. F.**

No biographical data available

Man is building, at accelerated speed, a super-bridge of knowledge reaching to the stars.

*Study of the Earth: Readings in Geological Science* (p. 6)

Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1962

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The consequences of a plethora of half-digested theoretical knowledge are deplorable.

*The Organization of Thought*

Chapter I (p. 9)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Knowledge does not keep any better than fish.

*The Aims of Education and Other Essays*

Chapter VII, Section III (p. 147)

The Macmillan Company. New York, New York, USA. 1959

...science is not discussing the causes of knowledge, but the coherence of knowledge.

*The Concept of Nature*

Chapter II (p. 41)

At The University Press. Cambridge, England. 1920

**Wilson, Edward O.** 1929–

American biologist and author

New knowledge is not science until it is made social. The scientific culture can be defined as new verifiable

knowledge secured and distributed with fair credit meticulously given.

*Naturalist*

The Forms of Things Unknown (p. 210)

Island Press. Washington, D.C. 1994

Now to the heart of wonder. Because species diversity was created prior to humanity, and because we evolved within it, we have never fathomed its limits. As a consequence, the living world is the natural domain of the most restless and paradoxical part of the human spirit.

In John A Murray

*The Islands and the Sea* (p. 265)

Oxford University Press, Inc. Oxford, England. 1991

**Wright, Frances** 1795–1852

Scottish-born American reformer

Knowledge signifies things known. Where there are no things known, there is no knowledge. Where there are no things to be known, there can be no knowledge. We have observed that every science, that is, every branch of knowledge, is compounded of certain facts, of which our sensations furnish the evidence. Where no such evidence is supplied, we are without data; we are without first premises; and when, without these, we attempt to build up a science, we do as those who raise edifices without foundations. And what do such builders construct? Castles in the air.

*Course of Popular Lectures*

Lecture 4

Published by the author. Philadelphia, Pennsylvania, USA. 1836

**Ziman, John M.** 1925–2005

English physicist

Scientific knowledge is not created solely by the piecemeal mining of discrete facts by uniformly accurate and reliable individual scientific investigations. The process of criticism and evaluation, of analysis and synthesis, are essential to the whole system. It is impossible for each one of us to be continually aware of all that is going on around us, so that we can immediately decide the significance of every new paper that is published. The job of making such judgments must therefore be delegated to the best and wisest among us, who speak, not with their own personal voices, but on behalf of the whole community of Science. Anarchy is as much a danger in that community as in any tribe or nation. It is impossible for the consensus — public knowledge — to be voiced at all, unless it is channeled through the minds of selected persons, and restated in their words for all to hear.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 7 (pp. 136–137)

Cambridge University Press. Cambridge, England. 1968



## L

### LABEL

**Mayr, Ernst** 1904–2005

German-born American biologist

**Ashlock, P. D.**

No biographical data available

So important...is the label that it is sometimes stated jocularly that the label is more important than the specimen.

*Principles of Systematic Zoology*

Chapter 6.1.8 (p. 106)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

### LABORATORY

**Armitage, Simon** 1963–

Poet and novelist

I am very bothered when I think  
of the bad things I have done in my life.  
Not least that time in the chemistry lab  
when I held a pair of scissors by the blades  
and played the handles  
in the naked lilac flame of the Bunsen burner,  
then called your name, and handed them over.

*Book of Matches*

I Am Very Bothered When I Think, l. 1–7

Chadwyck-Healey. Cambridge, England. 1999

**Berselius, Jöns Jacob** 1779–1848

Swedish chemist

A tidy laboratory means a lazy chemist.

In E.M. Melhardo and T. Frängsmyr (eds.)

*Enlightenment Science in the Romantic Era: The Chemistry of Berzelius and Its Cultural Setting*

Quoted by C.G. Bernard (p. 225)

Cambridge University Press. Cambridge, England. 1992

**Boyle, Robert** 1627–91

English natural philosopher and theological writer

In my laboratory...I find that water of Lethe which causes that I forget everything but the joy of making experiments.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 18)

Macmillan & Company Ltd. London, England. 1918

**Ciardi, John** 1916–86

American poet

To the laboratory then I went. What little right men they were exactly! Magicians of the microsecond precisely

wired to what they cared to ask no questions of but such as their computers clicked and hummed.

It was a white-smocked, glass, and lightened Hell. And there Saint Particle the Septic sat lost in his horn-rimmed thoughts. A gentlest pose. But in the frame of one lens as I passed I saw an ogre's eye leap from his face.

Fragment

*Saturday Review*, April 30, 1966

**Drake, Daniel** 1785–1852

American physician

The laboratory is not more necessary for the study of chemistry, or a garden of plants for the study of botany, than a hospital for the study of practical medicine and surgery.

Introductory lecture

Medical College of Ohio, 1849

**Fischer, Martin H.** 1879–1962

German-American physician

All the world is a laboratory to the inquiring mind.

In Howard Fabing and Ray Marr

*Fischerisms*

C.C. Thomas. Springfield, Illinois, USA. 1944

A laboratory is only a place where one may better set up and control conditions.

In Howard Fabing and Ray Marr

*Fischerisms*

C.C. Thomas. Springfield, Illinois, USA. 1944

**Henry, William**

No biographical data available

A chemical laboratory, though extremely useful, and even essential, to all who embark extensively in the practice of chemistry, either as an art, or as a branch of liberal knowledge, is by no means required for the performance of those simple experiments which furnish the evidence of the fundamental truths of science. A room that is well lighted, easily ventilated, and destitute of any valuable furniture is all that is absolutely necessary for the purpose.

*The Elements of Experimental Chemistry* (Volume 1)

Part I, Chapter 1 (p. 27)

Thomas & Andres. Boston, Massachusetts, USA. 1814

**Hilger, Adam**

No biographical data available

I also remember Len Hibbard, another of the more senior staff members, remarking half in jest, half in earnest, that there were two ways of pronouncing the word "laboratory." In American usage the accent was on the first syllable; in English, on the second. "But it is clear", he continued, "that the accent should be on the 'labor', and not on the 'oratory'."

In Joan Freeman

*A Passion for Physics: The Story of a Woman Physicist*

Chapter 5. The Radar Days (p. 90)

Institute of Physics Publishing, Bristol, England. 1993

**Huxley, Thomas Henry** 1825–95

English biologist

In truth, the laboratory is the fore-court of the temple of philosophy; and whoso has not offered sacrifices and undergone purification there has little chance of admission into the sanctuary.

*Hume, with Helps to the Study of Berkeley* (p. 61)

D. Appleton & Company, New York, New York, USA. 18 D. Appleton & Company, New York, New York, USA. 1873

**Jones, Thomas P.**

No biographical data available

Nature has the universe for her laboratory, in which she is continually employed in chemical operations, producing effects as interesting, as wonderful, and equally necessary with those which belong to Natural Philosophy.

*New Conversations on Chemistry*

Conversation I (p. 14)

Grigg, Elliot & Company, Philadelphia, Pennsylvania, USA. 1848

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

There is...one thing I feel strongly in respect to investigation in physical or chemical laboratories — it leaves no room for shady, doubtful distinctions between truth, half-truth, whole falsehood. In the laboratory everything tested or tried is found true or not.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (p. 24)

Macmillan & Company Ltd. London, England. 1918

The laboratory of a scientific man is his place of work. The laboratory of the geologist and of the naturalist is the face of this beautiful world. The geologist's laboratory is the mountain, the ravine and the seashore. The naturalist and the botanist go to foreign lands, to study the wonders of nature, and describe and classify the results of their observations.

*Popular Lectures and Addresses* (Volume 2)

The Bangor Laboratories

Address

Physical and Chemical Laboratories in University College

Bangor, North Wales, February 2, 1885 (p. 476)

Macmillan & Company Ltd. London, England. 1894

**Lagen, Doug**

No biographical data available

The lab is my jeopardy, I cannot breathe.

It eateth my clothes with strong acids.

It destroyeth my soles.

It leadeth me into the paths of science for its own sake.

Yea, though I walk through the welter of stink and smells, I will fear not chemical, for it is oneness.

It provideth me a bench in the presence of fluorine. It loadeth my day with toil.

My beaker runneth over. Surely bad tastes and odors shall follow me all the days of my life, and I shall dwell in the house of science forever.

The Lab

*Chemistry*, June 1976 (p. 27)

**Lamb, J. C.**

If you can make the vilest stinks invented  
And work in them from morn till late at night,  
Or with your lot be perfectly contented  
When you are asked to fool with dynamite;  
If you can still remain quite calm and placid  
When plant officials effervesce and fret,  
Or being told to test a fuming acid  
Can suck it through a 1-cc pipette:

...

If you can subjugate all thoughts of pleasure  
And still retain a meed of self-esteem;  
If you can give your few short hours of leisure  
To keeping up with every modern theme;  
If you donate your every waking minute  
And seek your sole reward in duty done,  
Yours is the Lab. And everything that's in it,  
And what is more, you're welcome to it, Son.

*Industrial and Engineering Chemistry: News Edition*, Volume 10, Number 11, June 1932 (p. 152)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Worse still is the “lock and key” laboratory in which suspicion and distrust reign, and everyone is jealous and fearful least the other should know of or find out about his work.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 280)

The Blakiston Company, Philadelphia, Pennsylvania, USA. 1932

**Pasteur, Louis** 1822–95

French chemist

...I implore you, take some interest in those sacred dwellings meaningfully described as laboratories. Ask that they may be multiplied and completed. They are the temples of the future, of riches and of comfort. There humanity grows greater, better, stronger; there she can learn to read the works of Nature, works of progress and universal harmony, while humanity's own works are too often those of barbarism, of fanaticism and of destruction.

In R. Vallery-Radot

*Life of Pasteur*

Chapter VI (p. 152)

Garden City Publishing Company, Garden City, New York, USA. 1926

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

What is a scientific laboratory? It is a small world, a small corner of reality. And in this small corner man labors with his mind at the task of...knowing this reality in order correctly to predict what will happen...even to direct this reality according to his will, to command it, if this is within our technical means.

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*

Introduction (p. xiii)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

**Sarewitz, Daniel**  
No biographical data available

The leap of faith that spans the chasm between laboratory and reality must be replaced with a bridge, lest, at the end of the age of physics, we look down and realize that there is nothing underneath our feet.

*Frontiers of Illusion*

Chapter 1 (p. 15)

Temple University Press. Philadelphia, Pennsylvania, USA. 1996

**Soddy, Frederick** 1877–1956  
English chemist

Laboratories are necessary, and though an artist without a studio or an evangelist without a church might conceivably find under the blue dome of heaven a substitute, a scientific man without a laboratory is a misnomer.

In Bernard Jaffe

*New World of Chemistry*

Chapter 4 (p. 44)

Silver, Burdett & Company. New York, New York, USA. 1935

**Witt, Otto N.** 1875–1923  
Swedish writer

From laboratories great and small, official and private, the results of research have flowed like the rivulets which, irrigating the well-watered fields, come together in brooks, then in streams and in rivers, bringing fertility to the habitations of men in the valleys. An Abundant harvest has been raised on these watered plains, a harvest which has been enthusiastically consumed by the people.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

Development of Technological Chemistry During the Last Forty Years (p. 255)

Government Printing Office. Washington, D.C. 1909

## LABYRINTH

**Borges, Jorge Luis** 1899–1986  
Argentine writer

I thought of a labyrinth of labyrinths, of one sinuous spreading labyrinth that would en--compass the past and the future and in some way involve the stars.

In Donald A. Yates & James E. Irby (eds.)

*Labyrinths: Short Stories & Other Writings*

The Garden of Forking Paths (p. 23)

A New Direction Book. New York, New York, USA. 1964

## LAKE

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

A lake is the landscape's most beautiful and expressive feature. It is earth's eye...

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter IX (p. 291)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

## LAND

**Harrington, Thomas**

No biographical data available

The Land we inhabit affords the ingenious and philosophic mind infinite matter for contemplation.

*Science Improved or the Theory of the Universe*

Section I (p. 9)

Printed for the Author. London, England. 1774

**Huxley, Thomas Henry** 1825–95

English biologist

Direct proof may be given that some parts of the land of the northern hemisphere are at this moment insensibly rising and others insensibly sinking; and there is indirect, but perfectly satisfactory, proof, that an enormous area now covered by the Pacific has been deepened thousands of feet, since the present inhabitants of that sea came into existence. Thus there is not a shadow of a reason for believing that the physical changes of the globe, in past times, have been effected by other than natural causes.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On a Piece of Chalk (p. 34)

Macmillan & Company Ltd. London, England. 1904

## The Bible

God said, "Let there be a vault between the waters, to separate water from water."

*The Revised English Bible*

Genesis 1:6

Oxford University Press, Inc. Oxford, England. 1989

## LANDSCAPE

### Dodge, Richard Elwood

No biographical data available

The great poets of the world have often attempted to depict in appealing phrases, more graphic than any of the carefully selected and more detailed descriptions of the scientists, the striking features of the landscape that everyone knows but perhaps does not appreciate.

Man and His Geographic Environment

*Journal of Geography*, Volume 8, 1910 (p. 184)

### Ehrlich, Gretel 1946–

American travel writer

I like to think of landscape not as a fixed place but as a path that is unwinding before my eyes, under my feet. To see and know a place is a contemplative act. It means emptying our minds and letting what is there, in all its multiplicity and endless variety, come in.

*Legacy of Light*

Introduction, Landscape

Alfred A. Knopf. New York, New York, USA. 1987

## LANGUAGE

### Abbey, Edward 1927–89

American environmentalist and nature writer

Language makes a mighty loose net with which to go fishing for simple facts, when facts are infinite.

*Desert Solitaire*

Author's Introduction (p. x)

Ballantine Books. New York, New York, USA. 1968

### Barthes, Roland 1915–80

French social and literary critic

As far as science is concerned language is simply an instrument, which it profits to make as transparent and neutral as possible: it is subordinate to the matter of science (workings, hypotheses, results) which, so it is said, exists outside language and precedes it. On the one hand and first there is the content of the scientific message, which is everything; on the other hand and next, the verbal form responsible for expressing that content, which is nothing.

In Michael Lane (ed.)

*Introduction to Structuralism*

Science versus Literature (p. 411)

Basic Books. New York, New York, USA. 1970

### Bloomfield, Leonard 1887–1949

American linguist

The use of language in science is specialized and peculiar. In a brief speech the scientist manages to say things which in ordinary language would require a vast amount

of talk. His hearers respond with great accuracy and uniformity. The range and exactitude of scientific prediction exceed any cleverness of everyday life: the scientist's use of language is strangely effective and powerful. Along with systematic observation, it is this peculiar use of language which distinguishes science from non-scientific behavior.

Linguistic Aspects of Science

*International Encyclopedia of Unified Science*, Volume 1, Number 4 (p. 1)  
The University of Chicago Press. Chicago, Illinois, USA. 1938–

### Bohr, Niels Henrik David 1886–1962

Danish physicist

What is it that we human beings ultimately depend on? We depend on our words. We are suspended in language. Our task is to communicate experience and ideas to others. We must strive continually to extend the scope of our description, but in such a way that our messages do not thereby lose their objective or unambiguous character.

In Aage Petersen

The Philosophy of Niels Bohr

*Bulletin of the Atomic Scientists*, Volume 19, Number 7, September 1963 (p. 10)

### Byron, George Gordon, 6<sup>th</sup> Baron Byron 1788–1824

English Romantic poet and satirist

I linger yet with nature for the night  
Hath been to me a more familiar face  
Than that of man; and in her starry shade  
Of dim and solitary loveliness  
I learned the language of another world.

*The Complete Poetical Works of Byron*

Manfred

Act III, Scene iv

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

### Casimir, Hendrik B. G. 1909–2000

Dutch physicist

The number of speakers of Broken English is so overwhelming and there are so many for whom B.E. is almost the only way of expressing themselves...that it is about time that Broken English be regarded as a language in its own right.

*Haphazard Reality: Half a Century of Science*

Chapter 4 (p. 122)

Harper & Row, Publishers. New York, New York, USA. 1983

### Davy, Sir Humphry 1778–1829

English chemist

The man of true genius, who studies science in consequence of its applications, pointing out to himself a definite end, will make use of all the instruments of investigation which are necessary for his purposes: and in the search of discovery, he will rather pursue the plans of his own mind than be limited by the artificial divisions of language.

*A Discourse, Introductory to a Course of Lectures on Chemistry* (pp. 10–11)  
Press of the Royal Institution of Great Britain. London. 1802

In natural science there is one language universally intelligible, — the language of facts; it belongs to nature, and it is permanent as the objects of nature; it is the same to the citizen of Paris and of London.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter III (p. 148)

Smith, Elder & Company. London, England. 1839–1840

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The point is we are bound up with a language, we are hanging in the language. If we want to do physics, we must describe our experiments and the results to other physicists, so that they can be verified or checked by others. At the same time, we know that the words we use to describe the experiments have only a limited range of applicability. That is a fundamental paradox which we have to confront. We cannot avoid it; we have simply to cope with it, to find what is the best thing we can do about it.

In Paul Buckley and F. David Peat

*Glimpsing Reality: Ideas in Physics and the Link to Biology*

Werner Heisenberg (p. 7)

University of Toronto Press. Toronto, Ontario, Canada. 1996

### **Hesse, Mary B.** 1924–

English science historian

...there is an external world which can in principle be exhaustively described in scientific language. The scientist, as both observer and language-user, can capture the external facts of the world in propositions that are true if they correspond to the facts and false if they do not. Science is ideally a linguistic system in which true propositions are in one-to-one relation to facts, including facts that are not directly observed because they involve hidden entities or properties, or past events or far distant events. These hidden events are described in theories, and theories can be inferred from observation, that is, the hidden explanatory mechanism of the world can be discovered from what is open to observation. Man as scientist is regarded as standing apart from the world and able to experiment and theorize about it objectively and dispassionately.

*Revolutions and Reconstructions in the Philosophy of Science*

Introduction (p. vii)

Indiana University Press. Bloomington, Indiana, USA. 1980

### **Hinshelwood, Sir Cyril** 1897–1967

English chemist

The creations of various men of science may be likened to pictures by artists of different schools, all conveying essential truth but in varied forms. The individual nature of its symbolism lays science open to the attack of those

philosophers who like to question minutely the use of language in every statement. Men of science, although some of them play at this game themselves, tend on the whole to be impatient of purely semantic discussions and indeed most of them would probably feel that present-day linguistic philosophy has been not unjustly described as an affair of limited risks and small returns.

Science and Scientists

*Nature*, Volume 207, Number 5001, September 4, 1965 (p. 1058)

### **Huxley, Aldous** 1894–1963

English writer and critic

Like the man of letters, the scientist finds it necessary to “give a purer sense to the words of the tribe.” But the purity of scientific language is not the same as the purity of literary language. The aim of the scientist is to say only one thing at a time, and to say it unambiguously and with the greatest possible clarity. To achieve this, he simplifies and jargonizes.

*Literature and Science*

Chapter 5 (p. 12)

Harper & Row, Publishers. New York, New York, USA. 1963

### **Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

I am not so lost in lexicography, as to forget that words are the daughters of earth, and that things are the sons of heaven. Language is only the instrument of science, and words are but the signs of ideas: I wish, however, that the instrument might be less apt to decay, and that signs might be permanent, like the things which they denote.

*Dictionary of the English Language*

Introduction

Longmans, Green & Company. London, England. 1882

### **Kistiakowsky, George B.** 1900–82

Russian American chemist

...science is today one of the few common languages of mankind; it can provide a basis for understanding and communication of ideas between people that is independent of political boundaries and ideologies.

Science and Foreign Affairs

*Bulletin of the Atomic Scientists*, Volume 16, Number 4, April 1960 (p. 115)

### **Lavoisier, Antoine Laurent** 1743–94

French chemist

The impossibility of separating the nomenclature of a science from the science itself is owing to this, that every branch of physical science must consist of three things: the series of facts which are the objects of the science, the ideas which represent these facts, and the words by which these ideas are expressed. Like three impressions of the same seal, the word ought to produce the idea, and the idea to be a picture of the fact.

In *Great Books of the Western World* (Volume 45)

*Elements of Chemistry*

Preface (p. 1)

Encyclopedia Britannica, Inc. Chicago, Illinois, USA. 1952

...we cannot improve the language of any science without at the same time improving the science itself; neither can we, on the other hand, improve a science, without improving the language or nomenclature which belongs to it.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xv)

Printed for William Creech. Edinburgh, Scotland. 1790

**Martin, Calvin Luther**

American historian

I thought of words as sculptors of space, as turn-keys: liberators or jailers of the powers about us.

*In the Spirit of the Earth*

Chapter 2 (p. 25)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1992

**Muir, M. M. Pattison** 1848–1931

Chemist and author

To write a full description of the origin, growth and misadventures of the language of chemistry is to write a history of science.

*A History of Chemical Theories and Laws*

Appendix to Part I (p. 189)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1906

**Oppenheimer, Frank** 1912–85

Physicist

At the leading edge of experience in philosophy, science and feeling there is inevitably a groping for language to translate the insecure novelty of noticing and understanding into a precision of meaning and imagery.

In K.C. Cole

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Chapter One (p. 15)

Harcourt Brace &amp; Company. New York, New York, USA. 1999

**Quine, Willard Van Orman** 1908–2000

American logician and philosopher

Language is conceived in sin and science is its redemption.

*The Roots of Reference*

Part II, Section 18 (p. 68)

Open Court Publishing. La Salle, Illinois, USA. 1974

**Shaler, Nathaniel Southgate** 1841–1906

American geologist

The greater part of the facts [with] which geologists have to deal possess for the general public a recondite character. They concern things which are not within the limits of familiar experience. In treating of them, the science uses a language of its own, an argot as special as that of the anatomist or the metaphysician.

*Aspects of the Earth: A Popular Account of Some Familiar Geological Phenomena*

Rivers and Valleys (p. 143)

Charles Scribner's Sons. New York, New York, USA. 1889

**Stoppard, Tom** 1937–

Czech-born English playwright

If there is any point in using language at all it is that a word is taken to stand for a particular fact or idea and not for other facts or ideas.

*Travesties*

Act I (p. 22)

Grove Press, Inc. New York, New York, USA. 1975

**Sylvester, James Joseph** 1814–97

English mathematician

Would it sound too presumptuous to speak of perception as a quintessence of sensation, language (that is, communicable thought) [as that] of perception, mathematics [as that] of language? We should then have four terms differentiating from inorganic matter and from each other: the Vegetable, Animal, Rational, and Supersensual models of existence.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to the British Association (p. 652)

University Press. Cambridge, England. 1904–1912

**Thomas, Lewis** 1913–93

American physician and biologist

The great thing about human language is that it prevents us from sticking to the matter at hand.

*The Lives of a Cell: Notes of a Biology Watcher*

Information (p. 95)

The Viking Press. New York, New York, USA. 1974

**van Gogh, Vincent Willem** 1853–90

Dutch painter

It is not the language of painters but the language of nature which one should listen to...The feeling for the things themselves, for reality, is more important than the feeling for pictures.

*The Complete Letters of Vincent Van Gogh with Reproductions of all the Drawings in the Correspondence* (Volume One)

Letter 218 (p. 416)

New York Graphic Society. Greenwich, Connecticut, USA. 1958

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

From the remotest nebulae and from the revolving double stars, we have descended to the minutest organisms of animal creation, whether manifested in the depths of ocean or on the surface of our globe, and to the delicate vegetable germs which clothe the naked declivity of the ice-crowned mountain summit; and here we have been able to arrange these phenomena according to partially

known laws; but other laws of a more mysterious nature rule the higher spheres of the organic world, in which is comprised the human species in all its varied conformation, its creative intellectual power, and the languages to which it has given existence.

*Cosmos: A Sketch of a Physical Description of the Universe*  
(Volume 1)

Conclusion of the Subject (p. 359)

Harper & Brothers. New York, New York, USA. 1869

**Walker, Kenneth** 1882–1966

Physician

Science is the product of the intellect and its language is the language of matter.

*Meaning and Purpose*

Chapter IX (p. 89)

Jonathan Cape. London, England. 1944

**Walker, Ruth A.**

No biographical data available

**Johnston, Helen**

No biographical data available

Equations are the language of the chemist.

*The Language of Chemistry*

Preface (p. viii)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1963

**Weaver, Warren** 1894–1978

American mathematician

With the extremely small or the extremely large, with inconceivably brief or extended phenomena, science has a difficult time. It is by no means clear that our present concepts or even our existing language is suitable for these ranges.

*Science and Imagination*

Chapter Two (p. 50)

Basic Books, Inc. New York, New York, USA. 1967

## LATIN SQUARE

**Kendall, Maurice G.** 1907–83

English statistician

The first mathematical discussion of the Latin Square known to modern statisticians was given by Euler in 1882. Euler does not make any specific references to previous work and merely mentions the problem as having aroused interest, but since he entitled his paper “Recherch sur un In-ouvelle espece de guarre magiques” he seems to have been under the impression that the problem was fairly new...

Who Discovered the Latin Square?

*The American Statistician*, Volume 11, Number 4, August 1948 (p. 13)

**Fleiss, Joseph L.** 1937–2003

American biostatistician

An Israeli statistician named Hare,

Had five factors he wished to compare,

Levels of each were nine,

So of course his design

Was a Hebro–Greco–Latin square.

Letters to the Editor

*The American Statistician*, Volume 21, Number 4, October 1967 (p. 49)

## LAVA

### Author undetermined

Hence on a level plain, and at some distance from its source, the lava-stream advances at a leisurely pace. In such circumstances the cooling proceeds so quickly that a crust of considerable thickness is soon formed on the top of the current, and persons who are bold enough may cross the stream by means of this natural bridge. Even where the current continues flowing rapidly, this crust may be formed on its surface; and a man, whose curiosity exceeds his prudence, may stand on the top of it, bore a hole through the crust, and see the lava flowing underneath his feet!

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Chapter I

T. Nelson. London, England. 1890

A simple jet of water of considerable volume, thrown into the air to the height of a hundred feet, is itself a beautiful spectacle. What then must be a huge jet of glowing white lava projected to the height of several hundred feet, and with what an awful thundering sound must it come tumbling to the ground, thence to rush as a roaring torrent down the mountain’s side!

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Chapter I

T. Nelson. London, England. 1890

**Twain, Mark (Clemens, Samuel**

**Langhorne)** 1835–1910

American author and humorist

Under us, and stretching away before us, was a heaving sea of molten fire of seemingly limitless extent... At unequal distances all around the shores of the lake were nearly white-hot chimneys or hollow drums of lava, four or five feet high, and up through them were bursting gorgeous sprays of lava-gouts and gem spangles, some white, some red and some golden — a ceaseless bombardment, and one that fascinated the eye with its unapproachable splendor. The more distant jets, sparkling up through an intervening gossamer veil of vapor, seemed miles away; and the further the curving ranks of fiery mountains receded, the more fairy-like and beautiful they appeared.

*Roughing It* (Volume 2)

Chapter XXXIV (pp. 304–305)

Harper & Brothers Publishers. New York, New York, USA. 1899

## LAVA BEDS

**Muir, John** 1838–1914  
American naturalist

Deserts are charming to those who know how to see them — all kinds of bogs, barrens, and heathy moors; but the Modoc Lava Beds have for me an uncanny look. As I gazed the purple deepened over all the landscape. Then fell the gloaming, making everything still more forbidding and mysterious. Then, darkness like death.

*Steep Trails*

Chapter V (p. 93)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

## LAW

**Babbage, Charles** 1792–1871  
English mathematician

The more man inquires into the laws which regulate the material universe, the more he is convinced that all its varied forms arise from the action of a few simple principles. These principles themselves converge, with accelerating force, towards some still more comprehensive law to which all matter seems to be submitted. Simple as that law may possibly be, it must be remembered that it is only one amongst an infinite number of simple laws: that each of these laws has consequences at least as extensive as the existing one, and therefore that the Creator who selected the present law must have foreseen the consequences of all other laws.

In John D. Barrow

*Theories of Everything: The Quest for Ultimate Explanation*

Chapter Two (p. 16)

The Clarendon Press. Oxford. London. 1991

**Bartusiak, Marcia**

No biographical data available

According to “Turner’s Law,” the invocation of the tooth fairy should not occur more than once in any scientific argument.

*Thursday’s Universe*

Chapter 8 (p. 207)

Random House, Inc. New York, New York, USA. 1986

**Bernard, Claude** 1813–78

French physiologist

But physicians have nothing to do with what is called the law of large numbers, a law which, according to a great mathematician’s expression, is always true in general and false in particular.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section ix (p. 138)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bloch, Arthur** 1948–  
American humorist

Negative expectations yield negative results.

Positive expectations yield negative results.

*Murphy’s Law*

The Nonreciprocal Laws of Expectation (p. 21)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Bohm, David** 1917–92  
American physicist

Indeed, the laws of chance are just as necessary as the causal laws themselves.

*Causality and Chance in Modern Physics*

Chapter One (p. 23)

University of Pennsylvania Press. Philadelphia, Pennsylvania, USA. 1957

**Boule, Pierre** 1912–94  
French novelist

...if they do only one jump, you know, there’s a fifty per cent chance of an injury. Two jumps it’s eighty percent. The third time, it’s dead certain they won’t get off Scot free. You see? It’s not a question of training, but the law of averages.

Translated by Xan Fielding

*The Bridge Over the River Kwai*

Part Two, Chapter 8 (p. 67)

The Vanguard Press, Inc. New York, New York, USA. 1954

**Boutroux, Émile** 1845–1921  
French philosopher

That which we call the laws of nature is the sum total of the methods we have discovered for adapting things to the mind, and subjecting them to be moulded by the will.

*Natural Law in Science and Philosophy* (p. 217)

The Macmillan Company. New York, New York, USA. 1914

**Burt, W. A.**

No biographical data available

The testimony of experiment is the ultimate criterion of truth, but experiment itself is impossible unless we assume that Nature is an intelligible order, that is, that its baffling complexity can be reduced to the simplicity of law.

In W.J. Greenstreet

*Isaac Newton*

The Contemporary Significance of Newton’s Metaphysics (p. 139)

G. Bell & Sons Ltd. London, England. 1927

**Casti, John L.** 1943–  
American mathematician

A law explains a set of observations; a theory explains a set of laws. The quintessential illustration of this jump in level is the way in which Newton’s theory of mechanics explained Kepler’s law of planetary motion. Basically,



a law applies to observed phenomena in one domain (e.g., planetary bodies and their movements), while a theory is intended to unify phenomena in many domains. Thus, Newton's theory of mechanics explained not only Kepler's laws, but also Galileo's findings about the motion of balls rolling down an inclined plane, as well as the pattern of oceanic tides. Unlike laws, theories often postulate unobservable objects as part of their explanatory mechanism. So, for instance, Freud's theory of mind relies upon the unobservable ego, superego, and id, and in modern physics we have theories of elementary particles that postulate various types of quarks, all of which have yet to be observed.

*Searching for Certainty: How Scientists Predict the Future*

Chapter One (p. 27)

William Morrow & Company, Inc. New York, New York, USA. 1990

### Coates, Robert M.

No biographical data available

In the course of the committee's investigations, it had been discovered, to everyone's dismay, that the Law of Averages had never been incorporated into the body of federal jurisprudence, and though the upholders of States' Rights rebelled violently, the oversight was at once corrected, both by Constitutional amendment and by a law — the Hills–Sloop Act — implementing it. According to the Act, people were required to be average, and, as the simplest way of assuring it, they were divided alphabetically and the permissible activities catalogued accordingly.

*The World of Mathematics* (Volume 3)

The Law (p. 2271)

Simon & Schuster. New York, New York, USA. 1956

### Collingwood, Robin George 1889–1943

English historian and philosopher

The scientist collects crude facts, but he stores only what he has converted them into: laws. Laws are the body of science. Laws are what it is a scientist's business to come at. Laws are what a master-scientist has to teach. Laws are what a pupil-scientist has to learn.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*

Part II, Chapter XXXI, aphorism 31.28 (p. 248)

At The Clarendon Press. Oxford, England. 1942

### Davy, Sir Humphry 1778–1829

English chemist

The appearances of the greater number of natural objects are originally delightful to us; and they become still more so when the laws by which they are governed are known, and when they are, associated with ideas of order and utility. The study of nature, therefore, in her various operations must be always more or less connected with the love of the beautiful and sublime...

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 24)

Press of the Royal Institution of Great Britain. London. 1802

### de Jouvenel, Bertrand 1903–87

French man of letters

I believe neither in chance nor in miracle, but only in phenomena regulated by laws.

In Ludwig Buchner

*Force and Matter* (p. 80)

Truth Seeker. New York, New York, USA. 1950

### de Moivre, Abraham 1667–1754

French-born mathematician

...as it is thus demonstrable that there are, in the constitution of things, certain Laws according to which Events happen, it is no less evident from Observation, that these Laws serve to wise, useful and beneficent purposes, to preserve the steadfast Order of the Universe, to propagate the several Species of Beings, and furnish to the sentient Kind such degrees of happiness as are suited to their State.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play* (3<sup>rd</sup> edition)

A Method of Approximating the Sum of the Terms of the Binomial...

(p. 252)

Printed for Millar. London, England. 1756

### Deming, William Edwards 1900–93

American statistician, educator, and consultant

It would be splendid if all action required in social, economic, and industrial planning could be based on scientific laws; but actually, so many of the laws remain yet to be discovered that most action must be taken on the basis of knowledge of the subject matter in related fields.

*Statistical Adjustment of Data* (p. 11)

John Wiley & Sons, Inc. New York, New York, USA. 1938

### Dewey, John 1859–1952

American philosopher and educator

Scientific principles and laws do not lie on the surface of nature. They are hidden, and must be wrested from nature by an active and elaborate technique of inquiry.

*Reconstruction in Philosophy*

Chapter II (p. 32)

Beacon Press. Boston, Massachusetts, USA. 1920

### Dirac, Paul Adrian Maurice 1902–84

English theoretical physicist

The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty is only that the application of these laws leads to equations much too complicated to be soluble.

*Quantum Mechanics of Many-Electron Systems*

*Proceedings of the Royal Society*, Volume 123, Number 792, 6 April

1929 (p. 714)

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

It is one thing for the human mind to extract from the phenomena of nature the laws which it has itself put into them; it may be a far harder thing to extract laws over which it has had no control.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter XII (p. 200)

At The University Press. Cambridge, England. 1921

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

The Greeks, says Mr. Galton, if they had known of the law of errors [the precision of the mean of a large number of observations], would have personified and deified it; the moderns should at least respect it as the most universal law of nature.

On the Representation of Statistics by Mathematical Formula (concluded)

*Journal of the Royal Statistical Society*, Volume XLII, 1899 (p. 552)

**Einstein, Albert** 1879–1955

German-born physicist

Who would be so venturesome as to decide today the question whether causal law and differential law, these ultimate premises of Newton's treatment of nature, must definitely be abandoned.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1927

Isaac Newton (p. 207)

Government Printing Office. Washington, D.C. 1928

The general laws of nature are to be expressed by equations which hold good for all the systems of co-ordinates, that is, are co-variant with respect to any substitutions whatever (generally co-variant).

*Proceedings of the American Catholic Philosophical Association*, Volume 11, 1935

As far as the laws of mathematics refer to reality, they are not certain; and as far as they are certain, they do not refer to reality.

*Sidelights on Relativity*

Geometry and Experience (p. 28)

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

...there is no logical way to the discovery of these elemental laws. There is only the way of intuition, which is helped by a feeling for the order lying behind the appearance.

In Max Planck

*Where Is Science Going?*

Prologue (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

A law cannot be definite for the one reason that the conceptions with which we formulate it develop and may prove insufficient in the future. There remains at the bottom of every thesis and of every proof some remainder of the dogma of infallibility.

*Cosmic Religion, with Other Opinions and Aphorisms*

On Science (p. 100)

Covici-Fiede. New York, New York, USA. 1931

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

A man does not tie his shoe without recognizing laws which bind the farthest regions of nature: moon, planet, gas, crystal, are concrete geometry and numbers.

*The Works of Ralph Waldo Emerson* (Volume 1)

Essays

Second Series

Nature (p. 356)

Harper & Brothers. New York, New York, USA. 1925

**Euclid of Alexandria** 325 BCE–265 BCE

Greek mathematician

The laws of nature are but the mathematical thoughts of God.

In Stanley Gudder

*A Mathematical Journey* (p. 112)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Faraday, Michael** 1791–1867

English physicist and chemist

How wonderful it is to me the simplicity of nature when we rightly interpret her laws and how different the convictions which they produce on the mind in comparison with the uncertain conclusions which hypothesis or even theory present.

*The Correspondence of Michael Faraday* (Volume 2)

Faraday to Svanberg, August 16, 1850 (p. 430)

Institution of Electrical Engineers. London, England. 1991

**Feynman, Richard P.** 1918–88

American theoretical physicist

There is also a rhythm and a pattern between the phenomena of nature which is not apparent to the eye, but only to the eye of analysis; and it is these rhythms and patterns which we call Physical Laws.

*The Character of Physical Law*

Chapter 1 (p. 13)

British Broadcasting Company. London, England. 1965

This is common to all our laws; they all turn out to be simple things, although complex in their actual actions.

*The Character of Physical Law*

Chapter 1 (p. 33)

British Broadcasting Company. London, England. 1965

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

From a long view of the history of mankind — seen from, say, ten thousand years from now — there can be little doubt that the most significant event of the 19<sup>th</sup> century will be judged as Maxwell's discovery of the laws of electrodynamics. The American Civil War will pale into provincial insignificance in comparison with this important scientific event of the same decade.

*The Feynman Lectures on Physics* (Volume 2)

Chapter 1–6 (p. 1–11)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

### **Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

Nor is it of much importance to us to know the manner in which nature executes her laws; it is enough if we know the laws themselves. It is of real use to know that china left in the air unsupported will fall and break; but *how* it comes to fall, and *why* it breaks, are matters of speculation. It is a pleasure indeed to know them but we can preserve our china without it.

*The Complete Works in Philosophy, Politics, and Morals, of the Late Dr. Benjamin Franklin* (Volume 1)

*Opinions and Conjectures*

Section 19 (p. 224)

Printed for J. Johnson. London, England. 1806

### **Frazer, Sir James George** 1854–1941

Scottish classicist and anthropologist

We must remember that at bottom the generalisations of science or, in common parlance, the laws of nature are merely hypotheses devised to explain that ever-shifting phantasmagoria of thought which we dignify with the high-sounding names of the world and the universe.

*The Golden Bough: A Study in Magic and Religion* (Volume 1)

Abridged edition, Chapter LXIX (p. 712)

The Macmillan Company. New York, New York, USA. 1922

### **Freeman, R. Austin** 1862–1943

British physician and mystery novelist

But when I came to reflect on the facts observed, I was struck by their singularity. Moustache hairs are shed very freely, but they do not drop out at regular intervals. One, two, or more hairs in any one box would not have been surprising. A man who was in the habit of pulling or stroking his moustache might dislodge two or three at once. The surprising thing was the regularity with which these hairs occurred; one, and usually one only, in each box, and no complete box in which there was none. It was totally opposed to the laws of probability.

*A Certain Dr. Thorndyke*

Thorndyke Connects the Links (p. 282)

Dodd, Mead & Company. New York, New York, USA. 1928

### **Friend, Julius W.**

European historian

### **Feibleman, James K.** 1904–87

American philosopher

If nature is not subject to law, then the whole of science is a fruitless proceeding.

*What Science Really Means*

Chapter IV (p. 95)

George Allen & Unwin Ltd. London, England. 1937

### **Froude, James Anthony** 1818–94

English historian and biographer

Superstition, hero worship, ignorance of the laws of probability, religious, political, or speculative prejudice. One or other of these has tended from the beginning to give us distorted pictures.

*Short Studies on Great Subjects* (Volume 2)

Scientific Method Applied to History (p. 470)

Charles Scribner's Sons. New York, New York, USA. 1890

### **Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

...the process of evolution on this earth, so far as we can judge, has been carried out neither with intelligence nor truth, but entirely through the routine of various sequences, commonly called "laws," established or necessitated we know not how.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (p. 197)

AMS Press. New York, New York, USA. 1973

### **Gamow, George** 1904–68

Russian-born American physicist

If and when all the laws governing physical phenomena are finally discovered, and all the empirical constants occurring in these laws are finally expressed through the four independent basic constants, we will be able to say that physical science has reached its end, that no excitement is left in further explorations, and that all that remains to a physicist is either tedious work on minor details or the self-educational study and adoration of the magnificence of the completed system. At that stage physical science will enter from the epoch of Columbus and Magellan into the epoch of *National Geographic Magazine*.

Any Physics Tomorrow?

*Physics Today*, Volume 2, Number 1, January 1949 (p. 18)

### **Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

If one were not animated with the desire to discover laws, they would often escape the most enlightened attention.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 43)

Cambridge University Press. Cambridge, England. 1978

### **Gibbon, Edward** 1737–94

English historian

...but the laws of probability, so true in general, so fallacious in particular...

In M.M. Reese (ed.)  
*Gibbon's Autobiography*  
Life and Visitors in Lausanne (p. 124)  
Routledge & Kegan Paul. London, England. 1971

**Harker, Alfred** 1859–1939

American petrologist

...the laws of physics and chemistry must be the same in a crucible as in the larger laboratory of Nature.

*The Natural History of Igneous Rocks*  
Chapter XII (p. 282)  
Hafner Publishing Company. New York, New York, USA. 1965

**Heinlein, Robert A.** 1907–88

American science fiction writer

Natural laws have no pity.

*Time Enough for Love*  
Second Intermission (p. 369)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

In physics, we can only work with the assumption that we have natural laws. If we have no natural laws, then anything can happen, and we can only describe what we see, and that's all.

In Paul Buckley and F. David Peat (eds.)  
*Glimpsing Reality: Ideas in Physics and the Link to Biology*  
Werner Heisenberg (p. 15)  
University of Toronto Press. Toronto, Ontario, Canada. 1996

**Herschel, Sir John Frederick William**

1792–1871

English astronomer and chemist

We must never forget that it is principles not phenomena, — laws, not insulated, independent facts, which are the objects of inquiry of the natural philosopher.

*A Preliminary Discourse on the Study of Natural Philosophy*  
Part I, Chapter I, Section 10 (pp. 13–14)  
Longman, Rees, Orme, Brown & Green. London, England. 1831

**Holton, Gerald** 1922–

Research professor of physics and science history

**Roller, Duane H. D.** ?–1994

Science historian

If we liken the facts to be explained to fish in a pond, then the law or set of laws is the net with which we make the catch. It may turn out that our particular net is not fine enough to haul in all fish, large and small, but it may still be quite satisfactory for supplying our ordinary needs. We may go even further and maintain that to be useful at all, our conceptual schemes, like our nets, must contain holes; if it were otherwise (if, so to speak, we were to go fishing with large buckets instead of nets), we should

not be able to distinguish between the significant and the trivial, the fish and the water.

*Foundations of Modern Physical Science*  
Chapter 15 (p. 260)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**Hopper, Grace Murray** 1906–92

Computer compiler

If you do something once, people will call it an accident. If you do it twice, they call it a coincidence. But do it a third time and you've just proven a natural law.

In Ethlie Ann Vare and Greg Ptacek  
*Mothers of Invention*  
From Eggbeaters to Eggheads (p. 187)  
Quill. New York, New York, USA. 1987

**Hospers, John**

No biographical data available

**Hopper, Grace Murray** 1906–92

Computer compiler

The laws of science are not viewed in independence of one another. Together they form a vast body or system of laws, with each law fitting into a system including many other laws, each mutually reinforcing the others. The laws that scientists are most loathe to abandon are those that form such an integral part of a system of laws that the abandonment of the one law would require the abandonment or alteration of a larger number of other laws in the system. Thus an observation that directly confirms one law indirectly confirms a group of laws, because of the interconnection of the laws in a system.... whether or not something is called a law, then, depends to a large extent on how deeply embedded it is in a wider system of laws.

In E.D. Klemke, Robert Hollinger and A. David Kline  
*Introductory Readings in the Philosophy of Science*  
Laws (p. 110)  
Prometheus Books. Buffalo, New York, USA. 1980

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

The laws of physics are governed by a process of intellectual natural selection. When they make correct predictions they survive. When they make incorrect predictions they become extinct. Physicists then look for new laws that do not make incorrect predictions.

*Frontiers of Astronomy*  
Chapter Eighteen (p. 318)  
Harper & Row, Publishers. New York, New York, USA. 1955

It is not only the smallest features of the Universe that are controlled by the laws of physics. The behavior of matter on the very large scale that concerns us in astronomy is also determined by physics. The heavenly bodies dance like puppets on strings. If we are to understand why

they dance as they do, it is necessary to find out how the strings are manipulated.

*Frontiers of Astronomy*

Chapter Three (p. 40)

Harper & Row, Publishers. New York, New York, USA. 1955

**Huxley, Thomas Henry** 1825–85

English biologist

You have all heard it repeated, I dare say, that men of science work by means of induction and deduction, and that by the help of these operations, they, in a sort of sense, wring from Nature certain other things, which are called natural laws... To hear all these large words, you would think that the mind of a man of science must be constituted differently from that of his fellow men; but if you will not be frightened by terms, you will discover that you are quite wrong, and that all these terrible apparatus are being used by yourselves every day and every hour of your lives.

*Collected Essays* (Volume 2)

*Darwiniana*

On Our Knowledge of the Causes of the Phenomena of Organic Nature, Section III (p. 364)

Macmillan & Company Ltd. London, England. 1904

“Law” means a rule which we have always found to hold good, and which we expect always will hold good.

*Collected Essays* (Volume 1)

*Method and Result*

On Descartes’ “Discourse Touching the Method of Using One’s Reason Rightly and of Seeking Scientific Truth”, Volume I (p. 193)

Macmillan & Company Ltd. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

...as the sciences have developed further, the notion has gained ground that most, perhaps all, of our laws are only approximations.

*Pragmatism: A New Name for Some Old Ways of Thinking*

Lecture II (p. 43)

Longmans, Green & Company. London, England. 1914

**Jevons, William Stanley** 1835–82

English economist and logician

“It is the glory of God,” said Solomon, “to conceal a thing, but the glory of a king to search it out.” The laws of nature are the invaluable secrets which God has hidden, and it is the kingly prerogative of the philosopher to search them out by industry and sagacity.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter VII (p. 126)

Macmillan & Company Ltd. London, England. 1887

**Johnson, George** 1952–

American science writer

In *Zen and the Art of Motorcycle Maintenance*, Phaedrus, the author Robert Pirsig’s alter ego, is sitting outside a

motel room in the West, drinking whiskey with his traveling companions and listening to his son, Chris, tell ghost stories. “Do you believe in ghosts?” Chris asks his father. “No,” Phaedrus says. “They contain no matter and have no energy and therefore, according to the laws of science, do not exist except in people’s minds.” Then he pauses and reflects: “Of course, the laws of science contain no matter and have no energy either and therefore do not exist except in people’s minds.”

*Fire in the Mind: Science, Faith, and the Search for Order*

Phaedrus’s Ghosts (p. 24)

Alfred A. Knopf. New York, New York, USA. 1995

**Kadanoff, Leo P.**

Theoretical physicist and applied mathematician

...all the richness of structure observed in the natural world is not a consequence of the complexity of physical law, but instead arises from the many-times repeated application of quite simple laws.

Complete Structure from Simple Systems

*Physics Today*, Volume 44, Number 3, March 1991 (p. 9)

**Kaplan, Abraham** 1918–93

American philosopher of science, author and educator

...laws serve to explain events and theories to explain laws; a good law allows us to predict new facts and a good theory new laws. At any rate, the success of prediction... adds credibility to the beliefs which led to it, and a corresponding force to the explanations they provide.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter IX, Section 40 (p. 346)

Chandler Publishing Company. San Francisco, California, USA. 1964

**Kingsley, Charles** 1819–75

English clergyman and author

It does seem to me strange, to use the mildest word, that people whose destiny it is to live, even for a few short years, on this planet which we call the earth, and who do not at all intend to live on it as hermits... should in general be so careless about the constitution of this same planet, and of the laws and facts on which depend, not merely their comfort and their wealth, but their health and their very lives, and the health and the lives of their children and descendants.

*Town Geology*

Preface (pp. xv–xvi)

D. Appleton & Company. New York, New York, USA. 1873

**Krass, F.**

No biographical data available

*Dieselbe Ordnung waltet iberall:*

*Im wechselvollen Reigen der Gestirne*

*Gebietet das Gesetz nach Mass und Zahl,*

*Wie in des Menschen denkendem Gehirne.*

The same order rules everywhere; the law of measure and number rules in the changeful hosts of the stars as it does in man's thinking brain.

In Ludwig Buchner

*Force and Matter* (p. 103)

Truth Seeker. New York, New York, USA. 1950

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Surrounded as we are by an infinite variety of phenomena, which continually succeed each other in the heavens and on the earth, philosophers have succeeded in recognizing the small number of general laws to which matter is subject in its motions. To them, all nature is obedient; and every thing is as necessarily derived from them, as the return of the seasons; so that the curve which is described by the lightest atom that seems to be driven at random by the winds, is regulated by laws as certain as those which confine the planets to their orbits.

*System of the World* (Volume 1)

Book II, Chapter VI (p. 221)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

All events, even those which on account of their insignificance do not seem to follow the great laws of nature, are a result of it just as necessarily as the revolutions of the sun. In ignorance of the ties which unite such events to the entire system of the universe, they have been made to depend upon final causes or upon hazard, according as they occur and are repeated with regularity, or appear without regard to order; but these imaginary causes have gradually receded with the widening bounds of knowledge and disappear entirely before sound philosophy, which sees in them only the expression of our ignorance of the true causes.

*A Philosophical Essay on Probabilities*

Chapter II (p. 3)

Dover Publications, Inc. New York, New York, USA. 1951

**Mauldin, Bill (William) Henry** 1921–2003

Editorial cartoonist

I feel like a fugitive from th' law of averages.

*Up Front*

Cartoon caption (p. 39)

Henry Holt & Company. New York, New York, USA. 1945

**Maxwell, James Clerk** 1831–79

Scottish physicist

The only laws of matter are those which our minds must fabricate, and the only laws of mind are fabricated for it by matter.

In Gerald M. Edelman

*Bright Air, Brilliant Fire: On the Matter of the Mind*

Chapter 3 (p. 16)

Basic Books. New York, New York, USA. 1992

If we are to ever discover the laws of nature, we must do so by obtaining the most accurate acquaintance with the

facts of nature, and not by dressing up in philosophical language the loose opinions of men who had no knowledge of the facts which throw most light on these laws.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1873*

Action at a Distance (p. 257)

Government Printing Office. Washington, D.C. 1874

**Meyerson, Emile** 1859–1933

Polish-born French chemist

In fact, we only attain laws by violating nature, by isolating more or less artificially a phenomenon from the whole, by checking those influences which would have falsified the observation. Thus the law cannot directly express reality. The phenomenon as it is envisaged by it, the "pure" phenomenon, is rarely observed without our intervention, and even with this it remains imperfect, disturbed by accessory phenomena.... Doubtless, if nature were not ordered, if it did not present us with similar objects, capable of furnishing generalized concepts, we could not formulate laws.

Translated by Kate Loewenberg

*Identity & Reality*

Chapter I (pp. 31 & 32)

George Allen & Unwin Ltd. London, England. 1930

**Michelson, Albert Abraham** 1852–1931

German-American physicist

The more important fundamental laws and facts of physical science have all been discovered, and these are now so firmly established that the possibility of their ever being supplanted in consequence of new discoveries is exceedingly remote...our future discoveries must be looked for in the sixth place of decimals.

*Light Waves and Their Uses*

Lecture II (pp. 23, 24)

The University of Chicago Press. Chicago, Illinois, USA. 1903

**Mill, John Stuart** 1806–73

English political philosopher and economist

When this phraseology [laws of Nature] was introduced, the poets and mythologists soon took hold of it and made it subservient to their purposes. Nature was personified: the phrase law of Nature...became a law laid down by the goddess Nature to be obeyed by her creatures. From the poets, this fictitious personage speedily penetrated into the closets of the philosopher...

In Ann P. Robson and John M. Robson (eds.)

*The Collected Works of J.S. Mill*

Volume XXII, Letter to the Republican, 3 January 1823 (p. 9)

University of Toronto Press. Toronto, Ontario, Canada. 1977

**Mitchell, Maria** 1818–89

American astronomer and educator

The laws which regulate the influence of sun and planets are complex; the nature of the influence is not yet

understood. The telescope, the spectroscope, and the camera are all at work, and although the unknown must always be infinite, Nature yields one truth after another to the earnest seeker.

In Helen Wright  
*Sweeper in the Sky*  
Chapter 11 (p. 219)  
Macmillan & Company. New York, New York, USA. 1949

The laws of nature...are not discovered by accident; theories do not come by chance even to the greatest minds; they are not born of the hurry and worry of daily toil; they are diligently sought; they are patiently waited for, they are received with cautious reserve, they are accepted with reverence and awe. And until able women have given their lives to investigation, it is idle to discuss their capacity for original work.

In Helen Wright  
*Sweeper in the Sky*  
Chapter 10 (pp. 203–204)  
The Macmillan Company. New York, New York, USA. 1949

The immense spaces of creation cannot be spanned by our finite powers; these great cycles of time cannot be lived even by the life of a race. And yet, small as is our whole system compared with the infinitude of creation, brief as is our life compared with cycles of time, we are tethered to all by the beautiful dependencies of law, that not only the sparrow's fall is felt to the outermost bound, but the vibrations set in motion by the words that we utter reach through all space and the tremor is felt through all time.

In Helen Wright  
*Sweeper in the Sky*  
Chapter 11 (p. 227)  
Macmillan & Company. New York, New York, USA. 1949

**Oersted, Hans Christian** 1777–1851  
Danish physicist and chemist

Added to this we already see numerous indications of a future, in which the chemical and mechanical laws of nature will be more intimately united. In short, the natural laws of chemistry, as well as those of mechanics, are laws of Reason, and both are so intimately connected, that they must be viewed as a unity of Reason.

*The Soul in Nature with Supplementary Contributions*  
All Existence a Dominion of Reason (p. 104)  
Henry C. Bohn. London, England. 1852

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

The scientist is not responsible for the laws of nature, but it is a scientist's job to find out how these laws operate. It is the scientist's job to find ways in which these laws can serve the human will. However, it is not the scientist's job to determine whether a hydrogen bomb should be used. This responsibility rests with the American people

and their chosen representatives.

In Lewis Wolpert and Alison Richards  
*A Passion for Science*  
Chapter 1 (p. 9)  
Oxford University Press, Inc. Oxford, England. 1988

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

The fact that the universe is governed by simple natural laws is remarkable, profound and on the face of it absurd. How can the vast variety in nature, the multitude of things and processes all be subject to a few simple, universal laws?

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Two, Chapter 1 (p. 160)  
Simon & Schuster. New York, New York, USA. 1985

Instead of finding an absolute universal law at the bottom of existence, they [scientists] may find an endless regress of laws, or even worse, total confusion and lawlessness — an outlaw universe.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Three, Chapter 1 (p. 264)  
Simon & Schuster. New York, New York, USA. 1985

**Pearson, Karl** 1857–1936  
English mathematician

Scientific Law is [a] description, not a prescription.  
The Grammar of Science (p. 87)  
Charles Scribner's Sons. London, England. 1892

**Planck, Max** 1858–1947  
German physicist

Thus from the outset we can be quite clear about one very important fact, namely, that the validity of the law of causation for the world of reality is a question that cannot be decided on grounds of abstract reasoning.

*Where Is Science Going?*  
Chapter IV (p. 113)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

Self-determination is given to us by our consciousness and is not limited by any causal law...

Translated by R. Jones and D.H. Williams  
*A Survey of Physics: A Collection of Lectures and Essays*  
Dynamical Laws and Statistical Laws (p. 68)  
Methuen & Company Ltd. London, England. 1925

How do we discover the individual laws of Physics, and what is their nature? It should be remarked, to begin with, that we have no right to assume that any physical law exists, or if they have existed up to now, that they will continue to exist in a similar manner in the future. It is perfectly conceivable that one fine day Nature should cause an unexpected event to occur which would baffle us all; and if this were to happen we would be powerless to make any objection, even if the result would be that, in spite of our endeavors, we should fail to introduce order

into the resulting confusion. In such an event, the only course open to science would be to declare itself bankrupt. For this reason, science is compelled to begin by the general assumption that a general rule of law dominates throughout Nature...

Translated by Walter Henry Johnston

*The Universe in the Light of Modern Physics* (p. 62)

W.W. Norton & Company, Inc. New York, New York, USA. 1931

...the outside world is something independent from man, something absolute, and the quest for the laws which apply to this absolute appeared to me as the most sublime scientific pursuit in life.

*Scientific Autobiography and Other Papers*

A Scientific Autobiography (p. 13)

Philosophical Library. New York, New York, USA. 1949

### **Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

The Author of nature has not given laws to the universe, which, like the institutions of men, carry in themselves the elements of their own destruction. He has not permitted, in his works, any symptom of infancy or of old age, or any sign by which we may estimate either their future or their past duration. He may put an end, as he no doubt gave a beginning, to the present system, at some determinate period; but we may safely conclude, that this great catastrophe will not be brought about by any of the laws now existing, and that it is not indicated by anything which we perceive.

*Illustrations of the Huttonian Theory of the Earth*

Section 118 (pp. 119–120)

Dover Publications, Inc. New York, New York, USA. 1964

Amid all the revolutions of the globe, the economy of nature has been uniform, and her laws are the only thing that have resisted the general movement. The rivers and the rocks, the seas and the continents have changed in all their parts; but the laws [to] which they are subject have remained invariably the same.

*Illustrations of the Huttonian Theory of the Earth*

Section 373 (p. 421)

Dover Publications, Inc. New York, New York, USA. 1964

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Are the laws of acceleration, the rule of the composition of forces only arbitrary conventions! Conventions, yes; arbitrary, no; they would be so if we lost sight of the experiments which let the creators of the science to adopt them, and which, imperfect as they may be, suffice to justify them. It is well that from time to time our attention is carried back on the experimental origin of these conventions.

*The Foundations of Science*

Science and Hypothesis, Chapter VI (p. 106)

The Science Press. New York, New York, USA. 1913

### **Polanyi, Michael** 1891–1976

Hungarian-born English scientist philosopher, and social scientist

Now, I am not suggesting that it is impossible to find natural laws; but only that this is not done, and cannot be done, by applying some explicitly known operation...

*Science, Faith, and Society*

Science and Reality (p. 22)

The University of Chicago Press. Chicago, Illinois. 1964

### **Poynting, John Henry** 1852–1914

English physicist

We must confess that physical laws have greatly fallen off in dignity. No long time ago they were quite commonly described as the Fixed Laws of Nature, and were supposed sufficient in themselves to govern the universe. Now we can only assign to them the humble rank of mere descriptions, often erroneous, of similarities which we believe we have observed.... A law of nature explains nothing, it has no governing power, it is but a descriptive formula which the careless have sometimes personified.

In J. Arthur Thomson

*The System of Animated Nature* (Volume 1)

Lecture I (p. 9)

William & Norgate. London, England. 1920

A law may fail or cease to be true, not because Nature has changed her ways, but because we have failed in our statement of likenesses, or because we learn new details with which our old description does not tally.

*Collected Scientific Papers*

Physical Law and Life, 1903 (p. 686)

At The University Press. Cambridge, England. 1920

### **Rowland, Henry Augustus** 1848–1901

American physicist

He who makes two blades of grass grow where one grew before is the benefactor of mankind; but he who obscurely worked to find the laws of such growth is the intellectual superior as well as the greater benefactor of the two.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aim of the Physicist (p. 669)

Johns Hopkins Press. Baltimore, Maryland, USA. 1902

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The discovery that all mathematics follows inevitably from a small collection of fundamental laws is one which immeasurably enhances the intellectual beauty of the whole; to those who have been oppressed by the fragmentary and incomplete nature of most existing chains of deduction this discovery comes with all the overwhelming force of a revelation; like a palace emerging from the autumn mist as the traveler ascends an Italian hill-side, the stately stories of the mathematical edifice appear in their due order and proportion, with a new perfection in every part.



*Mysticism and Logic and Other Essays*

Chapter IV (pp. 67–68)

Longmans, Green &amp; Company. London, England. 1925

The discovery of causal laws is the essence of science and therefore there can be no doubt that scientific men do right to look for them. If there is any region where there are no causal laws, that region is inaccessible to science. But the maxim [is] that mushroom gatherers should seek mushrooms.

*Religion and Science*

Determinism (pp. 146–147)

Henry Holt &amp; Company. New York, New York, USA. 1935

Scientific laws, when we have reason to think them accurate, are different in form from the common-sense rules which have exceptions: they are always, at least in physics, either differential equations or statistical averages.

*The Analysis of Matter*

Chapter XIX (p. 191)

Harcourt, Brace &amp; Company, Inc. New York, New York, USA. 1927

**Sagan, Carl** 1934–96

American astronomer and author

There is something stunningly narrow about how the Anthropic Principle is phrased. Yes, only certain laws and constants of nature are consistent with our kind of life. But essentially the same laws and constants are required to make a rock. So why not talk about a Universe designed so rocks could one day come to be, and strong and weak Lithic Principles? If stones could philosophize, I imagine Lithic Principles would be at the intellectual frontiers.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 3 (p. 38)

Random House, Inc. New York, New York, USA. 1994

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

**Schwarzschild, Martin** 1912–97

German American Astronomer

If simple perfect laws uniquely rule the universe, should not pure thought be capable of uncovering this perfect set of laws without having to lean on the crutches of tenuously assembled observations? True, the laws to be discovered may be perfect, but the human brain is not. Left on its own, it is prone to stray, as many past examples sadly prove. In fact, we have missed few chances to err until new data freshly gleaned from nature set us right again for the next steps. Thus pillars rather than crutches are the observations on which we base our theories; and for the theory of stellar evolution these pillars must be there before we can get far on the right track.

*Structure and Evolution of the Stars*

Chapter 1 (p. 1)

Princeton University Press. Princeton, New Jersey, USA. 1958

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

Biological laws, seen subtly, can make a girl proud.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #316 (p. 139)

Definition Press. New York, New York, USA. 1972

**Slosson, Edwin E.** 1865–1929

American chemist and journalist

There are no laws in nature. What we call the “laws of nature” are the memory schemes we invent to aid us in grasping a lot of facts at one time. When our knowledge is growing rapidly, as it is now, we have to shift to new and larger formulas very suddenly. But this requires stretching the mind to take in bigger ideas, which is as painful a process as stretching an unused muscle. No wonder we tend to dodge it.

*Chats on Science*

Chapter LXXX (pp. 248–249)

G. Bell &amp; Sons Ltd. London, England. 1924

**Snow, Charles Percy** 1905–80

English novelist and scientist

Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: Have you read a work of Shakespeare’s?

*The Two Cultures: And a Second Look*

Chapter I (pp. 14–15)

At The University Press. Cambridge, England. 1964

**Titchener, Edward Bradford** 1867–1927

English-born American psychologist

The formulation of a scientific law, therefore, means the final writing of some paragraph in some chapter of that book of the world which contains all the different sciences.

*A Text-Book of Psychology*

Subject-Matter, Method and Problem of Psychology, Section 1 (p. 5)

The Macmillan Company. New York, New York, USA. 1912

**Tolstoy, Leo** 1828–1910

Russian writer

Only by reducing this element of free will to the infinitesimal, that is, by regarding it as an infinitely small quantity, can we convince ourselves of the absolute inaccessibility of the causes, and then instead of seeking causes, history will take the discovery of laws as its problem.

*In Great Books of the Western World (Volume 51)**War and Peace*

Second Epilogue, Chapter XI (p. 694)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

In effect, it would be very singular that all nature, all the planets, should obey eternal laws, and that there should be a little animal five feet high, who, in contempt of these laws, could act as he pleased, solely according to his caprice.

*The Best Known Works of Voltaire*

Ignorant Philosophers

Chapter XIII (p. 428)

Blue Ribbon Books. New York, New York, USA. 1940

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

A law of nature, however, is not a mere logical conception that we have adopted as a kind of *memoria technicai* to enable us to more readily remember facts. We of the present day have already sufficient insight to know that the laws of nature are not things which we can evolve by any speculative method. On the contrary, we have to discover them in the facts; we have to test them by repeated observation or experiment, in constantly new cases, under ever-varying circumstances; and in proportion only as they hold good under a constantly increasing change of conditions, in a constantly increasing number of cases with greater delicacy in the means of observation, does our confidence in their trustworthiness rise.

*Popular Lectures on Scientific Subjects*

Lecture VIII (p. 370)

D. Appleton &amp; Company. New York, New York, USA. 1885

**Weyl, Hermann** 1885–1955

German mathematician

To gaze up from the ruins of the oppressive present toward the stars is to recognise the indestructible world of laws, to strengthen faith in reason, to realise the “*harmonia mundi*” that transfuses all phenomena, and never has been, nor will be, disturbed.

Translated by Henry L. Brose

*Space — Time — Matter*

Preface to the Third Edition (p. x)

Dover Publications, Inc. New York, New York, USA. 1922

**Wheeler, John Archibald** 1911–

American physicist and educator

There is no law except that there is no law.

In John D. Barrow

*The World within the World* (p. 293)

Clarendon Press. Oxford, England. 1988

**Whewell, William** 1794–1866

English philosopher and historian

The number and variety of the laws which we find established in the universe is so great, that it would be idle to endeavor to enumerate them. In their operation

they are combined and intermixed in incalculable and endless complexity, influencing and modifying each other’s effects in every direction.

*The Bridgewater Treatises on the Power, Wisdom, and Goodness of God as Manifested in the Creation* (Treatise III)

Astronomy and General Physics Considered with Reference to Natural Theology

Chapter III (p. 12)

Carey, Lea &amp; Blanchard. Philadelphia, Pennsylvania, USA. 1833

But with regard to the material world, we can at least go so far as this — we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws.

In *Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection* (p. xi)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The laws of physics are the decrees of fate.

*Science and the Modern World*

Chapter I (p. 16)

The Macmillan Company. New York, New York, USA. 1929

Laws are statements of observed facts.

*Adventures of Ideas*

Chapter VII (p. 148)

The Macmillan Company. New York, New York, USA. 1956

If the law states a precise result, almost certainly it is not precisely accurate; and thus even at the best the result, precisely as calculated, is not likely to occur.

*An Introduction to Mathematics*

Chapter 3 (p. 16)

Oxford University Press, Inc. New York, New York, USA. 1958

**Wilson, Edward O.** 1929–

American biologist and author

The laws of biology are written in the language of diversity.

The Coming Pluralization of Biology and the Stewardship of Systematics

*BioScience*, Volume 39, Number 4, April 1989 (p. 243)**LAW OF GRAVITATION****Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

If there were no matter in the universe, the law of gravitation would fall to the ground.

Gravitation and the Principle of Relativity

*Nature*, Volume 101, Number 2523, March 7, 1918 (p. 17)**LAW OF NATURE****Camus, Albert** 1913–60

Algerian-French novelist, essayist, and playwright

The laws of nature may be operative up to a certain limit, beyond which they turn against themselves to give birth to the absurd.

Translated by Justin O'Brien  
*The Myth of Sisyphus and Other Essays*  
 Philosophical Suicide (p. 37)  
 Alfred A. Knopf. New York, New York, USA. 1961

**Commoner, Barry** 1917–  
 American biologist, ecologist, and educator

The separation of the laws of nature among the different sciences is a human conceit; nature itself is an integrated whole.

*Science and Survival*  
 Chapter 2 (p. 25)  
 The Viking Press. New York, New York, USA. 1966

**Dumas, Jean Baptiste-Andre** 1800–84  
 French biochemist

Everything must give way to the laws of Nature, and he alone who has mastered those laws can control her processes. But the mastery cannot be obtained with a struggle. The fable of Proteus is a true picture of the combat between man, eager for knowledge, and the stubborn guardian, charged with the protection of the secrets of destiny. Proteus changed himself into a thousand shapes before speaking, and yielded only to the hero who, far from being moved by his transformations, bound him with bands of ever increasing strength. Such is Nature herself, her answers are always truthful, but like the ancient shepherd of Neptune's flocks, before allowing Truth to shine forth, she arrays herself in the garments of error, or hides herself behind the phantom of illusion, and will only assume her proper shape under the determined assaults of a resolute disciple of Science.

The Faraday Lecture  
*Chemical News and Journal of Physical Science*, Volume V, No. 3, 1870 (p. 122)

**Feuerbach, Ludwig** 1804–72  
 German philosopher

Who suspends one law of nature suspends them all.

In Ludwig Buchner  
*Force and Matter*  
 Chapter VII (p. 44)  
 Trubner & Company. London, England. 1864

**Fisher, H. A. L.** 1865–1940  
 English historian

The fact of progress is written plain and large on the page of history; but progress is not a law of nature.

*A History of Europe*  
 Preface (p. v)  
 Edward Arnold Publishers Ltd. London, England. 1936

**Hawking, Stephen William** 1942–  
 English theoretical physicist

...there are grounds for cautious optimism that we may now be near the end of the search for the ultimate laws of nature.

*A Brief History of Time: From the Big Bang to Black Holes*  
 Chapter 10 (p. 156)  
 Bantam Books. Toronto, Ontario, Canada. 1988

**Herschel, Sir John Frederick William** 1792–1871  
 English astronomer and chemist

But the laws of nature are not only permanent, but consistent, intelligible, and discoverable with such a moderate degree of research, as is calculated rather to stimulate than to weary curiosity.

*The Cabinet of Natural Philosophy*  
 Part I, Chapter III, Section 33 (pp. 42–43)  
 Longman, Rees, Orme, Brown & Green. London, England. 1831

**Huxley, Thomas Henry** 1825–95  
 English biologist

The chess-board is the world; the pieces are the phenomena of the universe; the rules of the game are what we call the laws of Nature. The player on the other side is hidden from us. We know that his play is always fair, just, and patient. But also we know, to our cost, that he never overlooks a mistake, or makes the smallest allowance for ignorance.

*Lay Sermons, Addresses and Reviews*  
 A Liberal Education (pp. 31–32)  
 New York, New York, USA. 1872

**Lynch, John Joseph**  
 No biographical data available

The laws of nature are written deep in the folds and faults of the earth. By encouraging men to learn those laws one can lead them further to a knowledge of the Author of all laws.

*New York Times*, December 5, 1963

**Mather, Kirtley F.** 1888–1978  
 American geologist

The laws of nature are not chains which shackle man, nor gods which drive him down any predetermined alley. They are tools which strengthen his hands and increase his efficiency; implements which have waited long for his master mind to make them useful.

In Edward H. Cotton  
*Has Science Discovered God?*  
 Sermons from Stones (p. 17)  
 Thomas Y. Crowell Company. New York, New York, USA. 1931

**Needham, Joseph** 1900–95  
 English biochemist and sinologist

There was no confidence that the code of Nature's laws could be unveiled and read, because there was no assurance that a divine being, even more rational than ourselves, had ever formulated such a code capable of being read.

*The Grand Titration: Science and Society in East and West* (p. 350)  
University of Toronto Press. Toronto, Ontario, Canada. 1969

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

The laws of physics are generally looked upon as a paradigm of exactitude. Therefore one would naturally take it for granted that probably no other science would be able to give such a clear and definite answer when asked what is meant when we speak of the law of nature.

*Science and the Human Temperament*

Chapter VI (p. 133)

W.W. Norton & Company, Inc. New York, New York, USA. 1935

**Scriven, Michael**  
No biographical data available

The most interesting fact about laws of nature is that they are virtually all known to be in error.

In H. Feigl and G. Maxwell (eds.)

*Current Issues in the Philosophy of Science — Proceedings of Section L of the American Association for the Advancement of Sciences*

The Key Property of Physical Laws — Inaccuracy (p. 91)

Holt, Rinehart & Winston. New York, New York, USA. 1961

**Weyl, Hermann** 1885–1955  
German mathematician

The truth as we see it today is this: The laws of nature do not determine uniquely the one world that actually exists.

*Symmetry*

Bilateral Symmetry (p. 27)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

The regularities in the phenomena which physical science endeavors to uncover are called the laws of nature. The name is actually very appropriate. Just as legal laws regulate actions and behavior under certain conditions but do not try to regulate all action and behavior, the laws of physics also determine the behavior of its objects of interest only under certain well-defined conditions but leave much freedom otherwise.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1914

Events, Laws of Nature, and Invariance principles (p. 6)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

## LAW OF VARIATION

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

All that is shown to the eye; and one of the most beautiful results of mathematics is the means of showing to the eye the law of variation, however complicated, of one independent variable.

*Popular Lectures and Addresses* (Volume 1)

Presidential Address  
Birmingham and Midland Institute  
October 3, 1883 (p. 274)  
Macmillan & Company Ltd. London, England. 1894

## LEARNING

**Barzun, Jacques** 1907–  
French-born American educator, historian, and educator

The school has not taught how to learn; now it wants to climb that Mt. Everest of intellect, critical thought. Critical thinking can only be learned by the discussion of an idea which is part of a subject, under the guidance of an able thinker. Thinking is like piano-playing; it is shown, not taught.

*Begin Here: The Forgotten Conditions of Teaching and Learning* (p. 46)  
The University of Chicago Press. Chicago, Illinois, USA. 1991

**Bryson, Lyman**  
No biographical data available

No man...can choose to do what he never heard of doing or never thought of doing. In this sense, the ultimate measure of freedom is knowledge and we learn in order to be free.

*Science and Freedom*

What Is Freedom?, Section II (p. 13)

Columbia University Press. New York, New York, USA. 1947

**Carson, Rachel** 1907–64  
American marine biologist and author

It is more important to pave the way for the child to want to know than to put him on a diet of facts he is not ready to assimilate.

*The Sense of Wonder* (p. 45)

Harper & Row, Publishers. New York 1984

**Dennett, Daniel Clement** 1942–  
American philosopher

...we often learn more from bold mistakes than from cautious equivocation.

*Consciousness Explained*

Preface (p. xi)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Ferris, Timothy** 1944–  
American science writer

Our ignorance, of course, has always been with us, and always will be. What is new is our awareness of it, our awakening to its fathomless dimensions, and it is this, more than anything else, that marks the coming of age of our species. Space may have a horizon and time a stop, but the adventure of learning is endless.

*Coming of Age in the Milky Way*

Chapter 20 (p. 383)

William Morrow & Company, Inc. New York, New York, USA. 1988

**Garrett, A. B.**

No biographical data available

Learning is motivated by intent and understanding by visualization.

Visualization: A Step to Understanding

*Journal of Chemical Education*, Volume 25, Number 10, October 1948 (p. 544)

**Hemingway, Ernest** 1899–1961

American novelist, short-story writer and journalist

There are some things which cannot be learned quickly, and time, which is all we have, must be paid heavily for their acquiring. They are the very simplest things...

*Death in the Afternoon*

Chapter Sixteen (p. 192)

Charles Scribner's Sons. New York, New York, USA. 1955

**Hoffmann, Banesh** 1906–86

Mathematician and educator

If you have read thus far, there is no dignified way of escape left to you. You have paid your fare, and climbed to the highest peak of the roller-coaster. You have therefore let yourself in for the inevitable consequences. It is no use trying to back out. You had warning in the preface of what to expect, and if contemplation of the heights there described makes you giddy and apprehensive, I cannot accept responsibility. The going will be rough, but I can promise you excitement aplenty. So hold tight to your seat and hope for the best. We are about to push off into vertiginous space.

*The Strange Story of the Quantum*

Chapter XII (p. 71)

Dover Publications, Inc. New York, New York, USA. 1959

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The easiest and surest way of acquiring facts is to learn them in groups, in systems, and systematized knowledge is science. You can very often carry two facts fastened together more easily than one by itself, as a house-maid can carry two pails of water with a hoop more easily than one without it.

*Medical Essays*

Scholastic and Bedside Teaching (p. 287)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Kingsley, Charles** 1819–75

English clergyman and author

No amount of book learning will make a man a scientific man: nothing but patient observation, and quiet and fair thought over what he has observed. He must go out for himself, compare and judge for himself, in the field, in the quarry, the cutting. He must study rocks, ores, fossils, in the nearest museum; and thus store his head, not with words, but with facts. He must verify — as far as he

can — what he reads in books, by his own observation; and be slow to believe in anything, even on the highest scientific authority, till he has either seen it, or something like enough to it to make it seem to him probable, or at least possible. So, and so only, will he become a scientific man, and a good geologist...

*Town Geology*

Preface (p. ix–x)

D. Appleton & Company. New York, New York, USA. 1873

**Landau, Edmund** 1877–1938

German mathematician

Please forget whatever you've been studying at school; for you have not learned it.

Translated by F. Steinhardt

*Foundations of Analysis: The Arithmetic of Whole, Rational, Irrational and Complex Numbers*

Preface to the Student (p. v)

Chelsea Publishing Company. Bronx, New York, USA. 1951

**Lowell, Percival** 1855–1916

American astronomer

That we are in some wise kin to all the rest of the cosmos science has been steadily demonstrating more and more clearly. The essential oneness of the universe is the goal to which all learning tends.

*Mars*

Chapter I, 1 (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Pythagoras of Samos** ca. 580 BCE–500 BCE

Greek mathematician, astronomer, and philosopher

The learning of many things does not teach intelligence...

In G.S. Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 260 (p. 218)

At The University Press. Cambridge, England. 1963

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

William James used to preach the “will to believe.” For my part, I should wish to preach the “will to doubt....” “What is wanted is not the will to believe, but the wish to find out, which is the exact opposite.

*Skeptical Essays*

Chapter XII (pp. 154, 157)

W.W. Norton & Company, Inc. New York, New York, USA. 1928

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

And this our life, exempt from public haunt,  
Find tongues in trees, books in the running brooks,  
Sermons in stones, and good in every thing.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

As You Like It  
Act II, Scene i, 1:125  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...and children

Have lost, or do not learn for want of time,  
The science that could become our country...

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The Life of King Henry Fifth  
Act V, Scene ii, 1.56–58  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Wheeler, John Archibald** 1911–

American physicist and educator

...how can anyone learn anything new who does not find it a shock.

*A Journey into Gravity and Spacetime* (p. 39)  
Scientific American Library. New York, New York, USA. 1990

## LECTURE

### **Feynman, Richard P.** 1918–88

American theoretical physicist

OMNI: As we came back to the office, you stopped to discuss a lecture on color vision you'll be giving. That's pretty far from fundamental physics, isn't it? Wouldn't a physiologist say you were "poaching?"

Feynman: Physiology? It has to be physiology? Look, give me a little time and I'll give a lecture on anything in physiology. I'd be delighted to study it and find out all about it, because I can guarantee you it would be very interesting. I don't know anything, but I do know that everything is interesting if you go into it deeply enough.

In Jeffrey Robbins, ed.  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 9 (p. 203)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

I am Professor Feynman, in spite of this suit-coat. I usually give lectures in shirtsleeves, but when I started out of the hotel this morning my wife said, "You must wear a suit." I said, "But I usually give lectures in shirtsleeves." She said, "Yes, but this time you don't know what you're talking about so you had better make a good impression..." So, I got a coat.

What Is and What Should Be the Role of Scientific Culture in Modern Society  
*Supp. Al Nuovo Cimento*, Volume 4, 1966

### **Huxley, Thomas Henry** 1825–95

English biologist

The object of lectures is, in the first place, to awaken the attention and excite the enthusiasm of the student; and this, I am sure, may be effected to a far greater extent by the oral discourse and by the personal influence of a

respected teacher than in any other way. Secondly, lectures have the double use of guiding the student to the salient points of a subject, and at the same time forcing him to attend to the whole of it, and not merely to that part which takes his fancy. And lastly, lectures afford the student the opportunity of seeking explanations of those difficulties which will, and indeed ought to, arise in the course of his studies.

*Collected Essays* (Volume 8)  
*Discourses, Biological and Geological*  
A Lobster; or, The Study of Zoology (p. 217)  
Macmillan & Company Ltd. London, England. 1904

### **Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Lectures were once useful; but now, when all can read, and books are so numerous, lectures are unnecessary. If your attention fails, and you miss a part of a lecture, it is lost; you cannot go back as you do upon a book.... People have nowadays got a strange opinion that everything should be taught by lectures. Now, I cannot see that lectures can do as much good as reading the books from which the lectures are taken. I know nothing that can be best taught by lectures, except where experiments are to be shown. You may teach chymistry by lectures. You might teach making shoes by lectures!

*Boswell's 'Life of Samuel Johnson'*  
15 April, 1781 (p. 1136)  
Oxford University Press, Inc. Oxford, England. 1965

### **Miller, Hugh** 1802–56

Scottish geologist and theologian

My lecture contains but little...Such is the scantiness of the materials on which I had to work, that it could not have contained much: if according to the dramatist, the "amount be beggarly," it is because the "boxes are empty."

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Eleventh (p. 462)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

### **Termier, Pierre** 1859–1930

French geologist

It is always necessary to close a lecture on geology with humility.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*  
The Drifting of the Continents (p. 236)  
Government Printing Office. Washington, D.C. 1925

### **Wächtershäuser, Günter**

International patent lawyer

Ladies and gentlemen, throughout my lecture I have presented to you nothing but speculation.

In J. and K. Tran Thon Van, J.C. Mounolou, J. Schneider and C. Mckay (eds.)

*Frontiers of Life*

Order Out of Order: Heritage of the Iron-Sulfur World

## LEMMA

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

If it were always necessary to reduce everything to intuitive knowledge, demonstration would often be insufferably prolix. This is why mathematicians have had the cleverness to divide the difficulties and to demonstrate separately the intervening propositions. And there is art also in this; for as the mediate truths (which are called lemmas, since they appear to be a digression) may be assigned in many ways, it is well, in order to aid the understanding and memory, to choose of them those which greatly shorten the process, and appear memorable and worthy in themselves of being demonstrated. But there is another obstacle, viz.: that it is not easy to demonstrate all the axioms, [or] to reduce demonstrations wholly to intuitive knowledge. And if we had chosen to wait for that, perhaps we should not yet have the science of geometry.

Translated by Peter Remnant and Jonatha Bebbett

*New Essays on Human Understanding*

Book 4, Chapter 2, 8

Cambridge University Press. Cambridge, England. 1981

## LEPROSY

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Her skin was as white as leprosy

The nightmare life-in-death was she.

*The Rime of the Ancient Mariner and Other Poems*

Rime of the Ancient Mariner, Part III, l. 189

Little Leather Library Corporation. New York, New York, USA. 1915

## LEVER

**Archimedes of Syracuse** 287 BCE–212 BCE

Sicilian mathematician

Give me a place on which to stand and I will move the world.

In Ebenezer Cobham Brewer

*A guide to Roman History* (p. 321)

Jarrod & Son. London, England. 1852

**Graham, L. A.**

No biographical data available

See Saw, Marjorie Daw,

She rocked — and learned the lever law.

She saw that he weighed more than she

For she sat higher up than he,

Which made her cry, excitedly,

“To see saw, it is plain to see,

There must be an equality

“Twixt You times X and Y times Me.”

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 19

Dover Publications, Inc. New York, New York, USA. 1959

## LIBERALITY

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

In New York, there are ninety different Christian denominations; each one confessing God the Lord in its own way without being led astray by the others. In science, indeed in research in general, we must achieve this, for what can it mean when everyone speaks of liberality and then wants to prevent others from thinking and expressing themselves in their own way.

In Karl J. Fink

*Goethe's History of Science*

Part IV (p. 127)

Cambridge University Press. Cambridge, England. 1991

## LIFE

**Abbey, Edward** 1927–89

American environmentalist and nature writer

I understand and sympathize with the reasonable needs of a reasonable number of people on a finite continent. All life depends upon other life. But what is happening today, in North America, is not rational use but irrational massacre. Man the Pest, multiplied to the swarming stage, is attacking the remaining forests like a plague of locusts on a field of grain.

*The Journey Home: Some Words in Defense of the American West*

Chapter 19 (p. 208)

E.P. Dutton & Company, Inc. New York, New York, USA. 1977

**Ackerman, Diane** 1948–

American writer

Astronauts returning from orbit have marveled at how little of human life can be seen from space — not the wars or political boundaries, not the cities or farms, not the subtleties of custom, adolescence, or love.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Insect Love (p. 173)

Vintage Books. New York, New York, USA. 1997

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

The system of life on this planet is so astoundingly complex that it was a long time before man even realised that it was a system at all and that it wasn't something that was just there.

*The Ultimate Hitchhiker's Guide to the Galaxy*

Last Chance to See  
Chapter 21 (p. 415)  
The Ballantine Book Company. New York, New York, USA. 2002

**Ardrey, Robert** 1908–80  
American anthropologist

As life is larger than man, so is life wiser than we are. As evolution has made us possible, so will evolution sit in final judgment. As natural selection declared us in, so natural selection should our hubris overcome us... declare us out.

*The Social Contract: A Personal Inquiry into the Evolutionary Sources of Order and Disorder*

The Risen Ape (pp. 367–368)  
Atheneum. New York, New York, USA. 1970

**Ball, Philip** 1962–  
English science writer

That we live on land is, in the grander scheme of things, best regarded as an anomaly, or even an eccentricity — albeit with sound evolutionary justification. The story of life is, if we retain a true sense of proportion, a story of life at sea.

*Life's Matrix: A Biography of Water*

Part Three, Chapter 8 (p. 223)  
Farrar, Straus & Giroux. New York, New York, USA. 2000

**Ballard, Robert** 1942–  
American oceanographer

The fact that this chain of life existed in the black cold of the deep sea and was utterly independent of sunlight — previously thought to be the font of all Earth's life — has startling ramifications. If life could flourish there, nurtured by a complex chemical process based on geothermal heat, then life could exist under similar conditions on planets far removed from the nurturing light of our parent star, the Sun.

*Explorations: My Quest for Adventure and Discovery Under the Sea*

Chapter Six (pp. 188–189)  
Hyperion. New York, New York, USA. 1995

**Bates, Marston** 1906–74  
American zoologist

Life in both the forest and the sea is distributed in horizontal layers.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*

Chapter 2 (p. 19)  
Random House, Inc. New York, New York, USA. 1960

**Bernal, John Desmond** 1901–71  
Irish-born physicist and x-ray crystallographer

The beauty of life is, therefore, geometrical beauty of a type that Plato would have much appreciated.

*The Origin of Life*

Preface (p. xiii)  
The World Publishing Company. Cleveland, Ohio, USA. 1967

The question of the origin of life is essentially speculative. We have to construct, by straightforward thinking on the basis of very few factual observations, a plausible and self consistent picture of a process which must have occurred before any of the forms which are known to us in the fossil record could have existed.

*The Origin of Life*

Chapter 1 (p. 2)  
The World Publishing Company. Cleveland, Ohio, USA. 1967

Life is a partial, continuous, progressive, multiform and conditionally interactive self-realization of the potentialities of atomic electron states...

*The Origin of Life*

Preface (p. xv)  
The World Publishing Company. Cleveland, Ohio, USA. 1967

Men will not be content to manufacture life: they will want to improve on it.

*The World, the Flesh and the Devil: An Enquiry into the Future of the Three Enemies of the Rational Soul*

Chapter III (p. 45)  
Indiana University Press. Bloomington, Indiana, USA. 1969

**Bernard, Claude** 1813–78  
French physiologist

If I had to define life in a single phrase, I should clearly express my thought by throwing into relief the one characteristic which, in my opinion, sharply differentiates biological science. I should say: life is creation.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Two, Chapter II, Section I (p. 93)  
Henry Schuman, Inc. New York, New York, USA. 1927

It is not by struggling against cosmic conditions that the organism develops and maintains its place; on the contrary, it is by an adaptation to, an agreement with, these conditions. So, the living being does not form an exception to the great natural harmony which makes things adapt themselves to one another; it breaks no concord; it is neither in contradiction to nor struggling against general cosmic forces; far from that, it forms a member of the universal concert of things, and the life of the animal, for example, is only a fragment of the total life of the universe.

In William Maddock Bayliss

*Principles of General Physiology*

Preface (p. xvii)  
Longmans, Green & Company. London, England. 1920

**Berrill, Norman John** 1903–96  
English-born American biologist

Life can be thought of as water kept at the right temperature in the right atmosphere in the right light for a long enough period of time.

*You and the Universe*

Chapter 15 (p. 117)  
Dodd, Mead & Company. New York, New York, USA. 1958



**Blumenberg, Hans** 1920–  
German philosopher

The combined circumstances that we live on Earth and are able to see stars — that the conditions necessary for life do not exclude those necessary for vision, and vice versa — is a remarkably improbable one.

This is because the medium [in] which we live is, on the one hand, just thick enough to enable us to breathe and to prevent us from being burned up by cosmic rays, while, on the other hand, it is not so opaque as to absorb entirely the light of the stars and block any view of the universe. What a fragile balance between the indispensable and the sublime.

*The Genesis of the Copernican World*

Introduction (p. 3)

The MIT Press. Cambridge, Massachusetts, USA. 1987

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

...the existence of life must be considered as an elementary fact that cannot be explained, but must be taken as a starting point in biology, in a similar way as the quantum of action, which appears as an irrational element from the point of view of classical mechanical physics, taken together with the existence of elementary particles, forms the foundation of atomic physics.

Light and Life

*Nature*, Volume 131, Number 3309, April 1, 1933 (p. 458)

**Borland, Hal** 1900–78  
American writer

The year holds one moment, which may last for a week, when tree and bush and vine are on the breathless verge of leafing out.

*Borland Country*

The Moment (p. 20)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

We are the survivors, all of us, not of a man-made holocaust but of infinitely more powerful and enduring forces, the surge of life, the rhythm of change, and the infinity of time.

*The Enduring Pattern*

Foreword (pp. 6–7)

Simon & Schuster. New York, New York, USA. 1959

Life persists, and so does its ultimate source, call it what you will. Man is a unique form of that life, but not alien to it. He happens to live in the midst of life on this earth, this particular small unit of a universe about which he actually has only a smattering of knowledge.

*The Enduring Pattern*

Foreword (p. 5)

Simon & Schuster. New York, New York, USA. 1959

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

They [early life] were but shapes in the dark, yet ordained soon to emerge into a brighter day at the head of a procession that spread with abundant triumph over the whole earth.

*Parade of the Living*

Part I, Chapter III (p. 35)

Coward-McCann, Inc. New York, New York, USA. 1930

The history of life on earth is more than a collection of shells and bones in a cabinet. It is more than a procession of changing forms and functions. It is a dramatic spectacle.

*Parade of the Living*

Apologia

Coward-McCann, Inc. New York, New York, USA. 1930

Not until creatures had grown to a size observable by the crude vision of man and his microscope, not until they had developed skeletons that could resist decay and become fossilized while their mud sepulchers were turning to stone, did they leave any certain records. The parade of living things through time began in a way we can never understand, in an age we can never know, just as it will end in a manner nobody can foresee, at a time that is lost over the dark horizon of the future.

*Parade of the Living*

Part I, Chapter III (p. 27)

Coward-McCann, Inc. New York, New York, USA. 1930

Living things are the result of a special, perhaps a unique combination of conditions. They stand small, weak, and alone in a wilderness of the dead. Cruel forces beat upon them and reduce them whenever possible to the unleavened clay from which they sprang.

*Parade of the Living*

Part I, Chapter II (p. 13)

Coward-McCann, Inc. New York, New York, USA. 1930

**Brooks, W. K.**

No biographical data available

Every reflective biologist must know that no living being is self-sufficient, or would be what it is, or would be at all, if it were not part of the natural world.... Living things are real things...but their reality is in their interrelations with the rest of nature, and not in themselves.

*Heredity and Variation: Logical and Biological*

*Proceedings of the American Philosophical Society*, Volume 45, April 20, 1906 (p. 74)

**Buck, Pearl S.** 1892–1973

American author

None but the ignorant can be bored by life. To the lovers of learning, life is pure adventure shared with adventurers.

*The Delights of Learning*

Address delivered on the occasion of the University of Pittsburgh Honors Convocation, April 6, 1960

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
English Romantic poet and satirist

‘Tis very certain the desire of life  
Prolongs it: this is obvious to the physicians,  
When patients, neither plagued with friends nor wife,  
Survive through very desperate conditions.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 44

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

The perplexity of life arises from there being too many  
interesting things in it for us to be interested properly in  
any of them.

*Tremendous Trifles*

The Secret of a Train (p. 8)

Dodd, Mead & Company. New York, New York, USA. 1909

**Claude, Albert** 1898–1983  
Belgian-American cytologist

Life, this anti-entropy, ceaselessly reloaded with energy,  
is a climbing force, toward order amidst chaos, toward  
light, among the darkness of the indefinite, toward the  
mystic dream of Love, between the fire which devours  
itself and the silence of the Cold. Such a Nature does not  
accept abdication, nor skepticism.

*Nobel Lectures, Physiology or Medicine 1971–1980*

Nobel lecture for award received in 1974

The Coming Age of the Cell

World Scientific Publishing Company. Singapore. 1992

**Cloud, Preston Ercele** 1912–91  
American biogeologist, paleontologist, and humanist

The gossamer web of life, spun on the loom of sunlight  
from the breath of an infant Earth, is nature’s crowning  
achievement on this planet.

*Oasis in Space: Earth History from the Beginning*

Chapter Two (p. 42)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

Elements and stars, planets and time, air and water —  
what would these things be without intelligent life to il-  
luminate them with perception and insight.

*Cosmos, Earth and Man: A Short History of the Universe*

Chapter 11 (p. 143)

Yale University Press. New Haven, Connecticut, USA. 1978

**Coman, Dale Rex** 1906–  
American research physician and wildlife writer

The search for some ultimate significance in the uni-  
verse, and in our little transient role in it, the compulsion  
to learn, to know, to find the truth, to answer questions  
and to solve problems — these constitute the essence of  
an aware existence, the central core of intelligent life.

*The Endless Adventure*

Once There Was a Planet (p. 184)  
Henry Regnery Company. Chicago, Illinois, USA. 1972

Life is a cruise on which one is already embarked, not a  
port toward which to steer.

*The Endless Adventure*

The Eagles as March Arrives (p. 120)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Cousteau, Jacques-Yves** 1910–77  
French naval officer and ocean explorer

The adventure of life as explored by man is truly a mys-  
tery tale. As in any good detective story, the evidence has  
been present all along but not until many apparently un-  
related facts were put together could logical conclusions  
solve the mystery.

*The Ocean World of Jacques Cousteau: The Adventure of Life*

Chapter I (p. 10)

The World Publishing Company. New York, New York, USA. 1973

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

An honest man, armed with all the knowledge available  
to us now, could only state that in some sense, the origin  
of life appears to be almost a miracle, so many are the  
conditions which would have had to have been satisfied  
to get it going.

*Life Itself: Its Origin and Nature* (p. 88)

Simon & Schuster. New York, New York, USA. 1981

**Cuvier, Georges** 1769–1832  
French zoologist and statesman

The development of life, the success of its forms, the  
precise determination of those organic types that first  
appeared, the simultaneous birth of certain species and  
their gradual extinction — the solution of these ques-  
tions would perhaps enlighten us regarding the essence  
of the organism as much as all the experiments that we  
can try with living species. And man, to whom has been  
granted but a moment’s sojourn on the earth, would gain  
the glory of tracing the history of the thousands of ages  
which preceded his existence and of the thousands of be-  
ings that have never been his contemporaries.

In John Noble Wilford

*The Riddle of the Dinosaur*

Chapter 1 (p. 23)

Alfred A. Knopf. New York, New York, USA. 1986

**Czapek, Frederick** 1868–1921

Life is, therefore, quite inseparable from chemical reac-  
tions, and on the whole what we call life is nothing else  
but a complex of innumerable chemical reactions in the  
living substance which we call protoplasm.

*Chemical Phenomena in Life*

Chapter VI (p. 63)

Harper & Brothers. London, England. 1911

**Dampier-Whetham, William** 1867–1952  
English scientific writer

Life...may be regarded either as a negligible accident in a bye-product of the cosmic process, or as the supreme manifestation of the high effort of creative evolution, for which the Earth alone, in the chances of time and space, has given a fitting home.

*A History of Science*  
Chapter X (p. 482)  
The Macmillan Company. New York, New York, USA. 1936

**Darwin, Erasmus** 1731–1802  
English physician and poet

Organic Life beneath the shoreless waves  
Was born, and nurs'd in Ocean's pearly caves;  
First forms minute, unseen by spheric glass,  
Move on the mud, or pierce the watery mass;  
These, as successive generations bloom,  
New powers acquire, and larger limbs assume;  
Whence countless groups of vegetation spring,  
And breathing realms of fin, and feet, and wing.

*The Botanic Garden*  
Production of Life, Canto I, V, l. 295–302 (pp. 14–15)  
Jones & Company. London, England. 1825

**Delaney, John**  
No biographical data available

...once life evolves, it tends to cover its tracks.  
*The Sciences*, July/August 1998

**Dewey, John** 1859–1952  
American philosopher and educator

In the degree in which life is uneasy and troubled, fancy is stirred to frame pictures of a contrary state of things. By reading the characteristic features of any man's castles in the air you can make a shrewd guess as to his underlying desires which are frustrated.

*Reconstruction in Philosophy*  
Chapter V (p. 104)  
Beacon Press. Boston, Massachusetts, USA. 1920

**Douglas, Norman** 1868–1952  
English writer

All life is a concession to the improbable.  
*South Wind*  
Chapter L (p. 417)  
The Book League of America. New York, New York, USA. 1929

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

From a drop of water...a logician could infer the possibility of an Atlantic or a Niagara without having seen or heard of one or the other. So all life is a great chain, the nature of which is known whenever we are shown a single link of it.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
A Study in Scarlet, Chapter 2 (p. 158)  
Wings Books. New York, New York, USA. 1967

**Dyson, Freeman J.** 1923–  
American physicist and educator

Why is life so complicated?  
*Origins of Life*  
Chapter 4 (p. 60)  
Cambridge University Press. Cambridge, England. 1985

**Eckstein, Gustav** 1875–16  
Scientist, physiologist, and writer

...life [is] the sum of forces that resist death.  
*The Body Has a Head*  
Chapter II, Physicist (p. 43)  
Little, Brown & Company. Boston, Massachusetts, USA. 1983

## Editorial

The fundamental distinction between the living and the non-living is that whilst it is possible to isolate the phenomena of the inorganic world, it is impossible to consider a living organism apart from its environment; it is, in fact, its reaction and adaptations to changes in its surroundings which distinguish the living from the inanimate and forms the basis of the science of biology.

Life and Death  
*Nature*, Volume 122, Number 3075, October 6, 1928 (p. 501)

**Einstein, Albert** 1879–1955  
German-born physicist

Conscious man, to be sure, has at all times been keenly aware that life is an adventure, that life must, forever, be wrested from death.

*Out of My Later Years* (p. 4–5)  
Thames & Hudson. London, England. 1950

**Eiseley, Loren C.** 1907–77  
American anthropologist, educator, and author

Men argue learnedly over whether life is chemical chance or antichance, but they seem to forget that the life in chemicals may be the greatest chance of all, the most mysterious and unexplainable property in matter.

*The Firmament of Time*  
Chapter VI, Part III (p. 172)  
Athenaeum. New York, New York, USA. 1960

**Feinberg, Gerald** 1933–92  
American physicist

**Shapiro, Robert**  
No biographical data available

...were we gifted with the vision of the whole Universe of life, we would not see it as a desert sparsely populated with identical plants which can survive only in rare

specialized niches. Indeed, we would envision something closer to a botanical garden, with countless species, each thriving in its own setting.

*Life Beyond Earth: The Intelligent Earthling's Guide to Life in the Universe*

Chapter 14 (pp. 435–436)

William Morrow & Company, Inc. New York, New York, USA. 1980

**Ferris, Timothy** 1944–

Science writer

Life, like the universe, rounds off to darkness where it runs out of time, and contemplation of one's death is perhaps the mainspring of astronomy and other human strivings.

*Seeing in the Dark*

Chapter 18 (p. 286)

Simon & Schuster. New York, New York, USA. 2002

**Flammarion, Camille** 1842–1925

French astronomer and author

From age to age living beings are replaced by others, and, on the continents as in the seas, if life always flourishes, it is not the same hearts which beat, it is not the same eyes which see, it is not the same lips which smile. Death lays successively in the tomb men and their affairs; but from our ashes, as from the ruins of empires, the flame of life is incessantly renewed.

*Popular Astronomy: A General Description of the Heavens*

Book I, Chapter VI (p. 68)

Chatto & Windus. London, England. 1894

**Forbes, Edward** 1815–54

English naturalist

As we descend deeper and deeper in this region its inhabitants become more and more modified, and fewer and fewer, indicating our approach towards an abyss where life is either extinguished, or exhibits but a few sparks to mark its lingering presence.

*The Natural History of the European Seas*

Chapter I (pp. 26–27)

John Van Voorst. London, England. 1859

**Foucault, Michel** 1926–1984

French philosopher and historian

Historians want to write histories of biology in the eighteenth century; but they do not realize that biology did not exist then, and that the pattern of knowledge that has been familiar to us for a hundred and fifty years is not valid for a previous period. And that, if biology was unknown, there was a very simple reason for it: that life itself did not exist. All that existed was living things, which were viewed through a grid of knowledge constituted by natural history.

*The Order of Things: An Archaeology of the Human Sciences*

Chapter 5 (pp. 127–128)

Vintage Books. New York, New York, USA. 1973

**Galton, Sir Francis** 1822–1911

English anthropologist, explorer and statistician

Life in general may be looked upon as a republic where the individuals are for the most part unconscious that while they are working for themselves they are also working for the public good.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (p. 195)

AMS Press. New York, New York, USA. 1973

**Garrison, W. M.**

No biographical data available

**Morrison D. C.**

No biographical data available

The question of the conditions under which living matter originated on the surface of the earth is still a subject limited largely to speculation.... One of the purposes of the observation reported herein is to add another fact that might have some bearing upon this interesting question.

One of the most popular current conceptions is that life originated in an organic milieu. The problem to which we are addressed is the origin of that organic milieu in the absence of any life.

*Reduction of Carbon Dioxide in Aqueous Solutions by Ionizing Radiation*

*Science*, Volume 114, Number 2964, October 19, 1951 (p. 416)

**Glazkov, Yuri** 1939–

Russian cosmonaut

The winds scatter across the planet the seeds of life to bring forth the grass and flowers and woods. The eternal winds of the universe are rushing along. What do they bring? No one knows. But I am sure that Nature has created us, endowed us with intelligence, so that we, like her servant the winds, can carry life into the vast and limitless emptiness and to its innumerable worlds. Reason should win out on Earth and then in the whole universe.

In Kevin W. Kelley

*The Home Planet*

With Plate 135

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1988

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Life is a copiously branching bush, continually pruned by the grim reaper of extinction, not a ladder of predictable progress.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter I (p. 35)

W.W. Norton & Company. New York, New York, USA. 1989

**Greenberg, J. Mayo** 1922–2001

Astrophysicist

There are messages being deciphered that tell of the existence of living material in places as inhospitable as the arctic and Antarctic as well as in geothermal vents. Were the prebiotic conditions for life to have evolved much more exotic than we had pictured? Planetary scientists, geochemists, astronomers and astrophysicists are searching for new answers.

*The Chemistry of Life's Origins*

Preface

Publisher undetermined

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

An “emergence” of life out of a Newtonian world would be a quite unintelligible miracle.

*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*

Lecture I, The Emergence of Life (p. 35)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...a feeling will gradually grow up that life on earth represents a unity, that damage at one point can have effects everywhere else, that we are jointly responsible for the ordering of life upon this our earth. From the cosmic distances to which man can penetrate by the means of modern technology, we see perhaps more clearly than from earth itself the unitary laws whereby all life on our planet is ordered.

*Across the Frontiers*

Chapter VI (p. 68)

Harper & Row, Publishers. New York, New York, USA. 1974

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

If matter exists in the universe for the purpose of life, nature would seem to tip a hogshead to fill a wineglass, when it makes life possible only on a little planet.

In W.H. Thomson

*Some Wonders of Biology* (p. 176)

Publisher undetermined

**Heyl, Paul R.**

American Scientist

There is an every day test which we all instinctively apply when we are in doubt whether a certain thing is alive. We watch for it to move.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1929*

The Lingering Dryad (p. 205)

Government Printing Office. Washington, D.C. 1930

**Holmes, Bob**

No biographical data available

...the best minds in the world may have no problem separating the quick from the dead in ordinary experience, but

they still can't agree on what life is. Living things eat, move, and excrete? So does your gas-guzzling, exhaust-belching car. Life maintains order in the face of entropy? A flame can do that. Life is the ability to replicate? Then crystals are alive but not so mules, old women and many old men.

Life Is...?

*New Scientist*, Number 2138, 13 June 1998 (pp. 38, 40)

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

The more we study the body and the mind, the more we find both to be governed, not by, but according to, laws, such as we observe in the larger universe.

*The Autocrat of the Breakfast-Table*

Chapter IV (p. 71)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

We know of no type of astronomical body in which the conditions can be favorable to life except planets like our own revolving round a sun... [O]nly an infinitesimally small corner of the universe can be in the least suited to form an abode of life.

*The Universe Around Us*

Chapter V (pp. 320, 321)

The Macmillan Company. New York, New York, USA. 1929

Is this, then, all that life amounts to? To stumble, almost by mistake, into a universe which was clearly not designed for life, and which, to all appearances, is either totally indifferent or definitely hostile to it, to stay clinging on to a fragment of a grain of sand until we are frozen off, to strut our tiny hour on our tiny stage with the knowledge that our aspirations are all doomed to final frustration, and that our achievement must perish with our race, leaving the universe as though we had never been?

*The Mysterious Universe*

Chapter I (pp. 15–16)

The Macmillan Company. New York, New York, USA. 1932

...it does not at present look as though Nature had designed the universe primarily for life; the normal star and the normal nebula have nothing to do with life except making it impossible. Life is the end of a chain of by-products; it seems to be the accident, and life-destroying radiation the essential.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

The Wider Aspects of Cosmogony (p. 177)

Government Printing Office. Washington, D.C. 1929

**Jennings, Herbert Spencer** 1868–1947

American zoologist

The universe did not become sterile with the first production of life. It is continuously creative now as in the past.

*The Universe and Life*

Chapter II (p. 51)

Yale University Press. New Haven, Connecticut, USA. 1941

In the study of the progress of life, therefore, we find no reason to doubt that life is traveling a new course, the final goal of which does not now exist, the end of which is not now predictable. Life that is upon a new adventure, life that is moving in directions not laid out beforehand, life that is transforming into what did not before exist, life that is rising to heights not before reached — this is the vision that biology presents to our eyes.

*The Universe and Life*

Chapter II (p. 65)

Yale University Press. New Haven, Connecticut, USA. 1941

[Life] will repeat the same unsuccessful experiment, the same tragic mistakes a hundred times.... In hundreds of ways, life produces imperfect types, many that cannot continue to exist even under the best of conditions.... The pathway of developing life is profusely marked with those imperfect starts, with the attempts of life to move in directions that lead but to conditions in which life is impossible.

*The Universe and Life*

Chapter II (pp. 54–55)

Yale University Press. New Haven, Connecticut, USA. 1941

**Kauffman, Stuart A.**

Theoretical biologist

Anyone who tells you that he or she knows how life started on the serene Earth some 3.45 billion years ago is a fool or a knave.

*At Home in the Universe: The Search for Laws of Self-Organization and Complexity*

Chapter 2 (p. 31)

Oxford University Press, Inc. New York, New York, USA. 1995

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Mathematics and dynamics fail us when we contemplate the earth, fitted for life but lifeless, and try to imagine the commencement of life upon it. This certainly did not take place by any action of chemistry, or electricity, or crystal-line grouping of molecules under the influence of force, or by any possible kind of fortuitous concourse of atoms. We must pause face to face with the mystery and miracle of the creation of living creatures.

Series 5, *The Age of the Earth as an Abode Fitted for Life**Philosophical Magazine*, Volume 47, 1899 (p. 89)**Krebs, Hans Adolf** 1900–81

German-born English biochemist

The existence of common features in different forms of life indicates some relationship between the different organisms, and according to the concept of evolution these relations stem from the circumstance that the

higher organisms, in the course of millions of years, have gradually evolved from simpler ones. The concept of evolution postulates that living organisms have common roots, and in turn the existence of common features is powerful support for the concept of evolution. The presence of the same mechanism of energy production in all forms of life suggests two other inferences, firstly, that the mechanism of energy production has arisen very early in the evolutionary process, and secondly, that life, in its present forms, has arisen only once.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1953

The Citric Acid Cycle (p. 409)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

...in principle, one by one, the difficulties of explaining living systems in terms of chemistry and physics disappear. “In principle” are the operative words. In practice the difficulties remain great and seem insurmountable in the foreseeable future. But, from the point of view of the theory of knowledge, there is nevertheless a decisive difference.

How the Whole Becomes More than the Sum of the Parts

*Perspectives in Biology and Medicine*, Volume 14, Number 3, Spring

1971 (p. 452)

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

No other contrast is so tremendous as this contrast between what lives and what does not.

In R.W. Moss

*Free Radical: Albert Szent-Gyorgyi and the Battle Over Vitamin C*

Chapter 19 (p. 243)

Paragon House. New York, New York, USA. 1988

**Large, E. C.**

No biographical data available

There was nothing enjoyable more than a good long wrangle about plant viruses and what was meant by “life.” But that wrangling was best left till after; until evening, when with a little alcohol to help things along, one could have a very good time, agreeing or disagreeing with each theory in turn. In the morning there was work to do.

*The Advance of the Fungi*

Chapter XXX (p. 416)

Henry Holt &amp; Company. New York, New York, USA. 1940

**Lewis, John S.**

No biographical data available

What is the best world for life? A world on which the world and its life have coevolved, accommodating each other. What is the best of all possible worlds? One that has been altered to our needs, and that we have met halfway by adapting ourselves. The best marriage of world and resident is consensual: both freely change for the

common good. This is the direction in which we are already headed. It is best to be aware of it.

*Worlds Without End: The Exploration of Planets Known and Unknown*  
Chapter 18 (p. 214)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Lewis, Wyndham** 1882–1957  
English author and painter

Every living form is a miraculous mechanism, however, and every sanguinary, vicious or twisted need produces in Nature's workshop a series of mechanical arrangements extremely suggestive and interesting for the engineer, and almost invariably beautiful or interesting for the artist.

*The Caliph's Design*  
The Physiognomy of Our Time (p. 77)  
Black Sparrow Press. Santa Barbara, California, USA. 1919

**von Liebig, Justus** 1803–73  
German organic chemist

I would more readily believe that a book on chemistry or on botany could grow out of dead matter by chemical processes.

In Lord Kelvin  
*Popular Lectures* (Volume 3)  
On the Dissipation of Energy (p. 464)  
Macmillan & Company Ltd. London, England. 1891–94

**Loeb, Jacques** 1859–1924  
German physiologist

Nothing indicates, however, at present that the artificial production of living matter is beyond the possibilities of science...

*The Mechanistic Conception of Life*  
Chapter I (p. 5)  
The University of Chicago Press. Chicago, Illinois, USA. 1912

**London, Jack** 1876–16  
American author

I believe that life is a mess. It is like yeast, a ferment, a thing that moves and may move for a minute, an hour, a year, or a hundred years, but that in the end will cease to move. The big eat the little and they may continue to move, the strong eat the weak that they may retain their strength. The lucky eat the most and move the longest, that is all.

*The Sea-Wolf*  
Chapter V (p. 50)  
The Macmillan Company. New York, New York, USA. 1931

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

The hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is that it is not unscientific.

Report of the Forty-First Meeting of the British Association for the Advancement of Science  
On the Origin Of Life  
Edinburgh, Scotland. 1871

**Lorenz, Konrad** 1903–89  
Austrian zoologist

Life itself is a process of acquiring knowledge ...

In P. Weiss  
*Hierarchically Organized Systems in Theory and Practice*  
Knowledge, Beliefs and Freedom (p. 231)  
Hafner Publishing Company. New York, New York, USA. 1971

**Lovelock, James Ephraim** 1919–  
English scientist

Like a message passed by word of mouth, the chain of life back to the remote past carries precise but inaccurate information. But it is the only way we have to conjure up what the origin might have been.

Living Alternatives  
*Nature*, Volume 320, Number 6063, 17 April, 1986 (p. 646)

**Mann, Thomas** 1875–1955  
German-born American novelist

What then was life? It was warmth, the warmth generated by a form-preserving insubstantiality, a fever of matter, which accompanied the process of ceaseless decay and repair of albumen molecules that were too impossibly complicated, too impossibly ingenious in structure.

*The Magic Mountain*  
Chapter V  
Research (p. 275)  
Alfred A. Knopf. New York, New York, USA. 1966

**Margulis, Lynn** 1938–  
American cell biologist and evolutionist

**Sagan, Dorion** 1959–  
American science writer

Life, a watery, carbon-based macromolecular system, is reproducing autopoiesis. The autopoietic view of life is circular. Life is a metabolic machine which not only reproduces but fiercely stores and uses information in order to resist breaking down.

*Microcosmos*  
Chapter 13 (p. 264)  
Summit Books. New York, New York, USA. 1986

...only life itself seems powerful enough to have promoted the conditions favoring its own prolonged survival...

*Microcosmos*  
Chapter 3 (p. 67)  
Summit Books. New York, New York, USA. 1986

**Masefield, John** 1878–  
English poet

What am I, Life?  
A thing of watery salt

Held in cohesion by unresting cells  
Which work they know not why, which never halt...

*Poems*

Sonnets (p. 357)

The Macmillan Company. New York, New York, USA. 1958

**Mather, Kirtley F.** 1888–1978

American geologist

You would surely all agree when I assert that the mystery of the origin of life upon the face of the earth is no greater than the mystery of the origin of any single individual today upon the face of the earth.

Forty Years of Scientific Thought Concerning the Origin of Life

*Journal of the Scientific Laboratories of Denison University*, Volume 22, 1927 (p. 151)

**Mathews, Albert P.**

No biographical data available

Living things are, as it were, universes. Were it possible to magnify the human body so that the positive electrons would be as large as small shot... a man would be about 10,000 times as tall as the distance from the earth to the sun. Were the electrons luminous, each individual would look like a nebula or collection of an immense number of suns, all of which would be in rapid orbital motion. There would be constellations, which we call molecules, and the atoms would be solar systems... We are in very truth minute universes, composed of quadrillions of suns and planets.

In E.V. Cowdry (ed.)

*General Cytology: A Textbook of Cellular Structure and Function for Students of Biology and Medicine*

Some General Aspects of the Chemistry of Life, Section III (pp. 20, 21)  
The University of Chicago Press. Chicago, Illinois, USA. 1924

**McCabe, Joseph** 1867–1955

English rationalist writer and ex-Franciscan priest

There is, perhaps, no other chapter in the chronicle of the earth that we approach with so lively an interest as the chapter which should record the first appearance of life. Unfortunately, as far as the authentic memorials of the past go, no other chapter is so impenetrably obscure as this. The reason is simple. It is a familiar saying that life has written its own record, the long-drawn record of its dynasties and its deaths, in the rocks. But there were millions of years during which life had not yet learned to write its record, and further millions of years the record of which has been irremediably destroyed.

*The Story of Evolution*

Chapter V (p. 41)

Publisher undetermined

**Mora, P. T.**

No biographical data available

...the presence of a living unit is exactly opposite to what we would expect on the basis of pure statistical and probability considerations.

Urge and Molecular Biology

*Nature*, Volume 199, Number 4890, July 20, 1963 (p. 215)

**Morris, Simon Conway** 1951–

English paleontologist

On a perfect planet, such as might be acceptable to a physicist, one might predict that from its origin the diversity of life would grow exponentially until the carrying capacity, however defined, was reached. The fossil record of the Earth, however, tells a very different story.

The Evolution of Diversity in Ancient Ecosystems: A Review

*Philosophical Transactions: Biological Sciences*, Volume 353, Number 1366, February 28, 1998

**Muggeridge, Malcolm** 1903–90

English journalist and social critic

Nor, as far as I am concerned, is there any recompense in the so-called achievements of science. It is true that in my lifetime more progress has been made in unraveling the composition and the mechanism of the material universe than previously in the whole of recorded history. This does not at all excite my mind, or even my curiosity. The atom has been split; the universe has been discovered, and will soon be explored. Neither achievement has any bearing on what alone interests me — which is why life exists, and what is the significance, if any, of my minute and so transitory part in it.

In Cecil Kuhne and Malcom Muggeridge

*Seeing Through the Eye. Malcom Muggeridge on Faith*(p. 24)

Ignatius Press, San Francisco, California. 2005

**Muller, Hermann Joseph** 1890–1967

American geneticist

To many an unsophisticated human being, the universe of stars seems only a fancy backdrop, provided for embellishing his own and his fellow creatures' performances. On the other hand, from the converse position, that of the universe of stars, not only all human beings but the totality of life is merely a fancy kind of rust, afflicting the surfaces of certain lukewarm minor planets. However, even when we admit our own littleness and the egotistical complexion of our interest in this rust, we remain confronted with the question: What is it that causes the rust to be so very fancy?

Life

*Science*, Volume 121, Number 3132, 7 January, 1955 (p. 1)

**Murchie, Guy** 1907–97

American biologist

Life is everywhere: slithering with the snake through nodding reeds, threading the parched desert with the kangaroo rat, swimming with the ameba in a drop of rain. Even if we project our musings beyond the world, life quickens the planets, binding them without a rope to moons, to suns, to the Pleiades...



*The Seven Mysteries of Life: An Exploration of Science and Philosophy*  
Part Three, Chapter 14 (p. 407)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

**Needham, James G.** 1868–1957  
Entomologist

...to the scientific mind the living and the non-living form one continuous series of systems of differing degrees of complexity..., while to the philosophic mind the whole universe, itself perhaps an organism, is composed of a vast number of interlacing organisms of all sizes.

Developments in Philosophy of Biology  
*Quarterly Review of Biology*, Volume III, Number 1, March 1928 (p. 79)

**Ochoa, Severo** 1905–93  
Biochemist and molecular biologist

Man has all but conquered the atom and is now preparing for the conquest of space. He has uncovered many of the secrets of inanimate matter and begins to delve deep into the frontier realm between the lifeless and the living, the world of the viruses. He may never find the clue to the nature or the meaning of life but we may look forward with confidence and anticipation to a much better comprehension of many of its riddles.

*Les Prix Nobel. The Nobel Prizes in 1959*  
Nobel banquet speech for award received in 1959  
Nobel Foundation. Stockholm, Sweden. 1960

**Oparin, Alexander Ivanovich** 1894–1980  
Russian biochemist

The epoch of interplanetary cosmic travel into which mankind just now enters opens for the science of life new vistas and distant perspectives. It may offer to us an insight into life and the pathways of its origin and development in forms that may be distinct from the terrestrial. Yet, even if, to our great disappointment, we do not discover life on our neighboring planets, we will still learn very much that is new about the pathways of evolution of organic matter which lay at the foundation of the origin of our terrestrial life.

In Cyril Ponnampertuma  
*Exobiology*  
The Appearance of Life in the Universe (p. 14)  
North-Holland Publishing Company. Amsterdam, Netherlands. 1972

Life — the word is so easy to understand, yet so enigmatic for any thoughtful person.

*Life: Its Nature, Origin and Development*  
Chapter I (p. 1)  
Academic Press, Inc. New York, New York, USA. 1962

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

We cannot in any sense be both the observers and the actors in any specific instance, or we shall fail properly to be either one or the other; yet we know that our life is

built of these two modes, is part free and part inevitable, is part creation and part discipline, is part acceptance and part effort.

*Science and the Common Understanding*  
Chapter 6 (p. 88)  
Simon & Schuster. New York, New York, USA. 1954

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

My own view is that although we do not yet know the fundamental physical laws, when and if we find them the possibility of life in a universe governed by those laws will be written into them. The existence of life in the universe is not a selective principle acting upon the laws of nature; rather it is a consequence of them.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Four, Chapter 1 (pp. 359–360)  
Simon & Schuster. New York, New York, USA. 1985

**Pasteur, Louis** 1822–95  
French chemist

And, therefore, gentlemen, I could point to that liquid and say to you, I have taken my drop of water from the immensity of creation, and I have taken it full of the elements appropriated to the development of microscopic organisms. And I wait, I watch, I question it! — begging it to recommence for me the beautiful spectacle of the first creation. But it is dumb, dumb since [the time] these experiments were begun several years ago; it is dumb because I have kept from it the only thing man does not know how to produce: from the germs which float in the air, from Life, for Life is a germ and a germ is Life. Never will the doctrine of spontaneous generation recover from the mortal blow of this simple experiment.

*Biology Through the Eyes of Faith*  
Chapter 3 (p. 93)  
Harper & Row, Publishers. San Francisco, California, USA. 1989

**Pattee, H. H.**  
No biographical data available

...when a problem persists, unresolved, for centuries in spite of enormous increase in our knowledge, it is a good bet that the problem entails the nature of knowledge itself. The nature of life is one of these problems.

In F. Morin, A. Moreno, J.J. Merelo and P. Chacón (eds.)  
*Advances in Artificial Life*  
Artificial Life Needs a Real Epistemology  
Proceedings of the Third European Conference on Artificial Life  
Granada, Spain  
June 1995

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

It is not accidental that all phenomena of human life are dominated by the search for daily bread — the oldest

link connecting all living things, man included, with the surrounding nature.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1904

Physiology of Digestion (p. 140)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

Whatever life is (and nobody can define it) it is something forever changing shape, fleeting, escaping us into death. Life is indeed the only things that can die, and it begins to die as soon as it is born, and never ceases dying. Each of us is constantly experiencing cellular death. For the renewal of our tissues means a corresponding death of them, so that death and rebirth become biologically, right and left hand of the same thing. All growing is at the same time a dying away from that which lived yesterday.

*The Road of a Naturalist*

Chapter 12 (pp. 149–150)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Perrett, J.**

No biographical data available

Life is a potentially self-perpetuating open system of linked organic reactions, catalyzed stepwise and almost isothermally by complex and specific organic catalysts which are themselves produced by the system.

Biochemistry and Bacteria

*New Biology*, Volume 12, 1952

**Ponnamperuma, Cyril** 1923–1995

Sri Lankan scientist

Physicists might eventually be able to come up with a grand unification theory that encompasses not just subatomic particles and the basic elements, but the code of life as well. Who knows? Life elsewhere in the universe may even be five feet tall and standing on two legs.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Seeds of Life (p. 3)

Ticknor & Fields. New York, New York, USA. 1984

**Poynting, John Henry** 1852–1914

English physicist

The threads of life, coming in we know not where, now twining together, now dividing, are weaving patterns of their own, ever increasing in intricacy, ever gaining in beauty.

*Collected Scientific Papers*

Presidential Address

The Mathematical and Physical Section

The British Association (Dover) 1899 (p. 612)

At The University Press. Cambridge. 1920

**Putter, A.**

No biographical data available

It [life] is the particular manner of composition of the materials and processes, their spatial and temporal organization which constitutes what we call life.

In L. von Bertalanffy

*Modern Theories of Development: An Introduction to Theoretical Biology* (p. 51)

Harper & Row Publishers. New York, New York, USA. 1962

**Pythagoras of Samos** ca. 580 BCE–500 BCE

Greek mathematician, astronomer, and philosopher

...life resembles the great and populous assembly of the Olympic games, wherein some exercise the body, that they may carry away the glory of the prize: others bring merchandise to sell for profit: there are also some (and those none of the worst sort) who pursue no other advantage than only to look on, and consider how and why everything is done, and to be spectators of the lives of other men, thereby the better to judge of and regulate their own.

In *Great Books of the Western World* (Volume 25)

*The Essays*

Of the Education of Children (p. 69)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Redi, Francesco** 1626–78

Italian physician

And, although it be a matter of daily observation that infinite numbers of worms are produced in dead bodies and decayed plants, I feel, I say, inclined to believe that these worms are all generated by insemination and that the putrefied matter in which they are found has no other office than that of serving as a place, or suitable nest, where animals deposit their eggs at the breeding season, and in which they also find nourishment....

Translated by Mab Bigeflow

*Experiments on the Generation of Insects*

Redi's Hypothesis (p. 27)

The Open Court Publishing Company, Chicago, Illinois, USA. 1909

Although content to be corrected by any one wiser than myself, if I should make erroneous statements, I shall express my belief that the Earth, after having brought forth the first plants and animals at the beginning by order of the Supreme and Omnipotent Creator, has never since produced any kinds of plants or animals, either perfect or imperfect; and everything which we know in past or present times that she has produced, came solely from the true seeds of the plants and animals themselves.

Translated by Mab Bigeflow

*Experiments on the Generation of Insects*

Redi's Hypothesis (pp. 26–27)

The Open Court Publishing Company, Chicago, Illinois, USA. 1909

**Rodbell, Martin** 1925–98

American biochemist

Life, like the first blooming, emerges tantalizing to the curious:

Why, How, When, Where;

Interlocked questions arising from the mysterious encompassing matters quite serious.

*Les Prix Nobel. The Nobel Prizes in 1994*

Nobel banquet speech for award received in 1994

Nobel Foundation. Stockholm, Sweden. 1995

### Rush, J. H.

No biographical data available

Life pushes its way through this fatalistically determined world like a river flowing upstream. It is a system of utterly improbable order, a message in a world of noise.

*The Dawn of Life*

Chapter I (p. 34)

Hanover House. Garden City, New York, USA. 1957

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

Organic life, we are told, has developed gradually from the protozoon to the philosopher, and this development, we are assured, is indubitably an advance. Unfortunately it is the philosopher, not the protozoon, who gives us this assurance, and we can have no security that the impartial outsider would agree with the philosopher's self-complacent assumption.

*Mysticism and Logic and Other Essays*

Chapter VI, Section I (p. 106)

Longmans, Green & Company. London, England. 1925

### Schrödinger, Erwin 1887–1961

Austrian theoretical physicist

Life seems to be orderly and lawful behavior of matter, not based exclusively on its tendency to go over from order to disorder, but based partly on existing order that is kept up.

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*

Chapter VI, Section 55 (p. 69)

At The University Press. Cambridge, England. 1945

### Shapiro, Robert 1935–

DNA researcher

... we desire the best available scientific status report on the origin of life. We shall see that adherents of the best known theory have not responded to increasing adverse evidence by questioning the validity of their beliefs, in the best scientific tradition; rather, they have chosen to hold it as a truth beyond question, thereby enshrining it as mythology.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*

Chapter One (p. 32)

Summit Books. New York, New York, USA. 1986

### Sherrington, Sir Charles 1857–1952

English physiologist

The microscope reveals that plants and animals are literally commonwealths of individually living units... Thus

the corporeal house of life is built of living stones. In that house each stone is a self-centered microcosm, individually born, breathing for itself, feeding itself, consuming its own substance in its living, renewing its substance to meet that consumption, harmonizing with its own inner life some special function for the benefit of the whole, and destined ultimately for an individual death.

In T.B. Strong (ed.)

*Lectures on the Method of Science*

Chapter III (p. 67)

Clarendon Press. Oxford, England. 1906

A grey rock, said Ruskin, is a good sitter. That is one type of behavior. A darting dragon-fly is another type of behavior. We call the one alive, the other not. But both are fundamentally balances of give and take of motion with their surround. To make "life" a distinction between them is at root to treat them both artificially.

*Man on His Nature*

Chapter III (p. 88)

Doubleday Anchor Books. Garden City, New York, USA. 1955

### Simpson, George Gaylord 1902–84

American paleontologist

The historian of life takes not only knowledge of fossils but also a tremendous array of pertinent facts from other fields of earth sciences and of life sciences and weaves them all into an integral interpretation of what the world of life is like and how it came to be so. Finally, he is bound to reflect still more deeply and to face the riddles of the meaning and nature of life and of man as well as problems of human values and conduct. The history of life certainly bears directly on all these riddles and problems, and realization of its won value demands investigation of this bearing.

*Meaning of Evolution: A Study of the History of Life and of Its Significance for Man*

Prologue (p. 3)

Yale University Press. New Haven, Connecticut, USA. 1949

### Singer, Charles 1876–1960

Historian of science and medicine

We are always looking for metaphors in which to express our ideas of life, for our language is inadequate for all its complexities. Life is a labyrinth.... Life is a machine.... Life is a laboratory.... It is but a metaphor. When we speak of ultimate things we can, maybe, speak only in metaphors. Life is a dance, a very elaborate and complex dance...

*A Short History of Scientific Ideas to 1900*

Chapter IX, Section 6 (p. 498)

At The Clarendon Press. Oxford, England. 1959

### Sinnott, E.W. 1888–1968

American biologist

Life can be studied fruitfully in its highest as well as its lowest manifestations. The biochemist can tell us

much about protoplasmic organisation, but so can the artist. Life is the business of the poet as well as of the physiologist.

*Cell and Psyche*

Chapter III (p. 107)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1950

### **Smuts, Jan Christiaan** 1870–1950

South African statesman, military leader, and holistic philosopher

According to quantum doctrine, the roots of life and mind lie imbedded deep down in the ultimate structure of this universe, and they are not mere singular apparitions of an unaccountable character, arising accidentally in the later phases of evolution.

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 719)

### **Spencer, Herbert** 1820–1903

English social philosopher

...a living thing is distinguished from a dead thing by the multiplicity of the changes at any moment taking place in it.

*The Principles of Biology* (Volume 1)

Part I, Chapter IV, Section 25 (p. 65)

D. Appleton & Company. New York, New York, USA. 1897

### **Stockbridge, Frank B.**

No biographical data available

Life is a chemical reaction; death is the cessation of that reaction; living matter, from the microscopic yeast spore to humanity itself, is merely the result of certain accidental groupings of otherwise inert matter, and life can actually be created by repeating in the laboratory nature's own methods and processes!

Creating Life in the Laboratory

*Cosmopolitan*, Volume 52, May 1912 (pp. 774–781)

### **Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

What drives life is thus a little electric current, kept up by the sunshine. All the complexities of intermediary metabolism are but the lacework around this basic fact.

Imre Csizmadia, Botond Penke and Gabor Toth (eds.)

*The Role of Chemistry in the Evolution of Molecular Medicine*

Introduction to Submolecular Biology

Chapter 3

Elsevier Publishing Company. Amsterdam, Netherlands. 2004

Every biologist has at some time asked “What is life?” and none has ever given a satisfactory answer. Science is built on the premise that Nature answers intelligent questions intelligently; so if no answer exists, there must be something wrong with the question.

*The Living State : With Observations on Cancer* (p. 1)

Academic Press. New York, New York, USA. 1972

It is common knowledge that the ultimate source of all our energy and negative entropy is the radiation of the sun. When a photon interacts with a material particle on our globe it lifts one electron from an electron pair to a higher level. This excited state as a rule has but a short lifetime and the electron drops back within  $10^{-7}$  to  $10^{-8}$  [second] to the ground state giving off its excess energy one way or another. Life has learned to catch the electron in the excited state, uncouple it from its partner and let it drop back to the ground state through its biological machinery utilizing its excess energy for life processes.

In W. D. McElroy and B. Glass (eds.)

*Light and Life*

Introductory Comments (p. 7)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1961

## **The X-Files**

SCULLY: It began with an act of supreme violence — a big bang expanding ever outward, cosmos born of matter and gas, matter and gas ten billion years ago. Whose idea was this? Who had the audacity for such invention? And the reason? Were we part of that plan ten billion years ago? Are we born only to die? To be fruitful and multiply and replenish the earth before giving way to our generations? If there is a beginning, must there be an end? We burn like fires in our time only to be extinguished. To surrender to the elements' eternal reclaim. Matter and gas... will this all end one day? Life no longer passing to life, the Earth left barren like the stars above, like the cosmos. Will the hand that lit the flame let it burn down? Let it burn out? Could we, too, become extinct? Or if this fire of life living inside us is meant to go on, who decides? Who tends the flames? Can he reignite the spark even as it grows cold and weak?

*Biogenesis*

Television program

Season 6 (2000)

### **Updike, John** 1932–

American novelist, short story writer, and poet

But I happen to know exactly how life arose; it's brand-new news, at least to the average layman like yourself. Clay. Clay is the answer. Crystal formation in fine clays provided the template, the scaffolding, for the organic compounds and the primitive forms of life. All life did, you see, was take over the phenotype that crystalline clays had evolved on their own.

*Roger's Version*

Chapter V (p. 305)

Alfred A. Knopf. New York, New York, USA. 1986

### **van Bergeijk, W. A.**

No biographical data available

Life is the necessary and sufficient condition for macromolecular systems, but macromolecules, though necessary, are not sufficient for life.

In George Gaylord Simpson

*Biology and Man*

Chapter Three (p. 32)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**von Humboldt, Alexander** 1769–1859

German naturalist and explorer

The starry vault and the wide expanse of the heavens belong to a picture of the universe in which the magnitude of masses, the number of congregated suns and faintly glimmering nebulae, although they excite our wonder and astonishment, manifest themselves to us in apparent isolation, and as utterly devoid of all evidence of their being the scenes of organic life.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)

Celestial Phenomena (p. 83)

Harper & Brothers. New York, New York, USA. 1869

**Wald, George** 1906–97

American biologist and biochemist

We are not alone in the universe, and do not bear alone the whole burden of life and what comes of it. Life is a cosmic event — so far as we know the most complex state of organization that matter has achieved in our cosmos. It has come many times, in many places — places closed off from us by impenetrable distances, probably never to be crossed even with a signal. As men we can attempt to understand it, and even somewhat to control and guide its local manifestations. On this planet that is our home, we have every reason to wish it well. Yet should we fail, all it not lost. Our kind will try again elsewhere.

The Origin of Life

*Scientific American*, Volume 191, Number 2, August 1954 (p. 53)

**Watson, James D.** 1928–

American geneticist and biophysicist

...we have complete confidence that further research of the intensity recently given to genetics will eventually provide man with the ability to describe with completeness the essential features that constitute life.

In James Darnell, Harvey Lodish, and David Baltimore

*Molecular Cell Biology* (2<sup>nd</sup> edition)

Chapter 1 (p. 1)

Scientific American Books. New York, New York, USA. 1990

**Watts, Alan Wilson** 1915–73

American philosopher

The naive idea that there is first of all empty space and then things filling it underlies the classical problem of how the world came out of nothing. Now the problem has to be rephrased, “How did something-and-nothing come out of...what?”

*Nature, Man, and Woman*

Part I, Chapter 2 (p. 56)

Vintage Books. New York, New York, USA. 1970

I cannot feel Christianly because I am in a world which grows from within. I am simply incapable of feeling its life as coming from above, from beyond the stars, even recognizing this to be a figure of speech. More exactly, I cannot feel that its life comes from Another, from one who is qualitatively and spiritually external to all that lives and grows. On the contrary, I feel this whole world to be moved from the inside, and from an inside so deep that it is my inside as well, more truly I than my surface consciousness.

*Nature, Man, and Woman*

Part I, Chapter 1 (p. 46)

Vintage Books. New York, New York, USA. 1970

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

We look back through countless millions of years and see the will to live struggling out of the intertidal slime, struggling from shape to shape and from power to power, crawling and then walking confidently upon the land, struggling generation after generation to master the air, creeping down into the darkness of the deep; we see it turn upon itself in rage and hunger and reshape itself anew; we watch it draw nearer and more akin to us, expanding, elaborating itself, pursuing its relentless, inconceivable purpose, until at least it reaches us and its being beats through our brains and arteries...

*The Discovery of the Future* (pp. 49–50)

B.W. Huebsch. New York, New York, USA. 1913

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...life is an offensive, directed against the repetitious mechanism of the Universe.

*Adventures of Ideas*

Chapter V (p. 102)

The Macmillan Company. New York, New York, USA. 1956

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

When we have fully discovered the scientific laws that govern life, we shall realize that the one person who has more illusions than the dreamer is the man of action. He, indeed, knows neither the origin of his deeds nor their results.

*The Works of Oscar Wilde* (Volume 10)

Intentions

The Critic as Artist, Part I

AMS Press. New York, New York, USA. 1909

**Young, Louise B.**

Science writer

...the tides of life never bring back the past.

*The Blue Planet*

Chapter 12 (p. 236)

Little, Brown & Company. Boston, Massachusetts, USA. 1983

## LIGHT

**Abbot, Charles Greeley** 1872–1973

American astrophysicist

Light is the messenger that brings the news. The message is in cipher, very long, faint, and hard to read. It tells of the materials, classifications, mass, size, and number of the stars.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1916*

News From the Stars (p. 157)

Government Printing Office. Washington, D.C. 1917

**Alighieri, Dante** 1265–1321

Italian poet and writer

O Supreme Light, that so high upliftest Thyself from mortal conceptions, re-lend to my mind a little of what Thou didst appear, and make my tongue so powerful that it may be able to leave one single spark of Thy glory for the folk to come.

In *Great Books of the Western World* (Volume 21)

*The Divine Comedy of Dante Alighieri*

Paradise, Canto XXXIII

1–67–72

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bohm, David** 1917–92

American physicist

This ocean of energy could be thought of as an ocean of light.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 155)

Routledge & Kegan Paul. London, England. 1986

When we come to light, we are coming to the fundamental activity in which existence has its ground.... Light is the potential of everything.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 155)

Routledge & Kegan Paul. London, England. 1986

**Bragg, Sir William Henry** 1862–1942

English physicist

Light brings us the news of the Universe.

*The Universe of Light*

Chapter I (p. 1)

The Macmillan Company. New York, New York, USA. 1933

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

...light is made up of certain little balls, which rebound from what is solid, and return obliquely; but pass thro'

what admits of an entrance in a right line, as air or glass: so that what makes the moon enlighten us, is, that she is a firm and solid body, from which the little balls rebound...

*Conversations on the Plurality of Worlds*

The Second Evening (pp. 45–46)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Dick, Thomas** 1600–80

Scottish theologian and philosopher

Light is that invisible ethereal matter which renders objects perceptible by the visual organs. It appears to be distributed throughout the immensity of the universe, and is essentially requisite to the enjoyment of every rank of perceptive existence. It is by the agency of this mysterious substance that we become acquainted with the beauties and sublimities of the universe, and the wonderful operations of the Almighty Creator.

*The Complete Works of Thomas Dick, LL.D.*

Volume IX, The Practical Astronomer, Part I, Introduction (p. 191)

Edwards & Bushnell. St. Louis, Missouri, USA. 1857

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Oh leave the Wise our measures to collate

One thing at least is certain, LIGHT has WEIGHT

One thing is certain, and the rest debate —

Light-rays, when near the Sun, DO NOT GO

STRAIGHT.

In Allie Vibert Douglas

*The Life of Arthur Stanley Eddington* (p. 44)

T. Nelson. London, England. 1956

The velocity of light plays a conspicuous part in the relativity theory, and it is of importance to understand what is the property associated with it which makes it fundamental. The fact that the velocity of light is the same for all observers is a consequence rather than a cause of its pre-eminent character.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter III (p. 59)

At The University Press. Cambridge, England. 1921

## Editor

Light crosses space with the prodigious velocity of 6,000 leagues per second.

*La Science Populaire*, April 28, 1881

A note correcting a first error appeared in our issue number 68, indicating that the speed of light is 6,000 leagues per hour. Our readers have corrected this new error. The speed of light is approximately 76,000 leagues per second.

*La Science Populaire*, June 16, 1881

A typographical error slipped into our last issue that is important to correct. The speed of light is 76,000 leagues per hour — and not 6,000.

*La Science Populaire*  
May 19, 1881

**Einstein, Albert** 1879–1955  
German-born physicist

All these fifty years of conscious brooding have brought me no nearer to the answer to the question “What are light quanta?” Nowadays every Tom, Dick, and Harry thinks he knows it, but he is mistaken.

In A.P. French

*Einstein: A Centenary Volume*

Letter to M. Besso, 1951 (p. 138)

Harvard University Press. Cambridge, Massachusetts, USA. 1979

**Feynman, Richard P.** 1918–88  
American theoretical physicist

I want to emphasize that light comes in this form — particles. It is very important to know that light behaves like particles, especially for those of you who have gone to school, where you were probably told something about light behaving like waves. I’m telling you the way it does behave — like particles.

*QED: The Strange Theory of Light and Matter*

Chapter 1 (p. 15)

Princeton University Press. Princeton, New Jersey, USA. 1985

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

Things on a very small scale behave like nothing that you have any direct experience about. They do not behave like waves, they do not behave like particles, they do not behave like clouds, or billiard balls, or weights on springs, or anything that you have ever seen.

*The Feynman Lectures on Physics* (Volume 3)

Chapter 1–1 (p. 1–1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

It isn’t that a particle takes the path of least action but that it smells all the paths in the neighborhood and chooses the one that has the least action.

*The Feynman Lectures on Physics* (Volume 2)

Chapter 19 (p. 19–9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Finlay, Victoria**  
No biographical data available

When light shines on a leaf, or a daub of paint, or a lump of butter, it actually causes it to rearrange its electrons, in a process called “transition.” There the electrons are,

floating quietly in clouds within their atoms, and suddenly a ray of light shines on them. Imagine a soprano singing a high C and shattering a wineglass, because she catches its natural vibration. Something similar happens with the electrons, if a portion of the light happens to catch their natural vibration. It shoots them to another energy level and that relevant bit of light, that glass-shattering “note”, is used up and absorbed. The rest is reflected out, and our brains read it as “colour”.

*Colour, Travels Through the Paintbox*

Hodder & Stoughton. London, England. 2002

**Frankel, Felice** 1945–  
Science photographer

**Whitesides, George M.**  
American chemist

We know light best in its diluted form: a gentle rain of photons falling from the sun that illuminates and warms. More concentrated, light is a furnace and a terror.

*On the Surface of Things: Images of the Extraordinary in Science*

Silicon, Etched by Light (p. 34)

Chronicle Books. San Francisco, California, USA. 1997

**Glashow, Sheldon L.** 1932–  
American physicist

Once upon a time, physicists wondered whether light was an electromagnetic wave or a beam of particles. Quantum mechanics revealed that this question is simply not meaningful since neither answer is quite correct. Light, and all other forms of electromagnetic radiation, sometimes displays particle-like properties as photons, and sometimes behaves like a wave. The same is true for the electron which is particulate as it produces a flash of light on the TV screen and wave-like as it passes through the electron microscope. In everyday life, when a pebble is thrown into a pond, the pebble is the particle and the ripple is the wave. In the quantum mechanical world, there is no such clear-cut distinction. The wave-particle duality is a universal attribute of material systems.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 4 (pp. 87–88)

Warner Books. New York, New York, USA. 1988

**Hale, George Ellery** 1868–1938  
American astronomer

Light is the most universal of all languages. Its messages reach us with equal faculty from the depths of the universe and from the electrons whirling in the nearest atom. Like the hieroglyphics of the Egyptians, its tones are silent, but unlike them, it tells of the present as well as of the past.

*Beyond the Milky Way*

Heat from the Stars (p. 40)

Charles Scribner’s Sons. New York, New York, USA. 1926

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

Whales can make progress through water either by wagging their tails up and down or from side to side. Light can travel through space in two ways, one like a tail moving up and down and the other like the tail moving from side to side.

*Frontiers of Astronomy* (p. 253)  
Harper & Row, Publishers. New York, New York, USA. 1955

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

A cannonball travels only two thousand miles an hour; light travels two hundred thousand miles a second. Such is the superiority of Jesus Christ over Napoleon.

*Les Misérables*  
Volume V, Book I, Chapter 8 (p. 29)  
The Heritage Press. New York, New York, USA. 1938

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

...I want to understand light as well as I can, without introducing things that we understand even less of. That is why I take plain dynamics. I can get a model in plain dynamics; I cannot in electromagnetics.

In Robert Kargon and Peter Achinstein (eds.)  
*Kelvin's Baltimore Lectures and Modern Theoretical Physics: Historical and Philosophical Perspectives*  
Lecture XX (p. 206)  
The MIT Press. Cambridge, Massachusetts, USA. 1987

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

Organization, voluntary movement, life, exist only at the surface of the earth, in places exposed to light. One might say that the fable of Prometheus's torch was the expression of a philosophic truth that the ancients had not overlooked. Without light, Nature was without life; she was inanimate and dead. A benevolent God, bringing light, diffused over the earth's surface organization, feeling, and thought.

In Fernand Papillon  
*Light and Life*  
*The Popular Science Monthly*, Volume 2, January 1873 (p. 303)

**Maxwell, James Clerk** 1831–79  
Scottish physicist

I have a paper afloat, with an electromagnetic theory of light, which 'til I am convinced to the contrary, I hold to be great guns.

In John N Shive and Robert L. Weber  
*Similarities in Physics*  
Chapter 10 (p. 123)  
John Wiley & Sons, Inc. New York, New York, USA. 1982

**Miner, Virginia Scott**  
No biographical data available

All color is to light as pitch to sound.  
The Human eye can see one octave's light,  
But those that soar past violet abound —  
And octaves still exist, though not to sight,  
Below the red.

Physics Inspires the Muses, Light  
*The Physics Teacher*, Volume 16, Number 9, December 1978 (p. 635)

**Mullaney, James**  
Astronomy writer, lecturer, and consultant

The light we see coming from celestial objects brings us into direct personal contact with remote parts of the universe as the photons end their long journey across space and time on our retinas.

Focal Point  
*Sky & Telescope*, Volume 79, Number 3, 1990 (p. 244)

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

Are not the Rays of Light very small Bodies emitted from shining Substances?

In *Great Books of the Western World* (Volume 34)  
*Optics*  
Book III, Part I, Query 29  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Planck, Max** 1858–1947  
German physicist

The velocity of light is to the Theory of Relativity as the elementary quantum of action is to the Quantum Theory: it is its absolute core.

*Scientific Autobiography and Other Papers*  
A Scientific Autobiography (p. 47)  
Philosophical Library. New York, New York, USA. 1949

**Pratchett, Terry** 1948–  
English author

Light thinks it travels faster than anything but it is wrong. No matter how fast light travels it finds the darkness has always got there first, and is waiting for it.

*Reaper Man* (p. 321)  
HarperCollins Publishers. New York, New York, USA. 1991

**Sommerfeld, Arnold** 1868–1951  
German physicist

The twofold nature of light as a light-wave and as a light-quantum is thus extended to electrons and, further, to atoms: their wave-nature is asserting itself more and more, theoretically and experimentally, as concurrent with their corpuscular nature.

Translated and edited by Henry L. Brose  
*Wave Mechanics* (p. 7)  
Methuen. London, England. 1930

**Standen, Anthony**  
Anglo-American science writer



The velocity of light occupies an extraordinary place in modern physics. It is *lèse-majesté* to make any criticism of the velocity of light. It is a sacred cow within a sacred cow, and it is just about the Absloutest Absolute in the history of human thought.

*Science Is a Sacred Cow*

Chapter III (p. 73)

E.P. Dutton & Company, Inc. New York, New York, USA. 1950

### The Bible

God said, "Let there be light..."

*The Revised English Bible*

Genesis 1:3

Oxford University Press, Inc. Oxford, England. 1989

**Thomas, Dylan** 1914–53

Welsh poet

Light breaks where no sun shines.

*The Poems of Dylan Thomas*

Light Breaks Where No Sun Shines (p. 82)

New Directions Publishing Corp. New York, New York, USA. 1971

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

There can no longer be any doubt that light waves consist of electric vibrations in the all-pervading ether, and that the latter possesses the properties of an insulator and a magnetic medium.

In Heinrich Rudolph Hertz

*The Principles of Mechanics, Presented in a New Form*

Preface (p. xvi)

Dover Publications, Inc. New York, New York, USA. No date

**Warren, Henry White** 1831–1912

Teacher, lecturer, and author

Light is the astronomer's necessity. When the sublime word was uttered, "Let there be light!" the study of astronomy was made possible.

*Recreations in Astronomy*

Chapter II (p. 22)

Chautauqua Press. New York, New York, USA. 1886

Light is the child of force, and the child, like its father, is full of power.

*Recreations in Astronomy*

Chapter II (p. 18)

Chautauqua Press. New York, New York, USA. 1886

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

When he [God] said Let there be light, then there was light and not a mere imitation or statistical average.

*Adventures of Ideas*

Chapter VII (p. 145)

The Macmillan Company. New York, New York, USA. 1956

**Young, Joshua**

No biographical data available

There was once a sailor named Lee  
Whose speed was much faster than "c."

But while racing his craft,

His bow followed his aft,

With a finish that no one could see.

Physics Poems

*The Physics Teacher*, Volume 20, Number 9, December 1982 (p. 587)

**Zee, Anthony**

American physicist

Let there be an SU(5) Yang–Mills theory with all its gauge bosons, let the symmetry be broken down spontaneously, and let all but one of the remaining massless gauge bosons be sold into infrared slavery. That one last gauge boson is my favorite. Let him rush forth to illuminate all of my creations!

*Fearful Symmetry*

Chapter 14 (p. 232)

Macmillan Publishing Company. New York, New York, USA. 1986

## LIGHT YEAR

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Light-year. This is without doubt the most stupendous and impressive phrase that exists in any language.

In Bernard DeVoto (ed.)

*Mark Twain in Eruption: Hitherto Unpublished Pages About Men and Events*

In a Writer's Workshop

Extract from Captain Stormfield's Visit to Heaven (p. 247)

Harper & Brothers Publishers. New York, New York, USA. 1922

## LIGHTNING

**Huxley, Thomas Henry** 1825–95

English biologist

The lightning was the angel of the Lord; but it has pleased Providence, in these modern times, that science should make it the humble messenger of man, and we know that every flash that simmers about the horizon on a summer's evening is determined by ascertainable conditions, and that its direction and brightness might, if our knowledge of these were great enough, have been calculated.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 59)

Macmillan & Company Ltd. London, England. 1904

**Muir, John** 1838–1914

American naturalist

It is a curious fact that all the very old Sequoias have lost their heads by lightning. All things come to him who waits. But of all living things Sequoia is perhaps the

only one able to wait long enough to make sure of being struck by lightning. Thousands of years it stands ready and waiting, offering its head to every passing cloud as if inviting its fate, praying for heaven's fire as a blessing; and when at last the old head is off, another of the same shape immediately begins to grow on.

*Our National Parks*

Chapter IX (p. 277)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

If you are not very strong, try to climb Electric Peak when a big bossy, well-charged thunder-cloud is on it, to breathe the ozone set free, and get yourself kindly shaken and shocked. You are sure to be lost in wonder and praise, and every hair of your head will stand up and hum and sing like an enthusiastic congregation.

*Our National Parks*

Chapter II (p. 59)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## LIKELIHOOD

**Crichton, Michael** 1942–

American novelist

“I wonder how we can account for such parallelism in door design,” Ted said. “The likelihood of its occurring by chance is astronomically small. Why, this door is the perfect size and shape for human beings!”

*Sphere*

The Door (p. 64)

Ballantine Books. New York, New York, USA. 1987

**Dickens, Charles** 1812–70

English novelist

He was a strange boy to be sure. There was always some ground of probability and likelihood mingled with his absurd behavior. That was the best of it.

*Martin Chuzzlewit*

Chapter XI (p. 166)

Dodd, Mead & Company. New York, New York, USA. 1944

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

No doubt if it had been discovered who wrote the “*Vestiges*,” many an ingenious structure of probabilities would have been spoiled, and some disgust might have been felt for a real author who made comparatively so shabby an appearance of likelihood.

*Impressions of Theophrastus Such: Essays and Leaves from a Notebook*

The Wasp Credited with the Honeycomb (p. 111)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1901

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

I have no objection to the study of likelihood as such.

Probability and Scientific Method

*Proceedings of the Royal Statistical Society*, Series A, Volume 146, 1934

**Martin, Jr., Thomas L.**

No biographical data available

A professor's enthusiasm for teaching introductory courses varies inversely with the likelihood of his having to do it.

*Malice in Blunderland*

Fuglemanship (p. 103)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1973

**Queneau, Raymond** 1903–76

French poet, novelist, and publisher

There was not much likelihood now that a third encounter would take place, and the fact is that from that day to this I have never seen the young man again, in conformity with the established laws of probability.

*Exercises in Style*

Probabilist (p. 1850)

New Direction Publishing Corporation. New York, New York, USA.

1981

**Wright, Jim**

No biographical data available

The likelihood of a thing happening is inversely proportional to its desirability.

*The Dallas Morning News*, September 9, 1969

## LIMIT

**Berlinski, David** 1942–

American mathematician

But now a professional secret must be imparted. The concept of a limit is simple. It is the definition that is complex. The concept involves nothing more obscure than the idea of getting closer and closer to something. It suggests the attempt by one human being to approach another: and the inexpugnable thing in love as in mathematics is that however the distance decreases, it often remains what it always was, which is to say, hopelessly poignant because hopelessly infinite.

*A Tour of the Calculus*

Chapter 14 (p. 120)

Pantheon Books. New York, New York, USA. 1995

**Merriman, Gaylord M.**

Mathematician

The limit concept is not armchair fantasy, dissolving with the pipesmoke of its dreamer. It is the stuff of life.

*To Discover Mathematics*

Chapter 9 (p. 254)

John Wiley & Sons, Inc. New York, New York, USA. 1942

**LINE**

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

The straight line of the geometers does not exist in the material universe. It is a pure abstraction, an invention of the imagination or, if one prefers, an idea of the Eternal Mind.

*The Magic of Numbers*

Chapter 7 (p. 57)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Gave his sentiment divine  
Against the being of a line.  
Line in Nature is not found;  
Unit and universe are round;

In vain produced, all rays return.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

Uriel (p. 15)

Houghton Mifflin & Company. Boston, Massachusetts, USA. 1904

**Newton, Sir Isaac** 1642–1727  
English physicist and mathematician

We ought either to exclude all lines, beside the circle and right line, out of geometry, or admit them according to the simplicity of their descriptions, in which case the Conchoid yields to none except the circle. That is arithmetically more simple which is determined by the more simple equations, but that is geometrically more simple which is determined by the more simple drawing of lines.

In William Allen

On the Curves of Trisection

*American Journal of Science*, Volume 4, 1822 (p. 344)

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

What will the line stretch out to the crack of doom?

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Macbeth

Act IV, Scene i, l. 117

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Euclid always contemplates a straight line as drawn between two definite points, and is very careful to mention when it is to be produced beyond this segment. He never thinks of the line as an entity given once for all as a whole. This careful definition and limitation, so as to exclude an infinity not immediately apparent to the senses, was very characteristic of the Greeks in all their many activities. It is enshrined in the difference between

Greek architecture and Gothic architecture, and between Greek religion and modern religion. The spire of a Gothic cathedral and the importance of the unbounded straight line in modern Geometry are both emblematic of the transformation of the modern world.

*An Introduction to Mathematics*

Chapter 9 (p. 86)

Oxford University Press, Inc. New York, New York, USA. 1958

**LITERATURE**

**Meredith, Owen (Edward Robert Bulwer-Lytton, 1<sup>st</sup> Earl Lytton)** 1831–91  
English statesman and poet

In science, read, by preference, the newest works; in literature, the oldest. The classic literature is always modern.

*Caxtoniana: A Series of Essays on Life, Literature, and Manners*

Hints on Mental Culture (p. 110)

W. Blackwood & Sons. Edinburgh, Scotland. 1863

In science, address the few; in literature the many. In science, the few must dictate opinion to the many; in literature, the many, sooner or later, force their judgment on the few.

*Caxtoniana: A Series of Essays on Life, Literature, and Manners*

Readers and Writers (p. 428)

W. Blackwood & Sons. Edinburgh, Scotland. 1863

**Carson, Rachel** 1907–64  
American marine biologist and author

The aim of science is to discover and illuminate truth. And that, I take it, is the aim of literature, whether biography or history or fiction; it seems to me, then, that here can be no separate literature of science.

In Paul Brooks

*The House of Life: Rachel Carson at Work*

Fame (p. 128)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1972

**Crothers, Samuel McChord** 1857–1927  
American clergyman and writer

The distinction between Literature and Science is fundamental. What is a virtue in one sphere is a vice in the other.

*The Gentle Reader*

The Hinter-Land of Science (p. 229)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Dickinson, G. Lowes** 1862–1932  
English historian and political activist

When Science arrives, it expels Literature.

In Subrahmanyan Chandrasekhar

*Truth and Beauty: Aesthetics and Motivation in Science*

Chapter 3, Section VII (p. 55)

The University of Chicago Press. Chicago, Illinois, USA. 1987

**Dyson, Freeman J.** 1923–

American physicist and educator

The world of science and the world of literature have much in common. Each is an international club, helping to tie mankind together across barriers of nationality, race, and language.

*From Eros to Gaia*

Preface (p. vii)

Pantheon Books. New York, New York, USA. 1992

**Huxley, Thomas Henry** 1825–95

English biologist

Science and literature are not two things, but two sides of one thing.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter XVI (p. 231)

D. Appleton &amp; Company. New York, New York, USA. 1901

However good lectures may be, and however extensive the course of reading by which they are followed up, they are but accessories to the great instrument of scientific teaching — demonstration. If I insist unweariedly, nay fanatically, upon the importance of physical science as an educational agent, it is because the study of any branch of science, if properly conducted, appears to me to fill up a void left by all other means of education. I have the greatest respect and love for literature; nothing would grieve me more than to see literary training other than a very prominent branch of education: indeed, I wish that real literary discipline were far more attended to than it is; but I cannot shut my eyes to the fact that there is a vast difference between men who have had a purely literary, and those who have had a sound scientific, training.

*Collected Essays* (Volume 8)*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 218)

Macmillan &amp; Company Limited. London, England. 1904

**James, William** 1842–1910

American philosopher and psychologist

The “marvels” of Science, about which so much edifying popular literature is written, are apt to be “*caviare*” to the men in the laboratories.

*The Principles of Psychology* (Volume 2)

The Emotions, No Special Brain-Centers for Emotion (p. 472)

Henry Holt &amp; Company. New York, New York, USA. 1918

**Langley, John Newport** 1852–1925

Physiologist

Those who have occasion to enter into the depths of what is oddly, if generously, called the literature of a scientific subject, alone know the difficulty of emerging with an unsoured disposition.

*Report of the British Association for the Advancement of Science (1899)*

Physiology, including Experimental Pathology and Experimental

Physiology (p. 891)

J. Murray. London, England. 1917–18

**Levine, George**

No biographical data available

Once one is committed to the view that science is not so clearly separable from the human sciences...or from other humanist enterprises, history of science begins to blur with social history. Literature becomes part of the history of science. Science is reflected in literature. And the tools of literary criticism become instruments in the understanding of scientific discourse.

*One Culture: Essays in Science and Literature*

One Culture: Science and Literature, II (p. 22)

University of Wisconsin Press. Madison, Wisconsin, USA. 1987

**Overhage, Carl F. J.** 1910–

Physicist and electrical engineer

The public printed record of the results of scholarly research is the universal device that transcends the barriers of space and time between scholars. It makes the most recent advances of human knowledge accessible to students and scholars throughout the world. Wherever there is a library, any person who has learned the language may participate in the outstanding intellectual adventures of his time. The same record extends into the past; through an unbroken sequence of communications, the scholars of today can trace the origin of a new concept in different periods and in different countries. By standing on the shoulders of a giant, he may see farther. The wide availability of the record is one of the guarantees of its soundness. In science especially, truth is held to reside in findings that can be experimentally verified anywhere, at any time.

Libraries: Prospects and Problems

*Science*, Volume 155, Number 3764, February 1967 (p. 804)**Tyndall, John** 1820–93

Irish-born English physicist

It has been said that science divorces itself from literature. The statement, like so many others, arises from a lack of knowledge. A glance at the less technical writings of its leaders — of its Helmholtz, its Huxley, and its Du Bois-Reymond — would show what breadth of literary culture they command. Where among modern writers can you find their superiors in clearness and vigor of literary style? Science desires no isolation, but freely combines with every effort toward the bettering of man’s estate. Single-handed and supported not with outward sympathy, but with inward force, it has built at least one great wing of the many-mansioned home which man in his totality demands.... The world embraces not only a Newton, but a Shakespeare; not only a Boyle, but a Raphael; not only a Kant, but a Beethoven; not only a Darwin, but a Carlyle. Not in

each of these, but in all, is human nature whole. They are not opposed, but supplementary; not mutually exclusive, but reconcilable.

Address

Delivered before the British association assembled at Belfast, 1874

Publisher undetermined

**Valéry, Paul** 1871–1945

French poet and critic

“Science” means simply the aggregate of all the recipes that are always successful. All the rest is...literature.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

Analects (p. 64)

Princeton University Press. Princeton, New Jersey, USA. 1971

**Weinberg, Alvin Martin** 1915–

American physicist

...the scientific community has evolved an empirical method for establishing scientific priorities — for deciding what is important in science and what is unimportant. This is the scientific literature. The process of self-criticism, which is integral to the literature of science, is one of the most characteristic features of science. Nonsense is weeded out and held up to ridicule in the literature, whereas what is worthwhile receives much sympathetic attention. This process of self-criticism embodied in the literature, though implicit is nonetheless real and highly significant. The existence of a healthy, viable, refereed scientific literature in itself helps assure society that the science it supports is valid and deserving of support. This is a most important, though little recognized, social function of the scientific literature.

*Reflections on Big Science*

Chapter III (p. 70)

The MIT Press. Cambridge, Massachusetts, USA. 1967

## LIVER

**Aterman, Kurt** 1913–2002

Pathologist

The liver is still one of those subjects “about which we know more than is true.”

In C. Rouiller (ed.)

*The Liver: Morphology, Biochemistry, Physiology*

The Structure of the Liver Sinusoids and the Sinusoidal Cells (p. 126)

Academic Press. New York, New York, USA. 1963

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

The liver is the lazaret of bile.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 215

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Jonson, Ben** 1573?–1637

English dramatist and poet

JUS: ...the lungs of the tobacconist are rotted, the liver spotted, the brain smoked like the backside of the pig-woman’s booth, here, and the whole body within, black as her pan you saw e’en now, without.

*Bartholomew Fair*

Act II, Scene VI (p. 65)

Manchester University Press. Manchester, England. 1960

**Molière (Jean-Baptiste Poquelin)** 1622–1673

French playwright and actor

GERONTE: But there was one little thing that puzzled me: the heart and the liver...the side they’re on. I think you got them back to front. The heart is on the left side, and the liver on the right.

SGANARELLE: Yes, that used to be the case. But we’ve changed all that, and currently in medicine we are following the modern method.

Translated by W. Hannan

*The Reluctant Doctor*

Act II (p. 21)

Heinemann Educational Books. London, England. 1963

**Selzer, Richard** 1928–

American physician and essayist

...the liver!...that great maroon snail.... No wave of emotion sweeps it. Neither music nor mathematics gives it pause in its appointed tasks.

*Mortal Lessons*

Liver (p. 64)

Simon & Schuster. New York, New York, USA. 1976

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Were my wife’s liver

Infected as her life, she would not live

The running of one glass.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

The Winter’s Tale

Act I, Scene ii, l. 304–306

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

If he were open’d, and you find so much blood in his liver as will clog the foot of a flea, I’ll eat the rest of th’ anatomy.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

The Twelfth Night

Act III, Scene ii, l. 65–67

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## LIVING FOSSILS

**Forbes, Edward** 1815–54

English naturalist

The result of the examination of the Aegean fauna does not hold out much prospect of the discovery of any more extinct forms in a living state.... To those who have looked forward to the finding of lost forms in the greater depths of the sea, the catalogues I here present to the Association must be unsatisfactory; for though two or three such have occurred, the majority of species in the great depths are either described existing forms, or altogether new. The zero of animal life in depth has been too nearly approached to hold out further hopes.

*Report of the Thirteenth Meeting of the British Association for the Advancement of Science Held at Cork in August 1843*  
Report on the Mollusca and Radiata of the Aegean Sea, and on their distribution, considered as bearing on Geology (p. 175)  
Published by J. Murray. London, England. 1843

## LIVING MATTER

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

From all we have learnt about the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics. And that not on the ground that there is any “new force” or what not, directing the behavior of the single atoms within a living organism, but because the construction is different from anything we have yet tested in the physical laboratory.

*What Is Life? Mind and Matter: The Physical Aspect of the Living Cell*  
Chapter 7 (p. 76)  
Cambridge University Press. New York, New York, USA. 1967

## LIVING VERSUS DEAD

**Pirie, N. W.**

...systems are being discovered and studied which are neither obviously living nor obviously dead, and it is necessary to define these words or else give up using them, and coin others. When one is asked whether a virus is living or dead the only sensible answer is :“I don’t know; we know a number of things it will do and a number of things it won’t and if some commission will define the word ‘living’ I will try to see how the virus fits into the definition.” This answer does not as a rule satisfy the questioner, who generally has strong but unfortunate opinions about what he means by the words living and dead.

In A.J. Khuyver and C.B. Van Neil (eds.)  
*The Microbe’s Contribution to Biology* (p. 162)  
Harvard University Press. Cambridge, Massachusetts, USA. 1956

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

If we are to reach a coherent view of Nature, such as could be included in a philosophy, we must arrive at

some discernment of the characteristics which mark off living organisms from their not-living surroundings. In the present state of science a definition of the organism cannot be more than tentative, but it must be continually attempted.

*The System of Animate Nature* (Volume 1)  
Lecture III (p. 79)  
William & Norgate. London, England. 1920

## LOCATION

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We have certain preconceived ideas about location in space which have come down to us from ape-like ancestors.

*The Nature of the Physical World*  
Chapter I (p. 16)  
The Macmillan Company. New York, New York, USA. 1930

## LOGARITHM

**Graham, L. A.**  
No biographical data available

Mary had a little lamb  
Whose fleece in spirals grew;  
She, being quite perceptive said, “They’re logarithmic, too.

Since a’s one inch, the length of wool  
At any time you see,  
Is merely 1.414  
Times the radian power of e.”

*Ingenious Mathematical Problems and Methods*  
Mathematical Nursery Rhyme Number 16  
Dover Publications, Inc. New York, New York, USA. 1959

## LOGIC

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

To say of what is that it is not, or of what is not that it is, is false, while to say of what is that it is, or of what is not that it is not, is true.

In *Great Books of the Western World* (Volume 8)  
*Metaphysics*  
Book IV, Chapter 7 (p. 531)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Boutroux, Pierre** 1880–1922  
Mathematician

Logic is invincible because in order to combat logic it is necessary to use logic.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 1182)  
Oxford University Press, Inc. New York, New York, USA. 1972

**Burroughs, Edgar Rice** 1875–1950  
American writer

Could it be that there were other things more desirable than cold logic and undefiled brain power?

*The Chessmen of Mars*  
Chapter VIII (p. 89)

Ace Books, Inc. New York, New York, USA. 1960

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“I know what you’re thinking about,” said Tweedledum; “but it isn’t so, nohow.”

“Contrariwise,” continued Tweedledee, “if it was so, it might be; and if it were so, it would be; but as it isn’t, it ain’t. That’s logic.”

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter IV (p. 181)

The Modern Library. New York, New York, USA. 1936

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

A great deal is said in these days about the value or valuelessness of logic. In the main, indeed, logic is not a productive tool so much as a weapon for defense. A man building up an intellectual system has to build like Nehemiah, with the sword in one hand and the trowel in the other. The imagination, the constructive quality, is the trowel, and the argument is the sword. A wide experience of actual intellectual affairs will lead most people to the conclusion that logic is mainly valuable as a weapon wherewith to exterminate logicians.

*The G.K. Chesterton Calendar*

January Ten

Cecil Palmer & Hayward. London, England. 1916

**Clough, Arthur Hugh** 1819–61  
English poet

Good, too, Logic, of course; in itself, but not in fine weather.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 3)

The Bothie of Tober-na-vuolich (p. 1878)

Simon & Schuster. New York, New York, USA. 1956

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

Logic is a large drawer, containing some useful instruments, and many more that are superfluous. A wise man will look into it for two purposes, to avail himself of those instruments that are really useful, and to admire the ingenuity with which those that are not so, are assorted and arranged.

*Lacon: Or Many Things in a Few Words* (p. 163)

William Gowans. New York, New York, USA. 1849

**Dawkins, Richard** 1941–  
English ethologist, evolutionary biologist, and popular science writer

...reason and logic are not masculine instruments of oppression. To suggest that they are is an insult to women.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 8 (p. 191)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Dunsany, Lord Edward John Moreton Drax Plunkett** 1878–1957  
Irish writer and dramatist

But, logic, like whiskey, loses its beneficial effect when taken in too large quantities.

*My Ireland*

Weeds & Moss (p. 186)

Funk & Wagnalls Company. New York, New York, USA. 1937

**Frege, Friedrich Ludwig Gottlob** 1848–1925  
German logician

...logic has much the same relation to truth as physics has to weight or heat.

In Michael Beaney (ed.)

*The Frege Reader*

Thought (p. 325)

Blackwell Publishers. Malden, Massachusetts, USA. 1997

**Heaviside, Oliver** 1850–1925  
English electrical engineer, mathematician, and physicist

Logic can be patient for it is eternal.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 3)

Oxford University Press, Inc. New York, New York, USA. 1972

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Logic is logic. That’s all I say.

*The Autocrat of the Breakfast-Table*

Chapter XI (p. 266)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hubbard, Elbert** 1856–1915  
American editor, publisher, and author

Logic is one thing and common sense another.

*The Note Book of Elbert Hubbard*

Wm H. Wise & Company. New York, New York, USA. 1927

**Jones, Raymond F.** 1915–94  
American writer

Logic hasn’t wholly dispelled the society of witches and prophets and sorcerers and soothsayers.

*The Non-Statistical Man* (p. 85)

Belmont Books, New York, New York, USA. 1964

**Joubert, Joseph** 1754–1824  
French moralist

Logic operates, metaphysics contemplates.

Translated by H.P. Collins  
*Pensées and Letters of Joseph Joubert*  
 Chapter XI (p. 88)  
 Books for Libraries Press. Freeport, New York, USA. 1972

**Jowett, Benjamin** 1817–93  
 English educator and Greek scholar

Logic is neither a science nor an art, but a dodge.  
 In James R. Newman (ed.)  
*The World of Mathematics* (Volume 4) (p. 2402)  
 Simon & Schuster. New York, New York, USA. 1956

**Merton, Thomas** 1915–68  
 American religious writer and poet

There is a logic of language and a logic of mathematics. The former is supple and lifelike, it follows our experience. The latter is abstract and rigid, more ideal. The latter is perfectly necessary, perfectly reliable: the former is only sometimes reliable and hardly ever systematic. But the logic of mathematics achieves necessity at the expense of living truth, it is less real than the other, although more certain. It achieves certainty by a flight from the concrete into abstraction. Doubtless, to an idealist, this would seem to be a more perfect reality. I am not an idealist. The logic of the poet — that is, the logic of language or the experience itself — develops the way a living organism grows: it spreads out towards what it loves, and is heliotropic, like a plant.

*The Secular Journal of Thomas Merton*  
 November 2, 1939  
 Farrar, Straus & Cudahy. New York, New York, USA. 1959

**Mumford, David** 1937–  
 English-born mathematician

Logic has virtually nothing to do with the way we think.  
 International Congress of Mathematics 2002  
 Beijing  
 August 21, 2002

**Rexroth, Kenneth** 1905–82  
 American writer and translator

The space of night is infinite,  
 The blackness and emptiness  
 Crossed only by thin bright fences  
 Of logic.

*The Collected Shorter Poems*  
 Theory of Numbers (p. 165)  
 New Directions. New York, New York, USA. 1966

**Russell, Bertrand Arthur William** 1872–1970  
 English philosopher, logician, and social reformer

...logic is the youth of mathematics...  
*Introduction to Mathematical Philosophy*  
 Chapter XVIII (p. 194)  
 Dover Publications, Inc. New York, New York, USA. 1993

**Schiller, Ferdinand Canning Scott** 1864–1937  
 English philosopher

Among the obstacles to scientific progress a high place must certainly be assigned to the analysis of scientific procedure which Logic has provided.... It has not tried to describe the methods by which the sciences have actually advanced, and to extract...rules which might be used to regulate scientific progress, but has freely rearranged the actual procedure in accordance with its prejudices. For the order of discovery there has been substituted an order of "proof"...

In Charles Singer (ed.)  
*Studies in the History and Method of Science* (Volume 1)  
 Scientific Discovery and Logical Proof (p. 235)  
 At The Clarendon Press. Oxford, England. 1917

...it is not too much to say that the more deference men of science have paid to Logic, the worse it has been for the scientific value of their reasoning.... Fortunately for the world, however, the great men of science have usually been kept in salutary ignorance of the logical tradition...

In Charles Singer (ed.)  
*Studies in the History and Method of Science* (Volume 1)  
 Scientific Discovery and Logical Proof (p. 236)  
 At The Clarendon Press. Oxford, England. 1917

**Selye, Hans** 1907–82  
 Austrian-American endocrinologist

...logic is to Nature as a guide is to a zoo. The guide knows exactly where to locate the African lion, the Indian elephant or the Australian kangaroo, once they have been captured, brought together and labeled for inspection. But this kind of knowledge would be valueless to the hunter who seeks them in their natural habitat. Similarly, logic is not the key to Nature's order but only the catalogue of the picture gallery in man's brain where his impressions of natural phenomena are stored.

*From Dream to Discovery: On Being a Scientist*  
 How to Think (p. 266)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shakespeare, William** 1564–1616  
 English poet, playwright, and actor

He dreweth out the thread of his verbosity finer than the staple of his argument.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
 Love's Labour's Lost  
 Act V, Scene i, l. 18  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Standen, Anthony**  
 Anglo-American science writer

A man gets drunk on Monday on whisky and soda water; he gets drunk on Tuesday on brandy and soda water, and on Wednesday on gin and soda water. What causes his drunkenness? Obviously, the common factor, the soda water.



*Science Is a Sacred Cow*

Chapter I (p. 25)

E.P. Dutton & Company, Inc. New York, New York, USA. 1950

**Tagore, Rabindranath** 1861–1941

Indian poet and philosopher

A mind all logic is like a knife all blade,  
It makes the hand bleed that uses it!

*Collected Poems and Plays of Rabindranath Tagore*

CXCII (p. 249)

The Macmillan Company. New York, New York, USA. 1958

**Weyl, Hermann** 1885–1955

German mathematician

Logic is the hygiene the mathematician practices to keep  
his ideas healthy and strong.

Volume 99, Part 2, Number 9

*The American Mathematical Monthly*, November, 1992 (p. 861)

**Wheeler, John Archibald** 1911–

American physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

Little astonishment should there be, therefore, if the description of nature carries one in the end to logic, the ethereal eyrie at the center of mathematics. If, as one believes, all mathematics reduces to the mathematics of logic, and all physics reduces to mathematics, what alternative is there but for all physics to reduce to the mathematics of logic? Logic is the only branch of mathematics that can “think about itself.”

In Charles W. Misner et al.

*Gravitation*

Part X, Chapter 44 (p. 1212)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Neither logic without observation, nor observation without logic, can move one step in the formation of science.

*The Organization of Thought*

Chapter VI (p. 132)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Logic is the olive branch from the old to the young, the wand which in the hands of youth has the magic property of creating science.

*The Organisation of Thought*

Chapter VI (p. 133)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Logic, properly used, does not shackle thought. It gives freedom, and above all, boldness. Illogical thought hesitates to draw conclusions, because it never knows either what it means, or what it assumes, or how far it trusts its own assumptions, or what will be the effect of any modification of assumptions.

*The Organisation of Thought*

Chapter VI (p. 132)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

The disastrous invasion of mathematics by logic....

*Remarks on the Foundations of Mathematics*

Appendix IV, 24 (p. 145e)

The MIT Press. Cambridge, Massachusetts, USA. 1967

*In der Logik ist nichts zufällig.*

Nothing, in logic, is accidental.

Translated by D.F. Pears & B.F. McGuinness

*Tractatus Logico-Philosophicus*

2.012 (p. 7)

Routledge & Kegan Paul. London, England. 1961

## LOGICIAN

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

An expert logician will not necessarily be a passable mathematician for all his skill in logic, any more than a scholarly prosodist will be a respectable poet for all his mastery of meter.

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 19)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

The poet only asks to get his head into the heavens. It is the logician who seeks to get the heavens into his head. And it is his head that splits.

*Orthodoxy*

Chapter II (p. 29)

John Lane Company. New York, New York, USA. 1918

**Reichenbach, Hans** 1891–1953

German philosopher of science

The act of discovery escapes logical analysis; there are no logical rules in terms of which a “discovery machine” could be constructed that would take over the creative function of the genius. But it is not the logician’s task to account for scientific discoveries; all he can do is to analyze the relation between given facts and a theory presented to him with the claim that it explains these facts. In other words, logic is concerned with the context of justification.

*The Rise of Scientific Philosophy*

Chapter 14 (p. 231)

University of California Press. Berkeley, California, USA. 1951

**LONELINESS**

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

Loneliness does not come from having no people about one, but from being unable to communicate the things that seem important to oneself, or from holding certain views which others find inadmissible.

*Memories, Dreams, Reflections*

Retrospect (p. 356)

Vintage Books. New York, New York, USA. 1963

**LUCK**

**Eastwood, Clint** 1930–  
American actor

Do you feel lucky? Well do ya?

*Dirty Harry*

Film (1971)

**Ramón y Cajal, Santiago** 1852–1934  
Spanish neuropathologist

To solicit the aid of luck is like stirring muddy water to bring objects submerged at the bottom to the top where they can be seen. Every worker would do well to tempt their good luck. Nevertheless, we should not depend on it too much...

*Advice for a Young Investigator*

Chapter 4 (p. 70)

The MIT Press. Cambridge, Massachusetts, USA. 1999

**LUNG**

**Mayow, John** 1641–79  
English chemist and physiologist

The lungs are placed in a recess so sacred and hidden that nature would seem to have specially withdrawn this part both from the eyes and from the intellect; for, beyond the wish, it has not yet been granted to any one to fit a window to the breast and redeem from darkness the profounder secrets of nature. For of all the parts of the body, the lungs alone, as if shrinking from observation, cease from their movement and collapse at once on the first entrance of light and self-revelation.... Still, let me draw near to the inmost vitals, and, concerning so obscure a matter, make at least a guess.

*Medico-Physical Works*

Second Treatise (p. 183)

The Alembic Club. Edinburgh, Scotland. 1907

**Ott, Susan**

Physician

Roses are red

Violets are blue

Without your lungs

Your blood would be too.

A Pulmonologist's Valentine

*The New England Journal of Medicine*, Volume 304, Number 12, 1981 (p. 739)

**Servetus, Michael** 1511–53

Spanish theologian and physician

It is in the lungs, consequently, that the mixture (of the inspired air with the blood) takes place, and it is in the lungs also, not in the heart, that the crimson colour of the blood is acquired.

In William Osler

*Michael Servetus*

Lord Baltimore Press. Blatimore, Maryland, USA. 1909

## M

### MACHINE

**Boorstin, Daniel J.** 1914–2004  
American historian

Just as the American's love affair with his land produced pioneering adventures and unceasing excitement in the conquest of the continent, so too his latter-day romance with the Machine produced pioneering adventures — of a new kind...there were no boundaries to a machine-made world.

*Hidden History*

From the Land to the Machine (pp. 252–253)

Harper & Row, Publishers. New York, New York, USA. 1987

**Bottomley, Gordon** 1874–1948  
English poet

Your worship is your furnaces,  
Which, like old idols, lost obscenes,  
Have molten bowels; your vision is  
Machines for making more machines.

*Poems of Thirty Years*

To Iron-Founders and Others

Constable. London, England. 1927

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

A machine is a machine because it cannot think.

*The G.K. Chesterton Calendar*

February Sixteen

Cecil Palmer & Hayward. London, England. 1916

**Disraeli, Benjamin, 1<sup>st</sup> Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

...the mystery of mysteries is to view machines making machines...

*Coningsby*

Book IV, Chapter II (p. 129)

J.M. Dent & Sons Ltd. London, England. 1911

A machine is a slave that neither brings nor bears degradation...

*Coningsby*

Book IV, Chapter II (p. 129)

J.M. Dent & Sons Ltd. London, England. 1911

**Florman, Samuel C.** 1925–  
Author and professional engineer

In his emotional involvement with the machine, the engineer cannot help but feel at times that he has come face to face with a strange but potent form of life.

*The Existential Pleasures of Engineering*

Chapter 10 (p. 139)

St. Martin's Press. New York, New York, USA. 1976

**Goodman, Ellen** 1941–  
American journalist

Once upon a time we were just plain people. But that was before we began having relationships with mechanical systems. Get involved with a machine and sooner or later you are reduced to a factor.

*The Human Factor*

*Washington Post*, January 1987

**Lee, Gerald Stanley** 1862–1944  
American clergyman

It is never the machines that are dead.

It is only the mechanically-minded men that are dead.

*Crowds: A Moving-Picture of Democracy*

Book III, Part II, Chapter V (p. 249)

Doubleday, Page. Garden City, New York, USA. 1913

**Lippmann, Walter** 1889–1974  
American journalist and author

You cannot endow even the best machine with initiative: the jolliest steamroller will not plant flowers.

*A Preface to Politics*

Routineer and Inventor (p. 30)

M. Kennerley. New York, New York, USA. 1913

**Mazlish, Bruce** 1923–  
American historian

...the human desire to escape the flesh, which took one form in asceticism, might take another form in the creation of machines. Thus, the wish to rise above the bestial body manifested itself not only in angels but in mechanical creatures. Certainly, once machines existed, humans clearly attached to them feelings of escape from the flesh.

*The Fourth Discontinuity: The Co-Evolution of Humans and Machines*  
(p. 218)

Yale University Press. New Haven, Connecticut, USA. 1941

**Platonov, Andrei** 1899–1951  
Russian writer

Frossia's husband had the ability to feel the voltage of an electric current like a personal emotion. He animated everything that his hands or mind touched, so he really understood the flow of forces in any piece of mechanism and could actually feel the painful, patient resistance of the metal body of a machine.

*Fro and Other Stories*

Fro (p. 88)

Progress Publishers. Moscow, Russia. 1972

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Machines are worshipped because they are beautiful, and valued because they confer power; they are hated because they are hideous, and loathed because they impose slavery.

*Skeptical Essays*

Chapter VI (p. 83)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1928

A machine is like a Djinn in the Arabian Nights: beautiful and beneficent to its master, but hideous and terrible to his enemies.

*Skeptical Essays*

Chapter VI (p. 83)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1928

**Ryle, Gilbert** 1900–76

English philosopher

...the dogma of the Ghost in the Machine.

*The Concept of Mind*

Chapter I (pp. 15–16)

Barnes &amp; Noble, Inc. New York, New York, USA. 1969

**Samuel, Arthur L.** 1901–90

American pioneer of artificial intelligence research

A machine is not a genie, it does not work by magic, it does not possess a will, and Wiener to the contrary, nothing comes out which has not been put in, barring of course, an infrequent case of malfunctioning.... The “intentions” which the machine seems to manifest are the intentions of the human programmer, as specified in advance, or they are subsidiary intentions derived from these, following rules specified by the programmer...the machine will not and cannot do any of these things until it has been instructed as to how to proceed.... To believe otherwise is either to believe in magic or to believe that the existence of man’s will is an illusion and that man’s actions are as mechanical as the machine’s.

Some Moral and Technical Consequences of Automation — A Refutation *Science*, Volume 132, Number 3429, September 16, 1960 (p. 741)

**Schumacher, Ernst Friedrich** 1911–77

German-born English economist

Ever bigger machines, entailing ever bigger concentrations of economic power and exerting ever greater violence against the environment, do not represent progress: they are a denial of wisdom. Wisdom demands a new orientation of science and technology towards the organic, the gentle, the non-violent, the elegant and beautiful.

*Small Is Beautiful*

Part I, Chapter II (p. 31)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

**Wright, Frank Lloyd** 1869–1959

American architect

Science can give us only the tools in a box, mechanical miracles that it has already given us. But of what use to us are miraculous tools until we have mastered the human, cultural use of them? We do not want to live in a world where the machine has mastered the man; we want to live in a world where man has mastered the machine.

## An Organic Architecture, Speech

London, England, May 1939

**MACHINERY****Moore, George** 1852–1933

The world is dying of machinery; that is the great disease, that is the plague that will sweep away and destroy civilization, man will have to rise against it sooner or later.

*Confessions of a Young Man*

Chapter Seven (p. 113)

McGill-Queen’s University Press. Montreal, Canada. 1972

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

There is nothing in machinery, there is nothing in embankments and railways and iron bridges and engineering devices to oblige them to be ugly. Ugliness is the measure of imperfection.

*A Modern Utopia*

Chapter the Third, Section 8 (p. 110)

University of Nebraska Press. Lincoln, Nebraska, USA. 1967

**MACROEVOLUTION****Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Experience shows...that there is no way toward understanding of the mechanisms of macroevolutionary changes, which require time on geological scales, other than through understanding of microevolutionary processes observable within the span of a human lifetime, often controlled by man’s will, and sometimes reproducible in laboratory experiments.

*Genetics and The Origin of Species*

Chapter I (p. 16)

Columbia University Press. New York, New York, USA. 1951

**MAGIC****Asimov, Isaac** 1920–92

American author and biochemist

Once upon a time, there were priesthoods of magic, and members of those priesthoods cast spells, muttered runes, and made intricate diagrams on the floor with powders of arcane composition.... Nowadays, there is a modern priesthood of science that calls on the power of expanding steam, of shifting electrons or drifting neutrons, of exploding gasoline or uranium, and does so without spells, powders, or even any visible change of expression. In response, onlookers are without awe, for indeed, they seem to participate in the magic.

November 19, 1967

*New York Times Book Review, Review of The Way Things Work, Volume 1*

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Man masters nature not by force but by understanding. That is why science has succeeded where magic failed because it has looked for no spell to cast on nature.

*Science and Human Values*  
The Creative Mind (p. 10)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

All the terms in the science books, “law”, “necessity”, “order”, “tendency”, and so on, are really unintellectual, because they assume an inner synthesis which we do not possess. The only words that ever satisfied me as describing Nature are the terms used in fairy books, “charm”, “spell”, “enhancement.” A tree grows because it is a magic tree. Water runs down because it is bewitched. The sun shines because it is bewitched.

*Orthodoxy*  
Chapter IV (p. 94)  
John Lane Company. New York, New York, USA. 1918

**Durant, William James** 1885–1981  
American historian and essayist

Magic begins in superstition and ends in science.  
*The Story of Civilization I: Our Oriental Heritage* (p. 67)  
Simon & Schuster. New York, New York, USA. 1939

### Editor

Nothing in science is magical. It may be puzzling, mysterious, inexplicable — but it is never magical.

In Isaac Asimov  
*Asimov on Chemistry*  
The Hate-Makers (p. 143)  
Anchor Press/Doubleday. Garden City, New York, USA. 1974

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Magic and all that is ascribed to it is a deep presentiment of the powers of science.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)  
Essays: First Series  
Chapter I (p. 34)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Farb, Peter** 1929–80  
American writer and anthropologist

In place of science, the Eskimo has only magic to bridge the gap between what he can understand and what is not known. Without magic, his life would be one long panic.

*Man’s Rise to Civilization as Shown by the Indians of North America from Primeval Times to the Coming of the Industrial State*  
Chapter III (p. 48)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1968

**Goodwin, Brian Carey** 1931–  
Biologist

There is no truth beyond magic...reality is strange. Many people think reality is prosaic. I don’t. We don’t explain things away in science. We get closer to the mystery.

In Roger Lewin  
*Complexity: Life at the Edge of Chaos*  
Chapter Two (p. 32)  
The Macmillan Company. New York, New York, USA. 1992

**Gould, Laurence M.** 1896–1995  
American polar explorer and geologist

Science is not a form of black magic. A thousand blind alleys must often be explored before a right road is found; a thousand amateurs must have their fling before a Darwin or an Einstein comes along.

Science and the Culture of Our Times  
*UNESCO Courier*, February 1968 (p. 4)

**Hilbert, David** 1862–1943  
German mathematician

The reason that I am now almost completely swimming in physical waters is because here at the moment as a pure mathematician I am the only feeling heart among the wraiths. So for now...in order to have points in common with other mortals, I have surrendered myself to magic — that is to say, physics.

In Constance Reid  
*Hilbert — Courant*  
Hilbert  
Chapter V (p. 35)  
Springer-Verlag. New York, New York, USA. 1986

Let us consider that we as mathematicians stand [on] the highest pinnacle of the cultivation of the exact sciences. We have no other choice than to assume this highest place, because all limits, especially national ones, are contrary to the nature of mathematics. It is a complete misunderstanding of our science to construct differences according to peoples and races, and the reasons for which this has been done are very shabby ones.

*Hilbert — Courant*  
Hilbert  
Chapter XXI (p. 188)  
Springer-Verlag. New York, New York, USA. 1986

**Hsu, Francis L. K.** 1909–99  
Anthropologist

...to achieve popular acceptance, magic has to be dressed like science in America, while science has to be cloaked as magic in Hsi-ch’eng.

*Health, Culture and Community Case Studies of Public Reactions to Health Programs*  
Part 2, A Cholera Epidemic in a Chinese Town (p. 149)  
Russell Sage Foundation. New York, New York, USA. 1955

**Porta, John Baptista** 1535?–1615  
Neapolitan scholar

There are two sorts of Magick: the one is infamous, and unhappie, because it hath to do with foul spirits, and consists of Inchantments and wicked Curiosity; and this is called Sorcery; an art which all learned and good men detest; neither is it able to yield any truth of Reason or Nature, but stands merely upon fancies and imaginations, such as vanish presently away and leave nothing behind them.... The other Magick is natural; which all excellent wise men do admit and embrace, and worship with great applause; neither is there anything more highly esteemed, or better thought of by men of learning.... I think that Magick is nothing else but the survey of the whole course of Nature.

*Natural Magick*

The First Book of Natural Magick, Chapter II (pp. 1–2)  
Printed for Thomas Young & Samuel Speed. London, England. 1658

**Rapoport, Anatol** 1911–  
Russian-born mathematician and biologist

Magic is essentially metaphorical. So are dreams. So is most artistic activity, Finally, theoretical science is essentially disciplined exploitation of metaphor.

*Operational Philosophy*

Chapter 17 (p. 203)  
Harper. New York, New York, USA. 1953

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910  
American author and humorist

Somehow, every time the magic of fol-de-rol tried conclusions with the magic of science, the magic of fol-de-rol got left.

*A Connecticut Yankee in King Arthur's Court*

Chapter XXXIX (p. 359)  
Harper & Brothers. New York, New York, USA. 1899

## MAGMA

**Bowen, Norman L.** 1887–1956  
Canadian geologist

Perhaps it is because we know so much about magmas that we have such a vivid appreciation of what there is yet to learn.

Magmas

*Bulletin of the Geological Society of America*, Volume 58, Number 3,  
April 1947 (p. 278)

**Warren, Robert Penn** 1905–89  
American writer and critic

Below all silken soil-slip, all crinkled earth-crust,  
Far deeper than ocean, past rock that against rock  
grieves,

There at the globe's deepest dark and visceral lust,  
Can you hear the groan-swish of magma as it churns  
and heaves?

*Being There: Poetry 1977–1980*

Youth Truth-Seeker, Half-Naked, at Night, Running Down Beach South  
of San Francisco  
Random House, Inc. New York, New York, USA. 1980

## MAGNET

**Dee, John** 1527–1609  
English mathematician and occultist

In the magnet, God has offered to the eyes of mortals for observation qualities which in other objects he has left for discovery to the subtler research of the mind and a greater investigative industry.

*John Dee on Astronomy*

XXIII (p. 133)  
University of California Press. Berkeley, California, USA. 1978

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

A magnet hung in a hardware shop,  
And all around was a loving crop  
of scissors and needles, nails and knives,  
Offering love for all their lives;  
But for iron the magnet felt no whim,  
Though he charmed iron, it charmed not him;  
From needles and nails and knives he'd turn,  
For he'd set his love on a silver churn!

But this magnetic,  
Peripatetic  
Lover he lived to learn  
By no endeavor  
Can magnet ever  
attract a Silver Churn!

*Patience*

Act II  
Shirmer. New York, New York, USA. 1950

## MAGNETISM

**Bullard, Edward Crisp** 1907–80  
English geophysicist

The straightness, symmetry, extent and ubiquity of these patterns is without parallel in geology and their discovery was completely unexpected.

Reversals of the Earth's Magnetic Field

*Philosophical Transactions of the Royal Society of London*, Volume 263,  
1968 (p. 492)

**Chandrasekhar, Subrahmanyan** 1910–95  
Indian-born American astrophysicist

When magnetic fields occur on the cosmic scale — as in interplanetary regions, in stellar atmospheres and in stellar envelopes, in stars and in interstellar space — they have patterns and properties which cannot be deduced by simply extrapolating from terrestrial experience; for, in these instances, the scale is the essence of the phenomenon, and the scale transcends terrestrial experience.

On Cosmic Magnetic Fields

*Proceedings of the National Academy of Sciences, USA*, Volume 47, Number 1, 1957

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Gilbert shall live till loadstones cease to draw  
Or British fleets the boundless ocean awe.

*The Poetical Works of Dryden*

Epistle to Doctor Walter

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Gilbert, William** 1544–1603

English scientist and physician

In like manner, the loadstone has from nature its two poles, a northern and a southern; fixed, definite points in the stone, which are the primary termini of the movements and effects, and the limits and regulators of the several actions and properties... whether its shape is due to design or chance, and whether it be long, or flat, or four-square, or three cornered, or polished; whether it be rough, broken-off, or unpolished: the loadstone ever has and ever shows its poles.

In *Great Books of the Western World* (Volume 28)

*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*

Book First, Chapter 3

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hale, George Ellery** 1868–1938

American astronomer

Thanks to Zeeman's discovery of the effect of magnetism on radiation, it appeared that the detection of such a magnetic field should offer no great difficulty, provided that it were sufficiently intense.

On the Possible Existence of a Magnetic Field in Sunspots

*Astrophysical Journal*, Volume 28, 1908 (p. 315)

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

Next in order I will proceed to discuss by what law of nature it comes to pass that iron can be attracted by that stone which the Greeks call the Magnet from the name of its native place, because it has its origin within the bounds of the country of the Magnesians.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book Six, l. 906–911 (p. 92)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Parker, E. N.**

No biographical data available

Magnetic fields (and their inevitable offspring fast particles) are found everywhere in the universe where we have the means to look for them.

*Cosmical Magnetic Fields*

Chapter 1 (p. 6)

Clarendon Press. Oxford, England. 1979

It appears that the radical element responsible for the continuing thread of cosmic unrest is the magnetic field.

*Cosmical Magnetic Fields*

Chapter 1 (p. 2)

Clarendon Press. Oxford, England. 1979

## MAGNITUDE

**Hugo, Victor** 1802–85

French author, lyric poet and dramatist

Here is the diatom, there the star. Above, just as below, specks; below, as above, vastness.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 410)

The Heritage Press. New York, New York, USA. 1961

## MAL DE MER

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

The best of remedies is a beef-steak

Against sea-sickness; try it, sir, before

You sneer, and I assure you this is true,

For I have found it answer — so may you.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 13

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Farris, Jean**

No biographical data available

Mal de mer — An ocean-motion notion.

*Quote, the Weekly Digest*, August 4, 1968 (p. 97)

**Flaubert, Gustave** 1821–90

French novelist

Sea-sickness. To avoid, all you have to do is think of something else.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Sterne, Laurence** 1713–68

English novelist and humorist

...the cells are broke loose one into another, and the blood, and the lymph, and the nervous juices, with the fix'd and

volatile salts, are all jumbled into one mass — good g — !  
everything turns round in it like a thousand whirlpools...

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 2)

Book VII, Chapter II (p. 66)

Macmillan & Company Ltd. London, England. 1900

## MALADY

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

Some maladies are rich and precious and only to be acquired  
by the right of inheritance or purchased with gold.

*Mosses from an Old Manse: The Procession of Life*

The Procession of Life (p. 167)

A.L. Burt Company, Publishers. New York, New York, USA. No date

**Maturin, Charles R.** 1782–1824

Anglo-Irish Protestant clergyman

A malady

Preys on my heart that med'cine cannot reach.

*Bertram*

Act IV, Scene II (p. 52)

Printed for J. Murray. London, England. 1816

## MALARIA

**Ross, Sir Ronald** 1857–1932

English bacteriologist

I was tired, and what was the use? I must have examined  
the stomachs of a thousand mosquitoes by this time. But  
the Angel of Fate fortunately laid his hand on my head  
[when he discovered that parasites carrying malaria lived  
in mosquitoes].

*Memoirs: With a full Account of the Great Malaria Problem and Its  
Solution*

Chapter 13

E.P. Dutton & Company, Inc. New York, New York, USA. 1923

I cannot help remembering the dingy little military hospi-  
tal, the old cracked microscope, and the medicine bottles  
which constituted all the laboratory and apparatus which  
I possessed for the purpose of attacking one of the most  
redoubtable of scientific problems.

*Les Prix Nobel. The Nobel Prizes in 1902*

Nobel banquet speech for award received in 1902

Nobel Foundation. Stockholm, Sweden. 1903

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

He is so shak'd of a burning quotidian tertian that it is  
most lamentable to behold.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

The Life of King Henry the Fifth

Act I, Scene ii, l. 123

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## MALARIOLOGIST

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

...DDT went further toward the eradication of malariolo-  
gists than of mosquitoes.

*Man Adapting*

Chapter XIV (p. 380)

Yale University Press. New Haven, Connecticut, USA. 1965

## MALPRACTICE

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

...no doctor dare accuse another of malpractice. He is  
not sure enough of his own opinion to ruin another man  
by it. He knows that if such conduct were tolerated in his  
profession no doctor's livelihood or reputation would be  
worth a year's purchase. I do not blame him: I should do  
the same myself. But the effect of this state of things is  
to make the medical profession a conspiracy to hide its  
own shortcomings.

*The Doctor's Dilemma*

Preface on Doctors

Why Doctors Do Not Differ

Doctors and Vivisection (pp. xiv–xv)

Brentano's. New York, New York, USA. 1920

## MAN

**Ardrey, Robert** 1908–80

American anthropologist

Man is man, and not a chimpanzee, because for millions  
upon millions of years we killed for a living.

*The Hunting Hypothesis*

Chapter 1 (p. 10)

Athenaeum. New York, New York, USA. 1876

**Asimov, Isaac** 1920–92

American author and biochemist

As we trace the development of man over the ages, it  
seems in many respects a tale of glory and victory; of  
the development of the brain; of the discovery of fire, of the  
building of cities and of civilization; of the triumph of  
reason; of the filling of the Earth and the reaching out to  
sea and space.

*Time and Space and Other Things*

Introduction (p. ix)

Doubleday & Company, Inc. Garden City, New York, USA. 1965

**Austin, Mary Hunter** 1868–1934

American novelist and essayist

Man is a great blunderer going about in the woods, and  
there is no other except the bear makes so much noise.



Being so well warned beforehand, it is a very stupid animal, or a very bold one, that cannot keep safely hid.

*The Land of Little Rain*

The Scavengers (p. 60)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**Balfour, Arthur J.** 1848–1930

English politician

Man, so far as natural science by itself is able to teach us, is no longer the final cause of the universe, the Heaven-descended heir of all the ages. His very existence is an accident, his story a brief and transitory episode in the life of one of the meanest of the planets.

*Essays and Addresses*

The Religion of Humanity (p. 307)

David Douglas, Edinburgh, Scotland, 1893

**Bates, Marston** 1906–74

American zoologist

Man's point of view is curiously different in the forest and in the sea. In the forest he is a bottom animal, in the sea a surface animal.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*

Chapter 2 (p. 20)

Random House, Inc. New York, New York, USA. 1960

**Becker, Carl L.** 1873–1945

American historian

Edit and interpret the conclusions of modern science as tenderly as we like, it is still quite impossible for us to regard man as the child of God for whom the earth was created as a temporary habitation. Rather must we regard him a little more than a chance deposit on the surface of the world, carelessly thrown up between two ice ages by the same forces that rust iron and ripen corn...The ultimate cause of this cosmic process of which man is a part, whether God or electricity or a "stress in the ether," we know not. Whatever it may be, if indeed it be anything more than a necessary postulate of thought, it appears in its effects as neither benevolent nor malevolent, as neither kind nor unkind, but merely as indifferent to us.

*The Heavenly City of the Eighteenth Century Philosophers*

Chapter I (p. 14)

Yale University Press. New Haven, Connecticut, USA. 1932

**Blake, William** 1757–1827

English poet, painter, and engraver

Where man is not, nature is barren.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell, Proverbs of Hell, l. 69

University of California Press. Berkeley, California, USA. 1982

**Bohm, David** 1917–92

American physicist

In some sense man is a microcosm of the universe; therefore what man is, is a clue to the universe. We are enfolded in the universe.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity*

Routledge & Kegan Paul. London, England. 1986

**Borland, Hal** 1900–78

American writer

There is a fundamental need in man to know three things: who he is, where he lives, and what time it is. With satisfying answers to those three questions, most of us could live in relative peace with the world and ourselves.

*The Enduring Pattern*

Foreword (p. 3)

Simon & Schuster. New York, New York, USA. 1959

As far as man is concerned, he may well be a biological accident, possibly a mutation that resulted from a particularly livid flare-up of sunspots, and consequent radiation, a million and a half or two million years ago.

*Borland Country*

Foreword (pp. 7–8)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

...man is the only animal who can face with a thought, a dream, and a smile the mystery and the madness and the terrible beauty of the universe.

*Autobiography of Earth*

Chapter 12 (p. 347)

Coward-McCann, Inc. New York, New York, USA. 1935

A germ on an eggshell cannot know the inner workings of eggs. Man is a germ on the shell of the earth, but a germ with reason and imagination. With these he has dug a tunnel toward the buried truth.

*Parade of the Living*

Part I, Chapter VIII (pp. 86–87)

Coward-McCann, Inc. New York, New York, USA. 1930

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

We are all afraid — for our confidence, for the future, for the world. That is the nature of the human imagination. Yet every man, every civilization, has gone forward because of its engagement with what it has set itself to do. The personal commitment of a man to his skill, the intellectual commitment and the emotional commitment working as one, has made the Ascent of Man.

*The Ascent of Man*

Chapter 13 (p. 438)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

Man is a carnivorous production,  
 And must have meals, at least one meal a day;  
 He cannot live, like woodcocks, upon suction,  
 But, like the shark and tiger, must have his prey;  
 Although his anatomical construction  
 Bears vegetables, in a grumbling way,  
 Your laboring people think beyond all question,  
 Beef, veal, and mutton better for digestion.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza 67

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
 English author

...this is practically the claim of the egoism which thinks that self-assertion can obtain knowledge. A beetle may or may not be inferior to a man — the matter awaits demonstration; but if he were inferior to a man by ten thousand fathoms, the fact remains that there is probably a beetle view of things of which a man is entirely ignorant.

In Alberto Manguel (ed.)

*On Lying in Bed and Other Essays*

A Defense of Humility (p. 366)

Bayeaux Arts Inc. Calgary, Ontario, Canada. 2000

**Clarke, Arthur C.** 1917–

English science and science fiction writer

For it may be that the old astrologers had the truth exactly reversed, when they believed that the stars controlled the destinies of men.

The time may come when men control the destinies of stars.

*Future Space Programs 1975*

Testimony (p. 200)

United States Congress. House Committee on Science and Technology.

US Government Printing Office. Washington, D.C. 1975

There are more suns in the whole of space than there are grains of sand on all the shores of Earth; and on any one of those grains, there may be civilizations that will make us look like primitive, ignorant savages.

*The Lost Worlds of 2001*

Chapter 15 (p. 105)

New American Library. New York, New York, USA. 1972

**Cornu, A.**

No biographical data available

Our era is distinguished from preceding ages by wonderful utilization of natural forces; man, that weak and defenseless being, has been enabled by his genius to acquire an extraordinary power, and to bend to his use those subtle yet dreadful agents whose very existence was unknown to our ancestors.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*

The Wave Theory of Light: Its Influence on Modern Physics (p. 93)

Government Printing Office. Washington, D.C. 1901

**Darwin, Charles Robert** 1809–82

English naturalist

We must, however, acknowledge, as it seems to me, that man with all his noble qualities, with sympathy which feels for the most debased, with benevolence which extends not only to other men but to the humblest living creature, with his god-like intellect which has penetrated into the movements and constitution of the solar system — with all these exalted powers — Man still bears in his bodily frame the indelible stamp of his lowly origin.

In *Great Books of the Western World* (Volume 49)

*The Descent of Man*

Part III, Chapter XXI (p. 597)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de La Mettrie, Julien Offroy** 1709–51

French philosopher and physician

It is clear that there is but one substance in this world, and that man is its ultimate expression. Compared to monkeys and the cleverest of animals he is just as Huygen's planet clock is to a watch of King Julien. If more wheels and springs are needed to show the motion of the planets than are required for showing and repeating the hours; and if Vaucanson needed more artistry in producing a flautist than a duck, and art would have been even harder put to produce a "talker", and such a machine, especially in the hands of this new kind of Prometheus, must no longer be thought of as impossible.

In Gerald M. Edelman

*Bright Air, Brilliant Fire: On the Matter of the Mind*

Chapter 19 (p. 188)

Basic Books. New York, New York, USA. 1992,

**de Voto, Bernard** 1897–1955

American historian

Man is a noisome bacillus whom our Heavenly Father created because he was disappointed in the monkey.

In Mark Twain

*Mark Twain in Eruption: Hitherto Unpublished Pages About Men and Events*

Introduction (p. xxvii)

Harper & Brothers Publishers. New York, New York, USA. 1922

**Dexter, William A.**

No biographical data available

Man's existence on the Earth is like the twinkling of an eye.

The Bigness and the Smallness of Time

*Journal of Geological Education*, Volume XV, Number 4, October 1967

(p. 161)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Nature made nearly every possible mistake before she reached her greatest achievement, Man — or perhaps some would say her worst mistake of all.

*Science and the Unseen World*

Chapter 1 (p. 21)

The Macmillan Company. New York, New York, USA. 1929

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

From the oscillating universe, beating like a gigantic heart, to the puzzling existence of antimatter, order, in a human sense, is at least partially an illusion. Ours, in reality, is the order of a time, and of an insignificant fraction of the cosmos, seen by the limited senses of a finite creature.

*The Unexpected Universe*

Chapter 2, Section 5 (p. 46)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

In three billion years of slow change and groping effort only one living creature has succeeded in escaping the trap of specialization that has led in time to so much death and wasted endeavor. It is man, but the word should be uttered softly, for his story is not yet done.

*The Unexpected Universe*

Chapter Three (p. 52)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

And looking so, across the centuries and the millennia, toward the animal men of the past, one can see a faint light, like a patch of sunlight moving over the dark shadows of the forest floor. It shifts and widens, it winks out, it comes again, but it persists. It is the human spirit, the human soul, however transient, however faulty men may claim it to be. In its coming man had no part. It merely came, that curious light, and man, the animal, sought to be something no animal had been before. Cruel he might be, vengeful he might be, but there had entered into his nature a curious wistful gentleness and courage...

*The Firmament of Time*

Chapter V, Part IV (p. 145)

Athenaeum. New York, New York, USA. 1960

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Nor has science sufficient humanity, so long as the naturalist overlooks the wonderful congruity which subsists between man and the world; of which he is lord, not because he is the most subtle inhabitant, but because he is its head and heart, and finds something of himself in every great and small thing, in every mountain stratum, in every new law of color, fact of astronomy, or atmospheric influence which observation or analysis lay open.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses and Lectures

Chapter VIII (p. 68)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Fiske, John** 1842–1901

American philosopher and historian

...Man does not dwell at the centre of things, but is the denizen of an obscure and tiny speck of cosmical matter

quite invisible amid the innumerable throng of flaming suns that make up our galaxy.

*The Destiny of Man Viewed in the Light of His Origin*

Chapter 1 (p. 15)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

**Fuller, R. Buckminster** 1895–1983

American engineer and architect

A self-balancing, 28-pointed adapter-based biped; an electrochemical reduction-plant, integral with segregated storages of special energy extracts in storage batteries, for subsequent activation of thousands of hydraulic and pneumatic pumps, with motors attached; 62,000 miles of capillaries; millions of warning signals, railroad and conveyor systems; crushers and cranes (of which the arms are magnificent 23-jointed affairs with self-surfacing and lubricating systems, and a universally distributed telephone system (needing no service for 70 years if well-managed); the whole extraordinarily complex mechanism guided with complete precision from a turret in which are located telescopic and microscopic self-registering and recording range-finders, a spectroscope, et cetera, air-conditioning intake-and exhaust and a main fuel intake Within the few cubic inches housing the turret mechanism, there is room also for two sound-wave and sound-direction-finder recording diaphragms, a filing and instant reference system, and an expertly devised analytical laboratory large enough not only to contain minute records of every last and continual event of up to 70 years experience or more, but to extend, by computation and abstract fabrication, this experience with relative accuracy into all corners of the observed universe. There is, also, a forecasting and tactical plotting department for the reduction of future possibilities and probabilities to general successful specific choice.

*Nine Chains to the Moon*

Chapter 4 (p. 18)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

Our part in the universe may possibly in some distant way be analogous to that of cells in an organised body, and our personalities may be the transient but essential elements of an immortal and cosmic mind.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (p. 196)

AMS Press. New York, New York, USA. 1973

**Gamow, George** 1904–68

Russian-born American physicist

...it took less than an hour to make the atoms, a few hundred million years to make the stars and planets, but five billion years to make man.

*The Creation of the Universe*

Conclusion (p. 139)

The Viking Press. New York, New York, USA. 1952

**Heinlein, Robert A.** 1907–88

American science fiction writer

By the data to date, there is only one animal in the Galaxy dangerous to man — man himself.

*The Notebooks of Lazarus Long* (p. 1)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

...man is a speculative as well as a sentient being, searching in everything for connexion and harmony, the perception of which mixes itself with his choicest pleasures...

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Whewell on the Inductive Sciences (p. 143)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

**Hewish, Antony** 1924–

English radio astronomer

The world of man lies midway in scale between the inner space of atoms and particles, and the outer space of stars and galaxies. The exploration of both these regions stretches our imagination to its limits.

*Les Prix Nobel. The Nobel Prizes in 1974*

Nobel banquet speech for award received in 1974

Nobel Foundation. Stockholm, Sweden. 1975

**Hinds, Norman E. A.**

No biographical data available

The mind of man can never encompass the total of Creation.

*Geomorphology: The Evolution of Landscape*

Chapter 22 (p. 842)

Prentice-Hall, Inc. New York, New York, USA. 1943

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Here we are in this wholly fantastic Universe with scarcely a clue as to whether our existence has any real significance.

*The Nature of the Universe*

Chapter 7 (p. 138)

The University Press. Cambridge, England. 1933

...only the biological processes of mutation and natural selection are needed to produce living creatures as we know them. Such creatures are no more than ingenious machines that have evolved as strange by-products in an odd corner of the Universe.

*The Nature of the Universe*

Chapter 7 (p. 136)

The University Press. Cambridge, England. 1933

**Huxley, Thomas Henry** 1825–95

English biologist

The question of questions for mankind — the problem which underlies all others, and is more deeply interesting

than any other is the ascertainment of the place which Man occupies in nature and of his relations to the universe of things.

*Collected Essays* (Volume 7)

On the Relations of Man to the Lower Animals

Chapter I (p. 77)

Macmillan & Company Ltd. London, England. 1904

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Old Mother Earth must regard man as a very recent apparition indeed; he has just appeared to burrow into her, burn her forests, put her waterfalls into pipes, and generally mar the beauty of her features. If he has done so much in the first few moments of his existence, she may well wonder what is in store for her in the long future ages in which he is destined to labor on her surface.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

The Wider Aspects of Cosmogony (p. 165)

Government Printing Office. Washington, D.C. 1929

**Jennings, Herbert Spencer** 1868–1947

American zoologist

Vast areas of the universe have not yet realized their potentialities for the production of life. If man disappears, if he turns out to be one of the numerous branches that is not capable of continued existence, and if none of the other existing types can seize the advance, still other innumerable types may well arise and start new cycles of evolution. Man is not indispensable to the advancement of life.

*The Universe and Life*

Chapter II (pp. 59–60)

Yale University Press. New Haven, Connecticut, USA. 1941

**Johanson, Donald**

American paleoanthropologist

**Edey, Maitland**

No biographical data available

...*Homo erectus*. put him on the subway and people would probably take a suspicious look at him. Before *Homo erectus* was a really primitive type, *Homo habilis*; put him on a subway and people would probably move to the other end of the car.

*Lucy: The Beginnings of Mankind*

Prologue (p. 20)

Simon & Schuster. New York, New York, USA. 1981

**Kepler, Johannes** 1571–1630

German astronomer

[I]t is no longer a surprise that man, the ape of his Creator, should finally have discovered the art of singing polyphonically, which was unknown to the ancients, namely in order that he might play the everlastingness

of all created time in some short part of an hour by means of an artistic concord of many voices and that he might to some extent taste the satisfaction of God the Workman with His own works, in that very sweet sense of delight elicited from this music which imitates God.

In *Great Books of the Western World* (Volume 16)

*Harmonies of the World*

Chapter 7 (p. 1048)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Koestler, Arthur** 1905–83

Hungarian-born English writer

But, glory be, man is not a flat-earth dweller all the time — only most of the time. Like the universe in which he lives, he is in a state of continuous creation.

*The Act of Creation*

Book One, Part Three, Chapter XX (p. 363)

The Macmillan Company. New York, New York, USA. 1964

### **Krauss, Lawrence M.** 1954–

American theoretical physicist

There may be no ultimate purpose to our existence or the existence of our atoms. The universe may become unimaginably worse, or it may not. There may be no reward in heaven. But surely the possibility that we, as conscious beings, have some hope of unraveling the secrets of a mysterious universe in the time we have allotted is itself a precious gift we should not squander.

*Atom: An Odyssey from the Big Bang to Life on Earth...and Beyond*

Chapter 19 (p. 283)

Little, Brown & Company. Boston, Massachusetts, USA. 2001

### **Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

How small a part of our system is known!

What a pitiful molehill is our Earth;

and, how insignificant are we —

we who creep so proudly on her surface.

Translated by James Jacque

*The System of the World*

Part I, Chapter V (p. 33)

Printed for Vernor & Hood. London, England. 1800

### **Landau, Lev** 1908–68

Russian physicist

The discovery of quantum mechanics and of the principle of uncertainty has shown that man can tear himself away from deeply rooted notions, discover, and accept something that is beyond his power of visualizing.

In Alexandre Dorozynski

*The Man They Wouldn't Let Die*

Chapter 7 (p. 95)

The Macmillan Company. New York, New York, USA. 1965

### **Lawrence, D. H. (David Herbert)** 1885–1930

English writer

Then came the melting of the glaciers, and the world flood. The refugees from the drowned continents fled to the high places of America, Europe, Asia, and the Pacific Isles. And some degenerated naturally into cave men, neolithic and paleolithic creatures, and some retained their marvelous innate beauty and life-perfection, as the South Sea Islanders, and some wandered savage in Africa...

*Fantasia of the Unconscious*

Forward (p. xi)

M. Secker. London, England. 1923

I am part of the sun as my eye is part of me. That I am part of the earth my feet know perfectly, and my blood is part of the sea.

*Apocalypse*

Twenty-three (p. 200)

The Viking Press. New York, New York, USA. 1932

### **Le Conte, Joseph** 1823–1901

Physiologist and geologist

Man must be set off not only against the animal kingdom, but against the whole of Nature besides, as an equivalent: Nature the book — the revelation — and man the interpreter.

*Elements of Geology: A Text-Book for Colleges and for the General Reader*

Part III, Chapter VI (p. 587)

D. Appleton & Company. New York, New York, USA. 1882

...the history of the earth find[s] its consummation, and its interpreter, and its significance, in man.

*Elements of Geology: A Text-Book for Colleges and for the General Reader*

Part III, Chapter VI (p. 587)

D. Appleton & Company. New York, New York, USA. 1882

### **Leakey, Mary** 1913–96

English archaeologist

I've found him — found our man!

*New York Times*, 30 October 1984

### **Lowell, Percival** 1855–1916

American astronomer

We pride ourselves upon being men of the world, forgetting that this is but objectionable singularity unless we are, in some wise, men of more worlds than one.

*Mars*

Chapter VI (p. 212)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

If astronomy teaches anything, it teaches that man is but a detail in the evolution of the Universe, and that resembling, though diverse details are inevitably to be expected in the host of orbs around him. He learns that, though he will probably never find his double anywhere, he is destined to discover any number of cousins scattered through space.

*Mars*

Chapter VI (p. 212)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Mallove, Eugene F.** 1947–2004  
Editor

No one yet can prove that life is a more general drive of matter and energy than mere creeping carbon-based creatures struggling to emigrate from a sticky planetary surface.

*The Quickening Universe: Cosmic Evolution and Human Destiny*  
Chapter I (p. 7)  
St. Martin's Press. New York, New York, USA. 1987

No matter how small or seemingly weak, there is unquestionably a special grace to a fragment of the universe that aspires to comprehend the whole.

*The Quickening Universe: Cosmic Evolution and Human Destiny*  
Chapter I (p. 7)  
St. Martin's Press. New York, New York, USA. 1987

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

the supercilious silliness  
of this poor wingless bird  
is cosmically comical  
and stellarly absurd

*the lives and times of archy & mehitabel*  
archy turns revolutionist (p. 227)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

insects have  
their own point of view about  
civilization a man  
thinks he amounts  
to a great deal  
but to a  
flea or a  
mosquito a  
human being is  
merely something good to eat

*the lives and times of archy & mehitabel*  
certain maxims of archy (pp. 53–54)  
Doubleday, Doran & Company, Inc. Garden City, New York,  
USA. 1933

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Up till the introduction of man upon our planet, the humbler creatures, his predecessors, formed but mere figures in its various landscapes, and failed to alter or affect by their works the face of nature.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture Sixth (p. 237)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Miller, Perry** 1905–63  
American historian

It is only too clear that man is not at home in this universe, and yet he is not good enough to deserve a better...

*The New England Mind: The Seventeenth Century*  
Chapter I (p. 7)  
Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Monod, Jacques** 1910–76  
French biochemist

...man knows at last that he is alone in the universe's unfeeling immensity, out of which he emerged only by chance.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*  
Chapter IX (p. 180)  
Vintage Books. New York, New York, USA. 1972

**Morris, Desmond** 1928–  
Zoologist and ethnologist

Despite our grandiose ideas and our lofty self-conceits, we are still humble animals, subject to all the basic laws of animal behavior... We tend to suffer from a strange complacency that...there is something special about us, that we are somehow above biologic control. But we are not. Many exciting species have become extinct in the past, and we are no exception. Sooner or later we shall go, making way for something else. If it is to be later rather than sooner, then we must take a long, hard look at ourselves as biological specimens, and gain some understanding of our limitations.

*The Naked Ape*  
Chapter Eight (p. 240)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

**Newman, Joseph S.** 1892–1960  
American poet

Man is born, eats, procreates, and dies  
This sequence of events alike applies  
To horses, herring, crocodiles, and flies.

*Poems for Penguins and Other Lyrical Lapses*  
Biochemistry  
Greenburg. New York, New York, USA. 1941

**Nietzsche, Friedrich** 1844–1900  
German philosopher

Man is a rope stretched between the animal and the superman — a rope over an abyss.

Translated by Thomas Common  
*Thus Spake Zarathustra*  
Zarathustra's Prologue, 4 (p. 8)  
The Modern Library. New York, New York, USA. No date

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

We [US and USSR] may be likened to two scorpions in a bottle, each capable of killing the other, but only at the risk of his own life.

Atomic Weapons and American Policy  
*Foreign Affairs*, July 1953 (p. 529)

**Osborne, John** 1939–94  
English playwright

Here we are, we're alone in the universe, there's no God, it just seems that it all began by something as simple as sunlight striking on a piece of rock. And here we are. We've only got ourselves. Somehow, we've just got to make a go of it. We've only ourselves.

*The Entertainer*  
No. 12

Criterion Books. New York, New York, USA. 1958

**Pascal, Blaise** 1623–62  
French mathematician and physicist

For, in fact, what is man in nature? A Nothingness in comparison with the Infinite, an All in comparison with the Nothing, a mean between nothing and everything.

In *Great Books of the Western World* (Volume 33)  
*Pensées*

Section II, 72

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Man is but a reed, the most feeble thing in nature; but he is a thinking reed. The entire universe need not arm itself to crush him. A vapour, a drop of water suffices to kill him. But, if the Universe were to crush him, man would still be more noble than that which killed him, because he knows that he dies and the advantage which the universe has over him; the universe knows nothing of this.

In *Great Books of the Western World* (Volume 33)  
*Pensées*

Section VI, 347

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pickering, James Sayre**  
No biographical data available

Man is a freak, colloidal combination of thirteen elements which happen to have a chemical affinity for each other, and is the strangest and one of the most amusing accidents of nature. The market value of the substance of the average man is about 98c.

*The Stars Are Yours* (p. 230)

The Macmillan Company. New York, New York, USA. 1948

**Plaskett, J. S.**

No biographical data available

...when we consider how the human mind, though inhabiting for only a few years this minute planet, accompanying a comparatively insignificant star of the system, has been able to reach out to the inconceivable depths of space and reduce some of the confusion of stars to orderly systems, has been able to deduce the laws which govern these systems, thus unifying, in certain degree, all the wonderful phenomena of suns and planets, comets, stars, nebulae and clusters, into one whole, we do not lose hope that eventually it will be able to much further unravel the mystery of the universe.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1911*

Developments in Astronomy (p. 270)

Government Printing Office. Washington, D.C. 1912

**Rabinowitch, Eugene** 1901–73  
Russian-born American biophysicist

We are indeed the detritus of stars, our atoms are the flour of celestial mills, our bodies the backings of solar fires.

The Role of Scientists: Thoughts for 1971

*Bulletin of the Atomic Scientists*, Volume XXVII, Number 1, January 1971 (p. 3)

**Raymo, Chet** 1936–  
American physicist and science writer

We are indeed the detritus of stars, our atoms are the flour of celestial mills, our bodies the backings of solar fires.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 21 (p. 196)

The Viking Press. New York, New York, USA. 1991

We are not playthings of the gods, comet-warned and fearful; we are the comet's offspring, volatile compounds made animate, made conscious.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Thirteen (p. 251)

Walker & Company. New York, New York, USA. 1998

**Riggs, Arthur Stanley**  
No biographical data available

Man is what he is today — as our descendants will be a million years hence — because of the virtues of all our ancestors.

*The Romance of Human Progress*

Introduction (p. xix)

The Bobbs-Merrill Company. New York, New York, USA. 1938

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

For countless ages the sun rose and set, the moon waxed and waned, the stars shone in the night, but it was only with the coming of Man that these things were understood. In the great world of astronomy and in the little world of the atom, Man has unveiled secrets which might have been thought undiscoverable.

*Portraits from Memory, and Other Essays* (p. 238)

Simon & Schuster. New York, New York, USA. 1956

Man is a part of Nature, not something contrasted with Nature.

*What I Believe*

Chapter I (p. 1)

E.P. Dutton & Company, Inc. New York, New York, USA. 1925

...Man is the product of causes which had no prevision of the end they were achieving; that his origin, his growth, his hopes and fears, his loves and his beliefs, are but the

outcome of accidental collocations of atoms; that no fire, no heroism, no intensity of thought and feeling, can preserve an individual life beyond the grave; that all the labors of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system, and that the whole temple of man's achievement must inevitably be buried beneath the debris of a universe in ruins — all these things, if not quite beyond dispute, are yet so nearly certain, that no philosophy which rejects them can hope to stand.

In Robert E. Egner and Lester E. Denonn

*The Basic Writings of Bertrand Russell*

A Free Man's Worship (first published as "The Free Man's Worship" in December 1903) (p. 67)

Simon & Schuster. New York, New York, USA. 1961

**Sackville-West, V.** 1892–1962

English Poet

...one might reply that man himself was but a collection of atoms, even as a house was but a collection of bricks, yet man laid claim to a soul, to a spirit, to a power of recording and or perception, which had not more to do with his restless atoms than had the house with its stationary bricks.

*All Passion Spent*

Part I (p. 82)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Sakharov, Andrei** 1921–89

Soviet physicist and dissident

"Like a gleam in the darkness, we have appeared for an instant from the black nothingness of the ever-unconscious matter, in order to make good the demands of Reason and create a life worthy of ourselves and of the Goal we only dimly perceive.

*Nobel Lectures, Peace 1971–1980*

Acceptance speech for award received in 1975

World Scientific Publishing Company, Singapore. 1997

**Shapley, Harlow** 1885–1972

American astronomer

We are brothers of the boulders, cousins of the clouds.

In Eric Chaisson

*Cosmic Dawn: The Origins of Matter and Life*

Epilogue (p. 299)

Little, Brown & Company. Boston, Massachusetts, USA. 1981

Mankind is made of star stuff, ruled by universal laws. The thread of cosmic evolution runs through his history, as through all phases of the universe — the microcosmos of atomic structures, molecular forms, and microscopic organisms, and the macrocosmos of higher organisms, of planets, stars, and galaxies. Evolution is still proceeding in galaxies and man — to what end, we can only vaguely surmise.

*The View from a Distant Star: Man's Future in the Universe*

Preface (p. 5)

Dell Publishing Company, Inc. New York, New York, USA. 1967

**Simpson, George Gaylord** 1902–84

American paleontologist

It is obvious that the great majority of humans throughout history have had grossly, even ridiculously, unrealistic concepts of the world. Man is, among many other things, the mistaken animal, the foolish animal. Other species doubtless have much more limited ideas about the world, but what ideas they do have are much less likely to be wrong and are never foolish. White cats do not denigrate black, and dogs do not ask Baal, Jehovah, or other Semitic gods to perform miracles for them.

*This View of Life: The World of an Evolutionist*

Preface (p. viii)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

**Squire, John Collings** 1884–1958

English poet

Men were on earth while climates slowly swung.

Fanning wide zones to heat and cold, and long

Subsidence turned great continents to sea,

And seas dried up, dried up interminably.

Age after age; enormous seas were dried

Amid wastes of land. And the last monster died.

*Collected Poems*

The Birds (p. 154)

Macmillan & Company Ltd. London, England. 1959

**Steinbeck, John** 1902–68

American novelist

Man is related...inextricably to all reality, known and unknowable....[P]lankton, a shimmering phosphorescence on the sea and the spinning planets and an expanding universe, all bound together by the elastic string of time. It is advisable to look from the tide pool to the stars and then back to the tide pool again.

*Sea of Cortez*

Chapter 21 (p. 217)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Teller, Woolsey** 1890–1954

Essayist

Out of the star-dust man came, and into it he will sink again, as oblivious of his own passing existence as he was before that existence painfully and slowly evolved and separated him, for one brief instant, from the blindly-groping Whole.

*The Atheism of Astronomy*

Chapter VI (pp. 120–121)

Arno Press & The New York Times. New York, New York, USA. 1972

**Thierry, Paul Henri, Baron d'Holbach** 1723–89

German-born French philosopher



Man is the work of nature: he exists in nature: he is submitted to her laws: he cannot deliver himself from them: nor step beyond them, even in thought.

Translated by M. Mirabaud

*System of Nature, or The Laws of the Moral and Physical World*  
(Volume First)

Part First, Chapter First (p. 13)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**Thomas, Lewis** 1913–93

American physician and biologist

...we are here by the purest chance, and by mistake at that.

*The Medusa and the Snail: More Notes of a Biology Watcher*

The Wonderful Mistake (p. 29)

The Viking Press. New York, New York, USA. 1979

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

We are surroundings, our very existence to it [the universe]. Looking at it as an evolutionist, I believe that it is only by tracing it back to some necessary earlier state that we shall be able to form some rational conception of *how* it has evolved, *how* it has come to be what it is, *how* we have come to be where we are. Then, and then only, shall we be able to give any probable answer to the question, What advantages have we derived from our nearly central position?

Man's Place in the Universe, A Reply to the Criticism

*The Independent*, Volume 55, Number 2856, August 27, 1903 (p. 2030)

**Weller, Stuart**

No biographical data available

Doubtless there is no topic which possesses a wider interest for members of the human race than the topic of man himself...

*Annual Report of the Board of Regents of the Smithsonian Institution, 1927*

Paleontology and Human Relations (p. 309)

Government Printing Office. Washington, D.C. 1928

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

...man, who at times dreamt of himself as a little lower than the angels, has submitted to become the servant and minister of nature.

*Science and the Modern World*

Chapter VI (p. 141)

The Macmillan Company. New York, New York, USA. 1929

**Whyte, Lancelot Law** 1896–1972

Scottish Physicist

In the vast tapestry of human experience there is nothing so extraordinary, or so challenging to human understanding as the process by which in a partly haphazard world of inorganic materials exploited their own laws so that organisms came into existence, and a cumulative process was started that led to the appearance of man.

*Accent on Form: An Anticipation of the Science of Tomorrow*

Chapter VI (p. 85)

Harper & Brothers Publishers. New York, New York, USA. 1954

**Young, Louise B.**

Science writer

Now in the vast spaces between the stars organic molecules like those that first formed life float on waves of energy that carry messages across the Milky Way. Because man has entered the cosmos, orderly patterns of form have taken wing and are spreading through the universe at the speed of light.

*The Unfinished Universe*

Chapter 8 (p. 166)

Simon & Schuster. New York, New York, USA. 1986

**Yourcenar, Marguerite** 1903–87

French writer

...if man is part and parcel of the universe, and is ruled by the same laws as govern the sky, it is not unreasonable to search the heavens for the patterns of our lives, and for those impersonal attractions which induce our success and our errors.

*Memoirs of Hadrien*

Tellus Stabilita (p. 148)

Farrar, Straus & Company. New York, New York, USA. 1963

## MANDELBROT SET

**Ewing, John**

No biographical data available

If the entire Mandelbrot set [a family of complex polynomials that describes a fractal] were placed on an ordinary sheet of paper, the tiny sections of boundary we examine would not fill the width of a hydrogen atom. Physicists think about such tiny objects; only mathematicians have microscopes fine enough to actually observe them.

The College Mathematics Journal

*Can We See the Mandelbrot Set?*, Volume 26, Number 2, March 1995

## MANKIND

**Coon, Carleton** 1904–81

American anthropologist

If Africa was the cradle of mankind, it was only an indifferent kindergarten. Europe and Asia were our principal schools.

*The Origin of Races*

Chapter 12 (p. 656)

Alfred A. Knopf. New York, New York, USA. 1966

**Hooke, Robert** 1635–1703

English physicist

It is the great prerogative of Mankind above other Creatures, that we are not only able to behold the works of Nature, or barely to sustain our lives by them, but we

have also the power of considering, comparing, altering, assisting, and improving them to various uses.

*Micrographia*

Preface (First page)

Printed by Jo. Martyn & Ja. Allestry. London, England. 1665

**Leakey, Richard Erskine** 1944–

Kenyan palaeoanthropologist and politician

**Lewin, Roger Amos**

Anthropologist

There is no law that declares the human species to be immortal.

*Origins: What New Discoveries Reveal About the Emergence of Our Species and Its Possible Future*

Chapter 10 (p. 256)

E.P. Dutton & Company, Inc. New York, New York, USA. 1977

**Ray, John** 1627–1705

English naturalist

Whatever may be said for ye Antiquity of the Earth itself and bodies lodged in it ye race of mankind is new.

In Charles Robert Gunther

*Further Correspondence of John Ray* (p. 260)

Printed for the Ray Society. London, England. 1928

**Sagan, Carl** 1934–96

American astronomer and author

In all the history of mankind, there will be only one generation that will be first to explore the Solar System, one generation for which, in childhood, the planets are distant and indistinct discs moving through the night sky, and for which, in old age, the planets are places, diverse new worlds in the course exploration.

*The Cosmic Connection: An Extraterrestrial Perspective*

Chapter 9 (p. 69)

Dell Publishing, Inc. New York, New York, USA. 1975

**Yalow, Rosalyn** 1921–

American medical physicist

If we are to have faith that mankind will survive and thrive on the face of the earth, we must believe that each succeeding generation will be wiser than its progenitors. We transmit to you, the next generation, the total sum of our knowledge. Yours is the responsibility to use it, add to it, and transmit it to your children.

*Les Prix Nobel. The Nobel Prizes in 1977*

Nobel banquet speech for award received in 1977

Nobel Foundation. Stockholm, Sweden. 1978

**MAP**

**Boehm, G. A. W.**

No biographical data available

The question of what properties, such as angle or area, are reproduced on a map without distortion is of prime

interest to mathematicians. The question extends far beyond the confines of geometry, for all mathematics can be considered broadly as a study of maps and mapping.

*The New World of Mathematics* (p. 124)

**Brown, Lloyd**

No biographical data available

[Maps]...art with a purpose.

*The Story of Maps*

The Earth Takes Shape (p. 32)

Little, Brown. Boston, Massachusetts, USA. 1949

**Bryan, Kirk**

No biographical data available

Time, thought, and money are never wasted on the production of a map which shows clearly the relation of one thing to another on the earth's surface.

Physical Geography in the Training of the Geographer

*Annals of the Association of American Geographers*, Volume 34, 1944 (p. 185)

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

He had bought a large map representing the sea

Without the least vestige of land:

And the crew were much pleased when they found it to be

A map they could all understand.

*The Complete Works of Lewis Carroll*

The Hunting of the Snark

Fit the Second

The Bellman's Speech (p. 760)

The Modern Library. New York, New York, USA. 1936

**Gleick, James** 1954–

American author, journalist, and essayist

Physicists' models are like maps: never final, never complete until they grow as large and complex as the reality they represent.

*Genius: The Life and Science of Richard Feynman*

Epilogue (p. 436)

Pantheon Books. New York, New York, USA. 1992

**Robinson, Arthur H.** 1915–2004

American geographer

Mathematical equations and literary phrases are useful but they are no substitute for the spatial eloquence of the map.

Uniqueness of the Map

*American Cartographer*, Volume 5, Number 1, 1978

**Robinson, Arthur H.** 1915–2004

American geographer

**Petchenik, Barbara Bartz**

No biographical data available

[Map]...a graphic representation of the milieu...

*The Nature of Maps*

Chapter 1 (p. 16)

The University of Chicago Press. Chicago, Illinois, USA. 1976

### **Sholander, Marlow**

Mathematician

Within your lifetime will, perhaps,  
As souvenirs from distant suns  
Be carried back to earth some maps  
Of planets and you'll find that one's  
So hard to color that you've got  
To use five crayons. Maybe, not.

Maybe

*Mathematics Magazine*, Volume 35, Number 1, January 1962 (p. 20)

### **Yukawa, Hideki** 1907–81

Japanese theoretical physicist

Those who explore an unknown world are travelers without a map: the map is the result of the exploration. The position of their destination is not known to them, and the direct path that leads to it is not yet made.

In Robert P. Crease and Charles C. Mann

*The Second Creation: Makers of the Revolution in 20<sup>th</sup> Century Physics*

Chapter 9 (p. 159)

The Macmillan Company. New York, New York, USA. 1986

## MARINE BIOLOGY

### **Spenser, Edmund** 1552–99

English poet

But what an endlesse worke have I in hand,  
To count the seas abundant progeny,  
Whose fruitful seede farre passeth those on land,  
And also those which wonne in th' azure sky;  
For much more eath, to tell the starres on hy,  
Albe they endlesse seem in estimation,  
Than to recount the seas posterity;  
So fertile be the floods in generation,  
So huge their numbers, and so numberlesse their nation.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book IV, Canto XII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

## MARTIAN

### **Lowell, Percival** 1855–1916

American astronomer

The evidence of handicraft, if such it be, points to a highly intelligent mind behind it. Irrigation, unscientifically conducted, would not give us such truly wonderful mathematical fitness in the several parts to the whole as we there behold. A mind of no mean order would seem to have presided over the system we see, — a mind certainly of considerably more comprehensiveness than that which presides over the various departments of our own

public works. Party politics at all events have had no part in them; for the system is planet wide. Quite possibly, such Martian folk are possessed of inventions of which we have not dreamed, and with them electrophones and kinetoscopes are things of a bygone past, preserved with veneration in museums as relics of the clumsy contrivances of the simple childhood of the race. Certainly what we see hints at the existence of beings who are in advance of, not behind us, in the journey of life.

*Mars*

Chapter VI (p. 208)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

## MARTYRDOM

### **Hilbert, David** 1862–1943

German mathematician

Only an idiot could believe that scientific truth needs martyrdom — that may be necessary in religion, but scientific results prove themselves in time.

In Constance Reid

*Hilbert — Courant*

Hilbert

Chapter XII (p. 92)

Springer-Verlag. New York, New York, USA. 1986

## MASS

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The law refers to the product of the masses of the two bodies; but the mass depends on the velocity — a fact unknown in Newton's day. Are we to take the variable mass, or the mass reduced to rest? Perhaps a learned judge, interpreting Newton's statement like a last will and testament, could give a decision; but that is scarcely the way to settle an important point in scientific theory.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter VI (p. 93)

At The University Press. Cambridge, England. 1921

## MATHEMATICAL SCIENCE

### **Abel, Niels Henrik** 1802–29

Norwegian mathematician

The divergent series are the invention of the devil, and it is a shame to base on them any demonstrations whatsoever.

In Morris Kline

*Mathematics: The Loss of Certainty*

Chapter VII (p. 170)

Oxford University Press, Inc. New York, New York, USA. 1980

### **Adams, Henry Brooks** 1838–1918

American man of letters

In the one branch he most needed — mathematics — barring the few first scholars, failure was so nearly universal that no attempt at grading could have had value, and whether he stood fortieth or ninetieth must have been an accident or the personal favor of the professor. Here his education failed lamentably. At best he could never have been a mathematician; at worst he would never have cared to be one; but he needed to read mathematics, like any other universal language, and he never reached the alphabet.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter IV (p. 60)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Adler, Alfred** 1870–1937

Austrian psychiatrist

Mathematics, like chess, requires too direct and personal a confrontation to allow graceful defeat.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 3)

Wadsworth, Inc. Belmont, California, USA. 1984

Mathematics is pure language — the language of science.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 3)

Wadsworth, Inc. Belmont, California, USA. 1984

...mathematics is whatever mathematicians are doing.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 4)

Wadsworth, Inc. Belmont, California, USA. 1984

**Aleksandrov, Aleksandre Danilovic** 1912–99

Russian mathematician and physicist

With even a superficial knowledge of mathematics, it is easy to recognize certain characteristic features: its abstractions, its precision, its logical rigor, the indisputable character of its conclusions, and finally, the exceptionally broad range for its applications.

In A.D. Aleksandrov, A.N. Kolmogorov and M.A. Laverent'ev (eds.)

*Mathematics: Its Contents, Methods, and Meaning* (p. 1)

The MIT Press. Cambridge, Massachusetts. 1963

**Allen, Woody** 1935–

American motion picture director and actor

Standard mathematics has recently been rendered obsolete by the discovery that for years we have been writing the numeral five backward. This has led to a reevaluation of counting as a method of getting from one to ten.

*Getting Even*

Spring Bulletin (p. 58)

Random House, Inc. New York, New York, USA. 1971

**Anglin, William S.**

Canadian philosopher and mathematician

Mathematics is not a careful march down a well-cleared highway, but a journey into a strange wilderness, where the explorers often get lost. Rigor should be a signal to the historian that the maps have been made, and the real explorers have gone elsewhere.

Mathematics and History

*The Mathematical Intelligencer*, Volume 14, Number 4, Fall 1992 (p. 10)

**Apostle, Hippocrates George**

No biographical data available

That mathematics is a theoretical science is evident from those who have pursued that science; they have been lovers of wisdom and have sought to discover eternal truths...those who have investigated the objects of mathematics have done so not for gain or use but for the sake of truth.

*Aristotle's Philosophy of Mathematics*

Chapter I (p. 3)

The University of Chicago Press. Chicago, Illinois, USA. 1952

**Arago, Francois** 1786–1853

French physicist

The mathematics have been in all ages the implacable adversaries of scientific romances.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1874*

Laplace (p. 156)

Government Printing Office. Washington, D.C. 1875

**Arbuthnot, John** 1667–1735

Scottish mathematician and physician

There are very few things which we know, which are not capable of being reduc'd to a Mathematical Reasoning...and where a Mathematical Reasoning can be had, it's as great folly to make use of any other, as to grope for a thing in the dark when you have a Candle standing by you.

*Of the Laws of Chance*

Preface

Benjamin Motte. London, England. 1692

The mathematics are the friends to religion, inasmuch as they charm the passions, restrain the impetuosity of the imagination, and purge the mind from error and prejudice. Vice is error, confusion and false reasoning; and all truth is more or less opposite to it. Besides, mathematical truth may serve for a pleasant entertainment for those hours which young men are apt to throw away upon their vices; the delightfulness of them being such as to make solitude not only easy but desirable.

*An Essay on the Usefulness of Mathematical Learning*

Printed at the Theater in Oxford. 1701

Mathematics makes the mind attentive to the objects which it considers. This they do by entertaining it with a great variety of truths, which are delightful and evident, but not obvious. Truth is the same thing to the understanding

as music to the ear and beauty to the eye. The pursuit of it does really as much to gratify a natural faculty implanted in us by our wise Creator as the pleasing of our senses: only in the former case, as the object and faculty are more spiritual, the delight is more pure, free from regret, turpitude, lassitude, and intemperance, that commonly attend sensual pleasures.

*An Essay on the Usefulness of Mathematical Learning*  
Printed at the Theater in Oxford. 1701

### Aristo, Chian

No biographical data available

Those who occupy themselves with Mathematics to the neglect of Philosophy, are like the wooers of Penelope, who, unable to attain the mistress, content themselves with the maids.

*Edinburgh Review*, Volume 52, January 1836 (p. 229)

### Aristotle 384 BCE–322 BCE

Greek philosopher

There are things which seem incredible to most men who have not studied mathematics.

In Stanley Gudder

*A Mathematical Journey* (p. 358)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

Mathematics...is concerned with a wider domain than that domain which it is the object of the natural sciences to describe and categorize. The natural sciences are concerned with the actual world. Mathematics is concerned with "all possible worlds."

*A Combinatorial Theory of Possibility*

Part II, Chapter 9, Section iv (p. 126)

Cambridge University Press. Cambridge, England. 1989

### Artstein, Zvi

Mathematician

Nature is a good approximation of Mathematics.

*Rutgers University Colloquium*

December 6, 2002

### Asimov, Isaac 1920–92

American author and biochemist

I'm saying suppose. In mathematics, we say "suppose" all the time and see if we can end up with something patently untrue or self-contradictory...

*Prelude to Foundation*

48 (p. 206)

Doubleday. New York, New York, USA. 1988

### Atkins, Peter William 1940–

English physical chemist and writer

Buttercups do not think, yet they are also built of mathematics.

*Creation Revisited: The Origin of Space, Time and the Universe*

Chapter Five (p. 119)

W. H. Freeman & Company. Oxford, England. 1992

### Author undetermined

Here's to mathematics, may it never be of use to anyone.  
Old Cambridge toast

### Bacon, Roger 1214–92

English philosopher, scientist, and friar

There are four great sciences.... Of these sciences the gate and key is mathematics, which the saints discovered at the beginning of the world...

Translated by Robert Belle Burke

*The Opus Majus of Roger Bacon*

Part 4, Chapter. 1 (p. 116)

Oxford University Press, Inc. London, England. 1928

Neglect of mathematics works injury to all knowledge, since he who is ignorant of it cannot know the other sciences or the things of this world. And what is worse, men who are thus ignorant are unable to perceive their own ignorance and so do not seek a remedy.

Translated by Robert Belle Burke

*The Opus Majus of Roger Bacon*

Part 4

Distinctia Prima

cao. 1

Oxford University Press, Inc. London, England. 1928

...mathematics is absolutely necessary and useful to other sciences.

Translated by Robert Belle Burke

*The Opus Majus of Roger Bacon*

Part 4, Chapter 3 (p. 126)

Oxford University Press, Inc. London, England. 1928

The knowledge of mathematical things is almost innate in us.... This is the easiest of sciences, a fact which is obvious in that no one's brain rejects it; for laymen and people who are utterly illiterate know how to count and reckon.

Translated by Robert Belle Burke

*The Opus Majus of Roger Bacon*

Part 4, Chapter 1

Oxford University Press, Inc. London, England. 1928

### Bacon, Sir Francis 1561–1626

English lawyer, statesman, and essayist

The mathematic is either pure or mixed: To pure mathematic belong those sciences which handle quantity entirely severed from matter and from axioms of natural philosophy; these are two, geometry and arithmetic; the one handling quantity continued, the other dissevered.... Mixed Mathematic has for its subject some axioms and parts of natural philosophy, and considers quantity in so far as it assists to explain, demonstrate and actuate these.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter VIII, Section 2 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

So if a man's wit be wandering, let him study the mathematics; for in demonstrations, if his wit be called away [ever] so little, he must begin again.

*Bacon's Essays*

Of Studies (p. 211)

Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

For it being the nature of the mind of man (to the extreme prejudice of knowledge) to delight in the spacious liberty of generalities, as in a champaign region, and not in the enclosures of particularity, the mathematics of all other knowledge were the goodliest fields to satisfy that appetite.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VIII, Section 1 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

For many parts of nature can neither be invented with sufficient subtlety, nor demonstrated with sufficient perspicuity, nor accommodated unto use with sufficient dexterity, without the aid and intervening of mathematics...

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VIII, Section 2 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Histories make men wise; poets, witty; the mathematics, subtle; natural philosophy, deep; moral, grave; logic and rhetoric, able to contend.

*Essays*

Of Studies

Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

In mathematics I can report no deficiency, except it be that men do not sufficiently understand the excellent use of the pure mathematics.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Book II, Chapter VIII, Section 2 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Bain, Alexander** 1818–1903

Scottish philosopher and psychologist

Those that can readily master the difficulties of Mathematics find a considerable charm in the study, sometimes amounting to fascination. This is far from universal; but the subject contains elements of strong interest of a kind that constitutes the pleasures of knowledge. The marvelous devices for solving problems elate the mind with the feeling of intellectual power; and the innumerable constructions of the science leave us lost in wonder.

*Education as a Science*

Chapter 5 (p. 153)

C. Kegan Paul & Company. London, England. 1879

### **Barnett, P. A.**

No biographical data available

The strength of mathematics is derived from the very fact that its truths are detachable by abstraction from the

concretes in which they exist for our senses. We argue *in vacuo*, so to speak, without any possibility of error arising from the accidents of individual experience, prejudice, opinion, or the imperfection of our senses.

*Common Sense in Education and Teaching*

Chapter IX (p. 222)

Longmans, Green & Company. London, England. 1899

### **Barrow, Isaac** 1630–77

English clergyman and mathematician

Mathematics — the unshaken Foundation of Sciences, and the plentiful Fountain of Advantage to human affairs.

In Carl B. Boyer

*A History of Mathematics* (p. 404)

John Wiley & Sons, Inc. New York, New York, USA. 1968

### **Barry, Frederick** 1876–1943

Historian of science

No amount of logical or mathematical investigation alone, moreover, can ever establish a fact.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 111)

Columbia University Press. New York, New York, USA. 1927

### **Bartlett, Albert A.**

American physicist

The greatest shortcoming of the human race is man's inability to understand the exponential function.

The Exponential Function

*The Physics Teacher*, Volume 14, Number 7, October 1976 (p. 394)

### **Beebe, William** 1877–1962

American ornithologist

Having an I.Q. in mathematics lower than would be thought possible in any human being alive, my mind is always excited at any simple kindergarten problems.

*High Jungle*

Chapter X (p. 164)

Duell, Sloan & Pearce. New York, New York, USA. 1949

### **Begley, Sharon** 1956–

Science editor

Pure mathematics is a sucker's game. It lures the curious and the confident with its seeming simplicity only to make them look like fools.

New Answer for an Old Question

*Newsweek*, July 5, 1993 (p. 52)

### **Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

No satisfactory justification has ever been given for connecting in any way the consequences of mathematical reasoning with the physical world.

*Debunking Science*

University of Washington Book Store. Seattle, Washington, USA. 1930

The toughminded suggest that the theory of the infinite elaborated by the great mathematicians of the Nineteenth and Twentieth Centuries, without which mathematical analysis as it is actually used today is impossible, has been committing suicide in an unnecessarily prolonged and complicated manner for the past half century.

*Debunking Science*

University of Washington Book Store. Seattle, Washington, USA. 1930

...we shall leave to the antiquarians the difficult and delicate task of restoring the roses to the cheeks of mathematical mummies.

*The Development of Mathematics*

To Any Prospective Reader (p. v)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

Just as "beauty is its own excuse for being," so mathematics needs no apology for existing.

*The Queen of the Sciences*

Chapter VI (p. 82)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

"Obvious" is the most dangerous word in mathematics.

*Mathematics: Queen and Servant of Science*

Points of View (p. 16)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Even stranger things have happened; and perhaps the strangest of all is the marvel that mathematics should be possible to a race akin to the apes.

*The Development of Mathematics*

Uncertainties and Probabilities (p. 546)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

For my own part I have swallowed mathematics enough in my life to be immune to just one more dose, and I shall continue to get smallpox vaccinations whenever I contemplate a vacation in any of the filthier parts of the North American continent.

*Mathematics: Queen and Servant of Science*

Choice and Chance (p. 381)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

The task of cleaning up mathematics and salvaging whatever can be saved from the wreckage of the past twenty years will probably be enough to occupy one generation.

*Debunking Science*

University of Washington Book Store. Seattle, Washington, USA. 1930

Mathematics has a light and wisdom of its own, above any possible applications to science, and it will richly reward any intelligent human being to catch a glimpse of what mathematics means to itself. This is not the old doctrine of art for art's sake; it is art for humanity's sake.

In Stanley Gudder

*A Mathematical Journey* (p. 107)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

Mathematics by itself has seldom got very far in the exploration of nature, as is attested by the numerous attempts of pure mathematicians of the past and present to resolve the universe with pencil and paper.

*Mathematics: Queen and Servant of Science*

A Metrical Universe (p. 211)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

"If it is not abstract it is not mathematics" might be taken as a touchstone for discriminating between mathematics and other departments of precise investigation.

*Mathematics: Queen and Servant of Science*

Abstraction and Prediction (p. 259)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

If a lunatic scribbles a jumble of mathematical symbols it does not follow that the writing means anything merely because to the inexperienced eye it is indistinguishable from higher mathematics.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 1)

The Prince of Mathematics (p. 308)

Simon & Schuster. New York, New York, USA. 1956

**Bellman, Richard** 1920–84

Applied mathematician

...mathematicians makes natural questions precise.

*Eye of the Hurricane: An Autobiography*

Chapter 9 (p. 114)

World Scientific Publishing Company. Ltd. Singapore. 1984

**Bentley, Arthur**

No biographical data available

The every-day language reeks with philosophies.... It shatters at every touch of advancing knowledge. At its heart lies paradox. The language of mathematics, on the contrary, stands and grows in firmness. It gives service to men beyond all other language.

*Linguistic Analysis of Mathematics*

Forward (p. viii)

The Principia press, Inc. Bloomington, Indiana, USA. 1932

**Bergson, Henri** 1859–1941

French philosopher

...calculation touches, at most, certain phenomena of organic destruction. Organic creation, on the contrary, the evolutionary phenomena which properly constitute life, we cannot in any way subject to mathematical treatment.

Translated by Arthur Mitchell

*Creative Evolution*

Chapter I (p. 20)

The Modern Library. New York, New York, USA. 1944

**Berlinski, David** 1942–

Mathematician

The concepts of mathematics, despite their unfamiliarity, are infinitely accessible. At their deaths, those who have minded mathematics will have known the continuous functions better than the crooked human heart. That so abstract a consideration should in the end be so lucid is a source of wonder.

*A Tour of the Calculus*  
Chapter 15 (p. 143)  
Pantheon Books. New York, New York, USA. 1995

**Bernard, Claude** 1813–78  
French physiologist

The application of mathematics to natural phenomena is the aim of all science.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I, Section vi (p. 129)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Bers, Lipman** 1914–93  
Mathematician

Mathematics develops, somehow, by its own inner laws.  
In Donald J. Albers and Constance Reid  
An Interview with Lipman Bers  
*The College Mathematics Journal*, Volume 18, September 1987 (p. 288)

...mathematics is very much like poetry...what makes a good poem — a great poem — is that there is a large amount of thought expressed in very few words. In this sense formulas like  $e^{i\pi} + 1 = 0$ ...are poems.

In D. Albers, G. Alexanderson and C. Reid (eds.)  
*More Mathematical People: Contemporary Conversations*  
Lipman Bers (p. 16)  
Harcourt Brace Jovanovich. Boston, Massachusetts, USA. 1990

**Bill, Max** 1908–94  
Swiss architect

I am of the opinion that it is possible to develop an art largely on the basis of mathematical thinking.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 139)  
Birkhäuser. Boston, Massachusetts, USA. 1987

**Birkhoff, George David** 1884–1944  
American mathematician

What is the inner secret of mathematical power? Briefly stated, it is that mathematics discloses the skeletal outlines of all closely articulated relational systems. For this purpose mathematics uses the language of pure logic with its score or so of symbolic words, which, in its important forms of expression, enables the mind to comprehend systems of relations otherwise completely beyond its power. These forms are creative discoveries which, once made, remain permanently at our disposal. By means of them the scientific imagination is enabled to penetrate ever more deeply into the rationale of the universe about us.

In J.G. Crowther (ed.)  
*Science Today*  
Mathematics: Quantity and Order (p. 297)  
Eyre & Spottiswoode. London, England. 1934

The primary service of modern mathematics is that it alone enables us to understand the vast abstract permanences which underlie the flux of things, without requiring us to

regard its self-consistent abstractions as more than specific limited instruments of thought.

In J.G. Crowther (ed.)  
*Science Today*  
Mathematics: Quantity and Order (p. 317)  
Eyre & Spottiswoode. London, England. 1934

Mathematics is the codified body of all logical thought.  
*George David Birkhoff: Collected Mathematical Papers* (Volume 3)  
Mathematics: Quantity and Order (p. 552)  
Dover Publications, Inc. New York, New York, USA. 1968

It will probably be the new mathematical discoveries which are suggested through physics that will always be most important, for, from the beginning, Nature has led the way and established the pattern which mathematics, the language of Nature, must follow.

Mathematical Nature of Physical Theories  
*American Scientist*, Volume 31, Number 4, October 1943 (p. 310)

Algebra tends to the study of the explicit structure of postulationally defined systems closed with respect to one or more rational operations.

Some Recent Advances in Algebra  
*The American Mathematical Monthly*, Volume 46, January 1939 (p. 18)

**Bishop, Errett** 1928–83  
American mathematician

Mathematics belongs to man, not to God. We are not interested in properties of the positive integers that have no descriptive meaning for finite man. When a man proves a positive integer to exist, he should show how to find it. If God has mathematics of his own that need to be done, let him do it himself.

*Foundations of Constructive Analysis*  
Chapter 1 (p. 2)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

**Black, Max** 1909–88  
Anglo-American philosopher

The progress of mathematics is not smooth, nor is the science, as the layman imagines, a collection of subtle principles and infallible results, springing mysteriously yet convincingly into the minds of their inventors.

*The Nature of Mathematics: A Critical Survey*  
Section III (p. 169)  
Routledge & Kegan Paul. London, England. 1933

**Bloor, David**  
No biographical data available

...mathematics like morality is designed to meet the requirements of men, who hold a great deal in common in their physiology and in their physical environment.

*Knowledge and Social Imagery*  
Chapter Six (p. 109)  
The University of Chicago Press. Chicago, Illinois, USA. 1991

**Bochner, Salomon** 1899–1982  
Galician-born American mathematician



What indeed is mathematics? This question, if asked in earnest, has no answer, not a satisfactory one; only part answers and observations can be attempted.

*The Role of Mathematics in the Rise of Science*

Chapter I (p. 13)

Princeton University Press. Princeton, New Jersey, USA. 1966

Ours is an age in which scientists are Wise Men, and the root of this Wisdom is in Mathematics.

*The Role of Mathematics in the Rise of Science*

Preface (p. v)

Princeton University Press. Princeton, New Jersey, USA. 1966

The word “mathematics” is a Greek word, and, by origin, it means “something that has been learned or understood,” or perhaps “acquired knowledge,” and perhaps even, somewhat against grammar, “acquirable knowledge,” that is, “learnable knowledge,” that is, “knowledge acquirable by learning.”

*The Role of Mathematics in the Rise of Science*

Chapter I (pp. 24–25)

Princeton University Press. Princeton, New Jersey, USA. 1966

[Mathematics] is a form of poetry which transcends poetry in that it proclaims a truth; a form of reasoning which transcends reasoning in that it wants to bring about the truth it proclaims; a form of action, of ritual behavior, which does not find fulfillment in the act but must proclaim and elaborate a poetic form of truth.

*The Role of Mathematics in the Rise of Science*

Chapter I

Paraphrasing Henri Frankfort (p. 14)

Princeton University Press. Princeton, New Jersey, USA. 1966

### **Bohr, Niels Henrik David** 1886–1962

Danish physicist

It will interest mathematical circles that the mathematical instruments created by the higher algebra play an essential part in the rational formulation of the new quantum mechanics. Thus the general proofs of the conservation theorems in Heisenberg’s theory carried out by Born and Jordan are based on the use of the theory of matrices, which go back to Cayley and were developed by Hermite. It is to be hoped that a new era of mutual stimulation of mechanics and mathematics has commenced. To the physicist it will seem first deplorable that in atomic problems we have apparently met with such a limitation of our usual means of visualisation. This regret will, however, have to give way to thankfulness that mathematics, in this field too, presents us with the tools to prepare the way for further progress.

Atomic Theory and Mechanics

*Nature*, Volume 116, Supplement, December 5, 1925 (p. 852)

### **Boutroux, Émile** 1845–1921

French philosopher

The mathematical laws presuppose a very complex elaboration. They are not known exclusively either *a priori* or *a posteriori*, but are a creation of the mind; and this

creation is not an arbitrary one, but, owing to the mind’s resources, takes place with reference to experience and in view of it. Sometimes the mind starts with intuitions which it freely creates; sometimes, by a process of elimination, it gathers up the axioms it regards as most suitable for producing a harmonious development, one that is both simple and fertile. The mathematics is a voluntary and intelligent adaptation of thought to things, it represents the forms that will allow of qualitative diversity being surmounted, the moulds into which reality must enter in order to become as intelligible as possible.

Translated by Fred Rothwell

*Natural Law in Science and Philosophy* (pp. 40–41)

Macmillan Publishing Company. New York, New York, USA. 1914

### **Bowditch, Nanthaniel** 1773–1838

American mathematician and astronomer

I never came across one of Laplace’s “Thus it plainly appears” without feeling sure that I have hours of hard work before me to fill up the chasm and find out and show how it plainly appears.

In Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter III (p. 104)

Government Printing Office. Washington, D.C. 1890

### **Boyer, Carl** 1906–76

Mathematical historian

Mathematics is neither a description of nature nor an explanation of its operation; it is not concerned with physical motion or with the metaphysical generation of quantities. It is merely the symbolic logic of possible relations, and as such is concerned with neither approximate nor absolute truth, but only with hypothetical truth. That is, mathematics determines what conclusions will follow logically from given premises. The conjunction of mathematics and philosophy, or of mathematics and science is frequently of great service in suggesting new problems and points of view.

*The History of the Calculus and Its Conceptual Development* (p. 308)

Dover Publications. New York, New York, USA. 1959

...mathematics is an aspect of culture as well as a collection of algorithms.

*The History of the Calculus and Its Conceptual Development*

Preface to second printing

Dover Publications. New York, New York, USA. 1959

### **Boyle, Robert** 1627–91

English natural philosopher and theological writer

Mathematicks may help the naturalist, both to frame hypotheses, and to judge of those that are proposed to them, especially such as relate to mathematical subjects in conjunction with others.

In William Thompson Sedgwick and H.W. Tyler

*A Short History of Science* (p. 335)

The Macmillan Company. New York, New York, USA. 1917

**Bragdon, Claude** 1866–1946

American architect, painter and author

The modern mind has adventured far and fearlessly in the new realms of thought opened up by research and discovery, but it has left no trail of beauty. That it has not done so is the fault of the artist, who has failed to interpret and portray the movement of the modern mind.... The new beauty, which corresponds to the new knowledge, is the beauty of principles...the world order. The world order is most perfectly embodied in mathematics.

In Stanley Gudder

*A Mathematical Journey* (p. 94)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

Mathematics is the handwriting on the human consciousness of the very Spirit of Life itself.

In John D. Barrow

*Pi in the Sky: Counting, Thinking, and Being* (p. 21)

Clarendon Press. Oxford, England. 1992

**Bridges, Robert Seymour** 1844–1930

English poet

...and see how Mathematick rideth as a queencheer'd on her royal progress thru'out nature's realm.

*The Testament of Beauty*

Book IV, l. 856–7

Oxford University Press, Inc. Oxford, England. 1930

**Bridgman, Percy Williams** 1882–1961

American physicist

As at present constructed, mathematics reminds one of the loquacious and not always coherent orator, who was said to be able to set his mouth going and go off and leave it.

*The Logic of Modern Physics*

Chapter II (p. 63)

The Macmillan Company. New York, New York, USA. 1927

It is the merest truism, evident at once to unsophisticated observation, that mathematics is a human invention.

*The Logic of Modern Physics*

Chapter II (p. 60)

The Macmillan Company. New York, New York, USA. 1927

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

...I find both a special pleasure and constraint in describing the progress of mathematics, because it has been part of so much speculation: a ladder for mystical as well as rational thought in the intellectual ascent of man.

*The Ascent of Man*

Chapter 5 (p. 155)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Brooks, Edward**

No biographical data available

Mathematics is the instrument by which the engineer tunnels out mountains, bridges our rivers, constructs

our aqueducts, erects out factories and makes them musical by the busy hum of spindles. Take away the results of the reasoning of mathematics, and there would go with it nearly all the material achievements which give convenience and glory to modern civilization.

*Mental Science and Culture* (p. 255)

Normal Publishing. Philadelphia, Pennsylvania, USA. 1891

**Browder, Felix E.** 1927–

American mathematician

**MacLane, Saunders** 1909–2005

American mathematician

The potential usefulness of a mathematical concept or technique in helping to advance scientific understanding has very little to do with what one can foresee before that concept or technique has appeared.

In Lynn Arthur Steen

*Mathematics Today: Twelve Informal Essays*

The Relevance of Mathematics (p. 348)

Springer-Verlag. New York, New York, USA. 1978

**Bruner, Jerome Seymour** 1915–

American psychologist

If we are not to live in embarrassed dread in the century ahead, we will have to understand the mathematical ideas that lie behind the scientific advances that are shaping the modern world.

In Kenneth J. Travers

Through Clouds of Failure into Orbit

*Arithmetic Teacher*, Volume 15, Number 7, November 1968 (p. 591)

**Buchanan, Scott** 1895–1968

American educator and philosopher

The structures with which mathematics deals are more like lace, the leaves of trees, and the play of light and shadow on a human face, than they are like buildings and machines, the least of their representatives. The best proofs in mathematics are short and crisp like epigrams, and the longest have swings and rhythms that are like music. The structures of mathematics and the propositions about them are ways for the imagination to travel and the wings, or legs, or vehicles to take you where you want to go.

*Poetry and Mathematics*

Chapter 1 (p. 36)

The University of Chicago Press. Chicago, Illinois, USA. 1975

The prestige of the engineer is another accretion to the tradition of mathematics. This more than any other one thing accounts for our present mathematical complex. The engineer is fast taking the position of authority, superseding the priest, the scholar, and the statesman in our organized thought and action.

*Poetry and Mathematics*

Chapter 1 (pp. 37–38)

The University of Chicago Press. Chicago, Illinois, USA. 1975

Mathematics then becomes the ladder by which we all may climb into the heaven of perfect insight and eternal satisfaction, and the solution of arithmetic and algebraic problems is connected with the salvation of our souls.

*Poetry and Mathematics*

Chapter 1 (p. 37)

The University of Chicago Press. Chicago, Illinois, USA. 1975

...mathematics and poetry move together between two extremes of mysticism, the mysticism of the commonplace where ideas illuminate and create facts, and the mysticism of the extraordinary where God, the Infinite, the Real, poses the riddles of desire and disappointment, sin and salvation, effort and failure, question and paradoxical answer...

*Poetry and Mathematics*

Chapter 1 (p. 42)

The University of Chicago Press. Chicago, Illinois, USA. 1975

### **Buck, R. C.**

No biographical data available

The intermarriage of traditional analysis with its neighbors has not come about as a rational decision of its practitioners. At first sight, the change seemed to have been largely a matter of semantics; one adopted the terminology of algebra and topology solely as a convenience to describe briefly certain situations which arose frequently. But it soon became evident that the adoption of another viewpoint, another observation platform, gave a clearer vision; the introduction of techniques borrowed from other fields enabled the analyst to achieve both striking economies in proof, and vivid insights into classical phenomena.

*Studies in Modern Analysis* (p. 2)

Prentice-Hall. Englewood, New Jersey, USA. 1962

### **Bullock, James**

Theoretical cosmologist

Mathematics is not a way of hanging numbers on things so that quantitative answers to ordinary questions can be obtained. It is a language that allows one to think about extraordinary questions.

Literacy in the Language of Mathematics

*The American Mathematical Monthly*, Volume 101, Number 8, October 1994 (p. 737)

### **Burke, Edmund** 1729–97

English statesman and philosopher

It is from this absolute indifference and tranquility of the mind, that mathematical speculations derive some of the most considerable advantages; because there is nothing to interest the imagination; because the judgment sits free and unbiased to examine the point. All proportions, every arrangement of quantity, is alike to the understanding, because the same truths result to it from all; from greater from lesser, from equality and inequality.

*On the Sublime and the Beautiful*

Part III, Section II (pp. 165–166)

Printed for F.C. & J Rivington and others. London, England. 1812

### **Burton, Leone** 1936–

Mathematics professor

Three shifts can be detected over time in the understanding of mathematics itself. One is a shift from completeness to incompleteness, another from certainty to conjecture, and a third from absolutism to relativity.

*Femmes et Mathématiques: Y a-t-il une?*

*Association for Women in Mathematics Newsletter*, Intersection 18 (November–December 1988)

### **Butler, Nicholas Murray** 1862–1947

American educator and university administrator

The analytical geometry of Descartes and the calculus of Newton and Leibniz have expanded into the marvelous mathematical method — more daring than anything that the history of philosophy records...defying the senses to follow its splendid flights, is demonstrating today, as it never has been demonstrated before, the supremacy of the pure reason.

*The Meaning of Education and Other Essays and Addresses*

What Knowledge Is of Most Worth? (p. 45)

The Macmillan Company. London, England. 1898

Modern mathematics, that most astounding of intellectual creations, has projected the mind's eye through infinite time and the mind's hand into boundless space.

*The Meaning of Education and Other Essays and Addresses*

What Knowledge Is of Most Worth? (p. 44)

The Macmillan Company. London, England. 1898

### **Cajori, Florian** 1859–1930

Swiss-born American educator and mathematician

The history of mathematics is important also as a valuable contribution to the history of civilization. Human progress is closely identified with scientific thought. Mathematical and physical researches are a reliable record of intellectual progress.

*A History of Mathematics*

Introduction (p. 3)

The Macmillan Company. London, England. 1919

One of the most baneful delusions by which the minds, not only of students, but even of many teachers of mathematics in our classical colleges, have been afflicted is that mathematics can be mastered by the favored few, but lies beyond the grasp and power of the ordinary mind.

*The Teaching and History of Mathematics in the United States*

Chapter III (p. 100)

Government Printing Office. Washington, D.C. 1890

The history of mathematics may be instructive as well as agreeable; it may not only remind us of what we have, but may also teach us to increase our store.

*A History of Mathematics*

Introduction (p. 1)  
Macmillan & Company Ltd. London, England. 1919

**Cantor, Georg** 1845–1918  
German mathematician

The essence of mathematics lies in its freedom.

*Mathematische Annalen*  
Bd. 21, 1883 (p. 564)

Mathematics is perfectly free in its development and is subject only to the obvious consideration, that its concepts must be free from contradictions in themselves, as well as definitely and orderly related by means of definitions to the previously existing and established concepts.

*Grundlagen einer allgemeinen Manigfaltigkeitslehre*  
Section 8  
Publisher undetermined. Leipzig, Germany 1883

**Carlyle, Thomas** 1795–1881  
English historian and essayist

It is a mathematical fact that the casting of this pebble from my hand alters the centre of gravity of the universe.

*Sartor Resartus*  
Book III, Chapter VII (p. 223)  
Ginn & Company. Boston, Massachusetts, USA. 1897

**Carmichael, Robert Daniel** 1879–1967  
American mathematician

Mathematics and poetry lie, if not on, at least not far from the extremes, the one of systematic and the other of unsystematic thought, and thus are about as far removed as possible one from the other.

*The Logic of Discovery*  
Chapter IX (p. 244)  
The Open Court Publishing. Chicago, Illinois, USA. 1930

Mathematics, by exhibiting a body of truth which can live through millenniums without needed connections, and at the same time can grow in magnitude and range and interest, has given the human spirit new ground for believing in itself and for rejoicing in its power of consistent thought.

*The Logic of Discovery*  
Chapter IX (pp. 263–264)  
The Open Court Publishing. Chicago, Illinois, USA. 1930

**Carus, Paul** 1852–1919  
American philosopher

There is no science which teaches the harmonies of nature more clearly than mathematics...

In William Symes Andrews  
*Magic Squares and Cubes*  
Introduction  
The Open Court Publishing Company. Chicago, Illinois, USA. 1908

There is no prophet that preaches the super personal God more plainly than mathematics.

The God Problem  
*The Monist*, Volume XVI, Number 1, January 1906 (p. 147)

**Cassiodorus** ca. 485–585  
Roman statesman and author

It is given to us to live for the most part under the guidance of mathematics.... It is impossible to distinguish from other living creatures anyone who does not understand how to quantify.

In David Ewing Duncan  
*The Calendar*  
Fourth Estate. London, England. 1998

**Casson, Stanley**  
No biographical data available

The nearer man approaches mathematics the farther away he moves from the animals.

*Progress and Catastrophe: An Anatomy of Human Adventure*  
Chapter VI (p. 93)  
Harper & Brothers. New York, New York, USA. 1937

**Cayley, Arthur** 1821–95  
English mathematician

As for everything else, so for a mathematical theory: beauty can be perceived but not explained.

In E.T. Bell and James R. Newman  
*The World of Mathematics* (Volume 1)  
Invariant Twins, Cayley and Sylvester (p. 341)  
Simon & Schuster. New York, New York, USA. 1956

**Chamberlain, Rollin T.**  
American geologist

To the geologist the recognised geologic facts, which he can understand and appreciate, are vastly more convincing than mathematical interpretations based upon assumptions, some of which he does not understand, and others of which seem to him clearly at variance with actual earth conditions.

Isostasy from the Geological Point of View  
*Journal of the Washington Academy of Science*, Volume 20, 1932  
(pp. 1–2)

**Chapman, C. H.**  
No biographical data available

There is probably no other science which presents such different appearances to one who cultivates it and one who does not, as mathematics. To [the noncultivator] it is ancient, venerable, and complete; a body of dry, irrefutable, unambiguous reasoning. To the mathematician, on the other hand, his science is yet in the purple of bloom of vigorous youth, everywhere stretching out after the "attainable but unattained," and full of the excitement of nascent thoughts; its logic is beset with ambiguities, and its analytic processes, like Bunyan's road, have a quagmire on one side and a deep ditch on the other, and branch off into innumerable by-paths that end in a wilderness.

*Bulletin of the New York Mathematical Society* (p. 61)  
1892

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

...the common idea [is] that mathematics is a dull subject whereas the testimony of all those who have any dealings with it shows that it is one of the most thrilling and tantalising and enchanting subjects in the world.

*Lunacy and Letters*

A Defense of Bores (pp. 58–59)

Sneed & Ward, Inc. New York, New York, USA. 1958

**Chrystal, George** 1851–1911  
Mathematician and academic

Every mathematical book that is worth reading must be read “backwards and forwards”, if I may use the expression. I would modify Lagrange’s advice a little and say, “Go on, but often return to strengthen your faith.” When you come on a hard or dreary passage, pass it over, and come back to it after you have seen its importance or found the need for it further on.

*Algebra: An Elementary Text Book for the Higher Classes of Secondary Schools and for Colleges* (Part II)

Preface (p. viii)

Adam & Charles Black. London, England. 1889

Any conception which is definitely and completely determined by means of a finite number of specifications, say by assigning a finite number of elements, is a mathematical conception. Mathematics has for its function to develop the consequences involved in the definition of a group of mathematical conceptions. Interdependence and mutual logical consistency among the members of the group are postulated, otherwise the group would either have to be treated as several distinct groups, or would lie beyond the sphere of mathematics.

*Encyclopaedia Britannica* (9<sup>th</sup> edition)

Mathematics

Adam & Charles Black. Edinburgh, Scotland. 1879

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

I had a feeling once about Mathematics — that I saw it all. Depth beyond Depth was revealed to me — the Byss and the Abyss. I saw — as one might see the transit of Venus or even the Lord Mayor’s Show — a quantity passing through infinity and changing its sign from plus to minus. I saw exactly why it happened and the tergiversation was inevitable — but it was after dinner and I let it go.

In Clifton Fadiman

*The Mathematical Magpie* (p. 255)

Simon & Schuster. New York, New York, USA. 1962

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Some people have contended that mathematics ought to be taught by making illustrations obvious to the senses. Nothing can be more absurd or injurious: It ought to be our never-ceasing effort to make people think, not feel.

*Lectures and Notes on Shakespeare and Other English Poets*

Lecture II (p. 52)

G. Bell & Sons. London, England. 1907

I have often been surprised that Mathematics, the quintessence of Truth, should have found admirers so few and so languid.

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

A Mathematical Problem

The Clarendon Press. Oxford, England. 1912

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

He that gives a portion of his time and talent to the investigation of mathematical truth will come to all other questions with a decided advantage over his opponents. He will be in argument what the ancient Romans were in the field: to them the day of battle was a day of comparative recreation because they were ever accustomed to exercise with arms much heavier than they fought; and reviews differed from a real battle in two respects: they encountered more fatigue, but the victory was bloodless.

*Lacon; or Many Things in a Few Words* (p. 178)

William Gowans. New York, New York, USA. 1849

The study of mathematics, like the Nile, begins in minuteness, but ends in magnificence...

*Lacon; or Many Things in a Few Words* (p. 181)

William Gowans. New York, New York, USA. 1849

The science of mathematics performs more than it promises.

*Lacon; or Many Things in a Few Words* (p. 181)

William Gowans. New York, New York, USA. 1849

**Colum, Padraic** 1881–1972  
Irish poet and writer

An age being mathematical, these flowers

Of linear stalks and spheroid blooms were prized...

In Helen Plotz

*Imagination’s Other Place*

Tulips (p. 76)

Thomas Y. Crowell Company. New York, New York, USA. 1955

**Comte, Auguste** 1798–1857  
French philosopher

Mathematical Analysis is...the true rational basis of the whole system of our positive knowledge.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (p. 42)

John Chapman. London, England. 1853

Every attempt to employ mathematical methods in the study of chemical questions must be considered profoundly, now as always, profoundly irrational, as being contrary to the nature of the phenomena. If mathematical analysis should ever hold a prominent place in chemistry — an aberration which is happily almost impossible — it would occasion a rapid and widespread degeneration of that science.

In G.H. Lewis

*Comte's Philosophy of the Sciences*

Section XI (p. 116)

Henry C. Bohn. London, England. 1853

Geometrical and Mechanical phenomena are the most general, the most simple, the most abstract of all, — the most irreducible to others, the most independent of them; serving, in fact, as a basis to all others. It follows that the study of them is an indispensable preliminary to that of all others. Therefore must Mathematics hold the first place in the hierarchy of the sciences, and be the point of departure of all Education, whether general or special.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Introduction, Chapter II (p. 33)

John Chapman. London, England. 1853

We can now define Mathematical science with precision. It has for its object the indirect measurement of magnitudes, and it proposes to determine magnitudes by each other, according to the precise relations which exist between them.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (p. 38)

John Chapman. London, England. 1853

It must be ever remembered that the true positive spirit first came forth from the pure sources of mathematical science; and it is only the mind that has imbibed it there, and which has been face to face with the lucid truths of geometry and mechanics, that can bring into full action its natural positively, and apply it in bringing the most complex studies into the reality of demonstration. No other discipline can fitly prepare the intellectual organ.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book III, Chapter I (p. 221)

John Chapman. London, England. 1853

In mathematics we find the primitive source of rationality; and to mathematics must the biologists resort for means to carry on their researches.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book 5, Chapter 1, To Mathematics (p. 321)

John Chapman. London, England. 1853

In the present state of our knowledge we must regard Mathematics less as a constituent part of natural philosophy than as having been, since the time of Descartes and Newton, the true basis of the whole natural philosophy; though it is, exactly speaking, both the one and the other. To us it is of less value for the knowledge of which it consists, substantial and valuable as that knowledge is, than as being the most powerful instrument that the human mind can employ in the investigation of the laws of natural phenomena.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Introduction, Chapter II (p. 32)

John Chapman. London, England. 1853

...it is only through Mathematics that we can thoroughly understand what true science is. Here alone can we find

in the highest degree simplicity and severity of scientific law, and such abstraction as the human mind can attain. Any scientific education setting forth from any other point is faulty in its basis.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (p. 39)

John Chapman. London, England. 1853

**Conant, James Bryant** 1893–1978

American educator and scientist

Mathematics and measurement are not to be unduly worshipped, nor can they be neglected by even the lay observer.

*Science and Common Sense*

Chapter Six (p. 163)

Yale University Press. New Haven, Connecticut, USA. 1951

**Condorcet, Marie Jean** 1743–94

French philosopher and mathematician

Mathematics is the science that yields the best opportunity to observe the working of the mind...and has the advantage that by cultivating it, we may acquire the habit of a method of reasoning which can be applied afterwards to the study of any subject and can guide us in the pursuit of life's object.

Filler

*The Mathematical Intelligencer*, Volume 10, Number 4, Fall 1988

(p. 43)

**Cooley, Hollis R.**

No biographical data available

Because mathematics has left its imprint upon so many aspects of present day civilization, its position in the modern world is a fundamental one, and a knowledge of mathematics is essential for a comprehensive understanding of current life and thought.

*Introduction to Mathematics* (p. 615)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1968

**Coolidge, Julian L.** 1873–1954

American professor of mathematics

However the formulae [of mathematical probability] may be derived, they frequently prove remarkably trustworthy in practice. The proper attitude is not to reject laws of doubtful origin, but to scrutinize them with care, with a view to reaching the true principles underneath. It seems to me that, in the last analysis, probability is a statistical, that is to say, an experimental science, and the mathematical problem is to establish rules which yield correct and valuable results.

*An Introduction to Mathematical Probability*

Preface (p. vi)

Dover Publications, Inc. New York, New York, USA. 1962

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

But if perchance there are certain “idle talkers” who take it upon themselves to pronounce judgment although wholly ignorant of mathematics, and if by shamelessly distorting the sense of some passage in Holy Writ to suit their purpose, they dare to reprehend and to attack my work; they worry me so little that I shall even scorn their judgments as foolhardy.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Preface and Dedication to Pope Paul, III (p. 503)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...if the worth of the arts were measured by the matter with which they deal, this art — which some call astronomy, others astrology, and many of the ancients the consummation of mathematics — would be by far the most outstanding. This art which is as it were the head of all the liberal arts and the one most worthy of a free man leans upon nearly all the other branches of mathematics. Arithmetic, geometry, optics, geodesy, mechanics, and whatever others, all offer themselves in its service.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, Introductory (p. 510)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Courant, Richard** 1888–1972

German-born American mathematician

The interplay between generality and individuality, deduction and construction, logic and imagination — this is the profound essence of live mathematics. Anyone or another of these aspects of mathematics can be found at the center of a given achievement. In a far reaching development all of them will be involved. Generally speaking, such a development will start from the “concrete,” then discard ballast by abstraction and rise to the lofty layers of thin air where navigation and observation are easy: after this flight comes the crucial test for learning and reaching specific goals in the newly surveyed low plains of individual “reality.” In brief, the flight into abstract generality must start from and return again to the concrete and specific.

Mathematics in the Modern World

*Scientific American*, Volume 211, Number 3, September 1964 (p. 43)

The question “What is mathematics?” cannot be answered meaningfully by philosophical generalities, semantic definitions or journalistic circumlocutions. Such characterizations also fail to do justice to music or painting. No one can form an appreciation of these arts without some experience with rhythm, harmony and structure, or with form, color and composition. For the appreciation of mathematics actual contact with its substance is even more necessary.

Mathematics in the Modern World

*Scientific American*, Volume 211, Number 3, September 1964 (p. 42)

Mathematics must take its motivation from concrete specific substance and aim again at some layer of “reality.”

The flight into abstraction must be something more than a mere escape; start from the ground and reentry are both indispensable, even if the same pilot cannot handle all phases of the trajectory.

Quoted in Stanley Gudder

*A Mathematical Journey* (p. 201)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

### **Courant, Richard** 1888–1972

German-born American mathematician

### **Robbins, Herbert** 1915–2001

American mathematician

For scholars and layman alike it is not philosophy but active experience in mathematics itself that alone can answer the question: What is mathematics?

*What Is Mathematics?* (p. xix)

Oxford University Press, Inc. London, England. 1941

Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality. Though different traditions may emphasize different aspects, it is only the interplay of these antithetic forces and the struggle for their synthesis that constitute the life, usefulness, and supreme value of mathematical science.

*What Is Mathematics?* (p. xv)

Oxford University Press, Inc. London, England. 1941

### **Cournot, Augustin** 1801–77

French philosopher, mathematician and economist

...those skilled in mathematical analysis know that its object is not simply to calculate numbers, but that it is also employed to find the relations between magnitudes which cannot be expressed in numbers and between functions whose law is not capable of algebraic expression.

*Researches into the Mathematical Principles of the Theory of Wealth*

Preface (p. 3)

The Macmillan Company. New York, New York, USA. 1927

### **Coxeter, H. S. M.** 1907–2003

Geometer and author

In our times, geometers are still exploring those new Wonderlands, partly for the sake of their applications to cosmology and other branches of science but much more for the sheer joy of passing through the looking glass into a land where the familiar lines, planes, triangles, circles, and spheres are seen to behave in strange but precisely determined ways.

*Non-Euclidean Geometry*

Committee on the Support of Research in the Mathematical Sciences,

The Mathematical Sciences (p. 58)

The MIT Press. Cambridge, Massachusetts, USA. 1969

**Crichton, Michael** 1942–  
American novelist

The mathematics of uncontrolled growth are frightening. A single cell of the bacterium *E. coli* would, under ideal circumstances, divide every twenty minutes. That is not particularly disturbing until you think about it, but the fact is that bacteria multiply geometrically: one becomes two, two becomes four, four becomes eight, and so on. In this way, it can be shown that in a single day, one cell of *E. coli* could produce a super-colony equal in size and weight to the entire planet earth.

*The Andromeda Strain*

Day 4 — Spread (p. 247)

Alfred A. Knopf. New York, New York, USA. 1969

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

Mathematics cares neither for science nor for engineering (except as a source of problems) but only about the relationship between abstract entities.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 14 (p. 160)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Cromwell, Oliver** 1599–58  
English soldier and statesman

I would have my son mind and understand business, read little history, study the mathematics and cosmography; these are good, with subordination to the things of God.... These fit for public services for which man is born.

*Letters and Speeches of Oliver Cromwell* (Volume 1) (p. 371)

Methuen & Company Ltd. London, England. 1904

**Cross, Hardy** 1885–1959  
American professor of civil and structural engineering

There is an unfortunate tendency to burden engineers, through books, with endless techniques and procedures of mathematical analysis. Few students know that at best books can furnish only a perishable net of large mesh through which they may begin to strain their information and that every fiber of that net must be rewoven from man's own thinking and that many new strands must be added if it is to be permanent and reliable in holding the selected data of years of engineering practice. Books present the sets of tools; it is the task of the analytical engineer to select those tools which can be used most advantageously.

*Engineers and Ivory Towers*

For Man's Use of God's Gifts (p. 106)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

**Dantzig, Tobias** 1884–1956  
Russian mathematician

Mathematics is not only the model along the lines of which the exact sciences are striving to design their

structure; mathematics is the cement which holds the structure together.

*Number: The Language of Science* (4<sup>th</sup> edition)

Chapter Four, 1 (p. 57)

The Macmillan Company. New York, New York, USA. 1954

Mathematics is the supreme judge; from its decisions there is no appeal.

*Number: The Language of Science* (4<sup>th</sup> edition)

Chapter Twelve, 12 (p. 245)

The Macmillan Company. New York, New York, USA. 1954

Banish the infinite process, and mathematics pure and applied is reduced to the state in which it was known to the pre-Pythagoreans.

*Number: The Language of Science* (4<sup>th</sup> edition)

Chapter Seven, 15 (p. 137)

The Macmillan Company. New York, New York, USA. 1954

It is a remarkable fact that the mathematical inventions which have proved to be most accessible to the masses are also those which exercised the greatest influence on the development of pure mathematics.

*Number: The Language of Science* (4<sup>th</sup> edition)

Chapter Ten, 10 (p. 192)

The Macmillan Company. New York, New York, USA. 1954

Mathematical achievement shall be measured by standards which are peculiar to mathematics. These standards are independent of a crude reality of our senses. They are: freedom from logical contradictions, the generality of the laws governing the created form, the kinship which exists between this new form and those that have preceded it.

*Number: The Language of Science* (4<sup>th</sup> edition)

Chapter Twelve, 2 (p. 231)

The Macmillan Company. New York, New York, USA. 1954

**d'Abro, Abraham**  
No biographical data available

Success has attended the efforts of mathematical physicists in so large a number of cases that, however marvelous it may appear, we can scarcely escape the conclusion that nature must be rational and susceptible to mathematical law.

*The Evolution of Scientific Thought from Newton to Einstein*

Foreword (pp. xii–xiii)

Dover Publications, Inc., New York, New York, USA. 1950

**D'Alembert, Jean Le Rond** 1717–83  
French mathematician

We shall content ourselves with the remark that if mathematics (as is asserted with sufficient reason) only make straight the minds which are without bias, so they only dry up and chill the minds already prepared for this operation by nature.

*Edinburgh Review*, Volume 52, January 1836 (p. 224)

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor



Therefore, O students, study mathematics, and do not build without foundations.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Philosophy (p. 82)

George Braziller. New York, New York, USA. 1958

He who blames [refutes] the supreme certainty of mathematics feeds on confusion, and will never impose silence upon the contradictions of the sophistical sciences, which occasion a perpetual clamor.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Philosophy (p. 83)

George Braziller. New York, New York, USA. 1958

There is no certainty where one can neither apply any of the mathematical sciences nor any of those which are based upon the mathematical sciences.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Mathematics (p. 619)

George Braziller. New York, New York, USA. 1958

**Darwin, Charles Galton** 1887–1962

English physicist and administrator

Every new body of discovery is mathematical in form, because there is no other guidance we can have.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

The belief that the underlying order of the world can be expressed in mathematical form lies at the very heart of science. So deep does this belief run that a branch of science is considered not to be properly understood until it can be cast in mathematics.

*The Mind of God: The Scientific Basis for a Rational World*

Chapter 6 (p. 140)

Simon & Schuster. New York, New York, USA. 1992

...the heart of the scientific method is the problem-hypothesis-test process. And, necessarily, the scientific method involves predictions. And predictions, to be useful in scientific methodology, must be subject to test empirically.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 2 (p. 12)

Simon & Schuster. New York, New York, USA. 1988

**Davies, Robertson** 1913–95

Canadian novelist

Although I am almost illiterate mathematically, I grasped very early in life that any one who can count to ten can count upward indefinitely if he is fool enough to do so.

*The Table Talk of Samuel Marchbanks*

Of the Conservation of Youth (pp. 27–28)

Clarke, Irwin. Toronto, Ontario, Canada. 1949

**Davis, Chandler** 1926–

American-born Canadian writer and educator

Mathematics is armchair science.

In R.S. Cohen, J.J. Stachel and M.W. Wartofsky

*Boston Studies in the Philosophy of Science* (Volume 15)

Materialist Mathematics (p. 38)

D. Reidel Publishing Company. Dordrecht, Netherlands.

**Davis, Philip J.** 1923–

American mathematician

One of the endlessly alluring aspects of mathematics is that its thorniest paradoxes have a way of blooming into beautiful theories.

Numbers

*Scientific American*, Volume 211, Number 3, September

1964 (p. 55)

**Davis, Philip J.** 1923–

American mathematician

**Hersh, Reuben** 1927–

American mathematician

As mathematicians, we know that we invent ideal objects, and then try to discover the facts about them. Any philosophy which cannot accommodate this knowledge is too small. We need not retreat to formalism when attacked by philosophers. Neither do we have to admit that our belief in the objectivity of mathematical truth is Platonic in the sense of requiring an ideal reality apart from human thought. Lakatos' and Popper's work shows that modern philosophy is capable of accepting the truth of mathematical experience. This means accepting the legitimacy of mathematics as it is: fallible, correctible, and meaningful.

*The Mathematical Experience*

True Facts About Imaginary Objects (pp. 410–411)

Birkhäuser. Boston, Massachusetts, USA. 1981

It seems certain that there is a limit to the amount of living mathematics that humanity can sustain at any time. As new mathematical specialties arise, old ones will have to be neglected.

*The Mathematical Experience*

How Much Mathematics Can There Be? (p. 25)

Birkhäuser. Boston, Massachusetts, USA. 1981

In the realm of ideas, of mental objects, those ideas whose properties are reproducible are called mathematical objects, and the study of mental objects with reproducible properties is called mathematics.

*The Mathematical Experience*

Intuition (p. 399)

Birkhäuser. Boston, Massachusetts, USA. 1981

...mathematics is the one subject in which time is irrelevant.

*Descartes' Dream: The World According to Mathematics*  
Chapter IV  
Of Time and Mathematics (p. 193)  
Harcourt Brace Jovanovich. San Diego, California, USA. 1986

All too many mathematical textbooks today have a nervous, breathless quality in which a fixed goal is systematically and inexorably pursued. The goal having been attained, one is left not with a feeling of exhilaration but of anticlimax. Nowhere in such books is any appreciation to be found of why or how the goal is important, other, possibly, than the statement that the goal may now be used as the starting point for reaching other, deeper goals, which considerations of space, alas, prevent the author from pursuing. Blame it on Euclid, if you want, for the tendency was already in his exposition.

*The Mathematical Experience*  
Utility (pp. 82–83)  
Birkhäuser. Boston, Massachusetts, USA. 1981

### de Bruijn, N. G.

No biographical data available

Usually in mathematics one has to choose between saying more and more about less and less on one hand, and saying less and less about more and more on the other.

*Asymptotic Methods in Analysis*  
Preface (p. v)  
North-Holland Publishing Company. Amsterdam, Netherlands. 1961

### de Morgan, Augustus 1806–71

English mathematician and logician

The greatest writers on mathematical subjects have a genius which saves them from their own slips, and guides them to true results through inaccurate expression, and sometimes through absolute error.

*The Differential and Integral Calculus* (p. 619)  
Baldwin & Cradick. London, England. 1836

### Dee, John 1527–1609

English mathematician and occultist

A marvelous neutrality have these things mathematicall, and also a strange participation between things supernaturall, immortall, intellectuall, simple and indivisible, and things naturall, mortall, sensible, compounded and divisible.

*Euclid*  
Preface (p. 2)  
Printed by Robert & William Leybourn. London, England. 1651

### Dieudonné, Jean 1906–92

French mathematician and educator

...in the flowering of a mathematical talent social environment has an important part to play.

*Mathematics — The Music of Reason*  
Chapter I, Section 2 (p. 9)  
Springer-Verlag. Berlin, Germany. 1992

### Dillingsley, H.

No biographical data available

Many arts there are which beautify the mind of man; of all other none do more to garnish and beautify it than those arts which are called mathematical.

*The Elements of Geometrie of the Most Ancient Philosopher Euclide of Megara*

Note to the Reader  
John Day. Imprinted at London (England). 1570

### Dirac, Paul Adrian Maurice 1902–84

English theoretical physicist

Theoretical physicists accept the need for mathematical beauty as an act of faith... For example, the main reason why the theory of relativity is so universally accepted is its mathematical beauty.

*From a Life of Physics*  
Lecture 2, Methods in Theoretical Physics (p. 21)  
World Scientific Publishing Company. Singapore. 1989

The new theories, if one looks apart from their mathematical setting, are built up from physical concepts which cannot be explained in terms of things previously known to the student, which cannot even be explained adequately in words at all. Like the fundamental concepts (e.g., proximity, identity) which every one must learn on his arrival into the world, the newer concepts of physics can be mastered only by long familiarity with their properties and uses.

*The Principles of Quantum Mechanics* (2<sup>nd</sup> edition)  
From the Preface to the First Edition (p. vi)  
At The Clarendon Press. Oxford, England. 1935

### Doob, J. L. 1910–2004

American mathematician

The basic difference between the roles of mathematical probability in 1946 and 1988 is that the subject is now accepted as mathematics whereas in 1946 to most mathematicians mathematical probability was to mathematics as black marketing to marketing; that is, probability was a source of interesting mathematics but examination of the background context was undesirable.

In Peter Duren (ed.)  
*A Century of Mathematics in America*  
Part II, Commentary on Probability (p. 353)  
American Mathematical Society. Providence, Rhode Island, USA. 1989

### de Jouvenel, Bertrand 1903–87

French man of letters

...the social scientist who lacks a mathematical mind and regards a mathematical formula as a magic recipe, rather than as the formulation of a supposition, does not hold forth much promise. A mathematical formula is never more than a precise statement. It must not be made into a Procrustean bed — and that is what one is driven to by the desire to quantify at any cost. It is utterly implausible that

a mathematical formula should make the future known to us, and those who think it can would once have believed in witchcraft. The chief merit of mathematicization is that it compels us to become conscious of what we are assuming.

Translated by Nikita Lary

*The Art of Conjecture*

Chapter 15 (p. 173)

Basic Books, Inc. New York, New York, USA. 1967

### **de Morgan, Augustus** 1806–71

English mathematician and logician

The moving power of mathematical invention is not reasoning but imagination.

In Robert Graves

*Life of Sir William Rowan Hamilton* (p. 219)

Hodges, Figgis & Company. Dublin, Ireland. 1882–89

The pseudomath is a person who handles mathematics as the monkey handled the razor.

*A Budget of Paradoxes*

Pseudomath, Philomath, and Graphomath (p. 473)

Longmans, Green. London, England. 1872

### **de Pavlovsky, G.**

No biographical data available

In the secular labour of ideas...mathematics plays the part that is played by capital in the history of societies; it is the crystallization of intellectual labour; it represents acquisitions of which we are proud, a security well earned; it may even serve as a basis and a point of departure for new enterprises themselves.

In Maurice Maeterlinck

*The Life of Space*

The Fourth Dimension, VI (p. 21)

Dodd, Mead & Company. New York, New York, USA. 1928

### **de Stael, Madame** 1766–1817

French romantic writer

The mathematics lead us to lay out of account all that is not proved; while the primitive truths, those which sentiment and genius apprehend, are not susceptible of demonstration.

*Edinburgh Review*, Volume 52, January 1836 (p. 248)

### **Dehn, Max**

No biographical data available

Mathematics is the only instructional material that can be presented in an entirely undogmatic way.

The Mentality of the Mathematician

*The Mathematical Intelligencer*, Volume 5, Number 2, 1983 (p. 73)

### **Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

But as I considered the matter carefully it gradually came to light that all those matters only were referred to Mathematics in which order and measurement are inves-

tigated, and it makes no difference whether it be in numbers, figures, stars, sounds or any other objects that the question of measurement arises.

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule IV (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Dickens, Charles** 1812–70

English novelist

The worst class of sum worked in the every-day world is ciphered by the diseased arithmeticians who are always in the rule of Subtraction as to the merits and successes of others, and never in Addition as to their own.

*Little Dorrit*

Book the Second, Chapter VI (p. 462)

Bradbury & Evans. London, England. 1857

### **Dieudonné, Jean** 1906–92

French mathematician and educator

On foundations we believe in the reality of mathematics, but of course when philosophers attack us with their paradoxes we rush to hide behind formalism and say: "Mathematics is just a combination of meaningless symbols..."

The Works of Nicholas Bourbaki

*The American Mathematical Monthly*, Volume 77, Number 2, February

1970 (p. 134)

Modern algebraic geometry has deservedly been considered for a long time as an exceedingly complex part of mathematics, drawing practically on every other part to build up its concepts and methods and increasingly becoming an indispensable tool in many seemingly remote theories. It shares with number theory the distinction of having one of the longest and most intricate histories among all branches of our science, of having always attracted the efforts of the best mathematicians in each generation, and of still being one of the most active areas of research.

The Historical Development of Algebraic Geometry

*The American Mathematical Monthly*, Volume 79, Number 8, October

1972 (p. 827)

### **Dillmann, E.**

No biographical data available

Pure mathematics proves itself a royal science both through its content and form, which contains within itself the cause of its being and its methods of proof. For in complete independence mathematics creates for itself the object of which it treats, its magnitudes and laws, its formulas and symbols.

*Die Mathematik die Fackelträgerin einer neuen Zeit* (p. 94)

Publisher undetermined. Stuttgart, Germany. 1889

### **Dirac, Paul Adrian Maurice** 1902–84

English theoretical physicist

From now on there will be no physical treatise which is not primarily mathematical.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 1, Section 1.1 (p. 25)

The Macmillan Company. New York, New York, USA. 1967

The steady progress of physics requires for its theoretical formulations a mathematics that gets continually more advanced.

Quantized Singularities in the Electromagnetic Field

*Proceedings of the Royal Society, Series A, Volume 133, Number A821, 1931 (p. 60)*

Our feeble attempts at mathematics enable us to understand a bit of the universe, and as we proceed to develop higher and higher mathematics we can hope to understand the universe better.

The Evaluation of the Physicist's Picture of Nature

*Scientific American, Volume 208, Number 5, May 1963 (p. 53)*

God used beautiful mathematics in creating the world.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II (p. 191)

Simon & Schuster. New York, New York, USA. 1982

A good deal of my research work in physics has consisted in not setting out to solve some particular problem but simply examining mathematical quantities of a kind that physicists use and trying to fit them together in an interesting way, regardless of any application that the work may have. It is simply a search for pretty mathematics. It may turn out later that the work does have an application. Then one has good luck.

*International Journal of Theoretical Physics, Volume 21, 603 (1982)*

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

While the individual man is an insoluble puzzle, in the aggregate he becomes a mathematical certainty. You can, for example, never foretell what any one man will be up to, but you can say with precision what an average number will be up to. Individuals vary, but percentages remain constant. So says the statistician.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes (Volume 1)*

The Sign of the Four, Chapter 10 (p. 666)

Wings Books. New York, New York, USA. 1967

**Dresden, Arnold** 1882–1954

American mathematician

A mathematic may be established through the free choice of a logic, and of primitive ideas and primitive propositions; if this choice is guided by wisdom, the mathematic will be capable of development and application. The application will then, sometimes directly, but more frequently through a chain of intermediate stages, have significant bearing upon the content of human experience and furnish

results which may be called true. The truth then gives, retroactively, a sound basis for belief in the validity of the conclusion of mathematics.

*Bulletin of the American Mathematical Society*

Some Philosophical Aspects of Mathematics, Volume 34, July–August 1928 (p. 452)

**Dutton, S. T.**

No biographical data available

Mathematics, while giving no quick remuneration, like the art of stenography or the craft of bricklaying, does furnish the power of deliberate thought and accurate statement, and to speak the truth is one of the most social qualities a person can possess. Gossip, flattery, slander, deceit, all spring from a slovenly mind that has not been trained in the power of truthful statement, which is one of the highest utilities.

*The American Mathematical Monthly, Volume 102, Number 1, January 1995 (p. 61)*

**Dyson, Freeman J.** 1923–

American physicist and educator

The place of mathematics in the physical sciences is not something that can be defined once and for all. The interrelations of mathematics with science are as rich and various as the texture of science itself.

Mathematics in the Physical Sciences

*Scientific American, Volume 211, Number 3, September 1964 (p. 129)*

I see some parallels between the shifts of fashion in mathematics and in music. In music, the popular new styles of jazz and rock became fashionable a little earlier than the new mathematical styles of chaos and complexity theory. Jazz and rock were long despised by classical musicians, but have emerged as art-forms more accessible than classical music to a wide section of the public. Jazz and rock are no longer to be despised as passing fads. Neither are chaos and complexity theory. But still, classical music and classical mathematics are not dead. Mozart lives, and so does Euler. When the wheel of fashion turns once more, quantum mechanics and hard analysis will once again be in style.

Book Review of "Nature's Numbers"

*The American Mathematical Monthly, Volume 103, Number 7, August–September 1996 (p. 612)*

One factor that has remained constant through all the twists and turns of the history of physical science is the decisive importance of the mathematical imagination.

*Mathematics in the Modern World,*

Mathematics in the Physical Sciences (p. 249)

W.H. Freeman & Company. San Francisco, California, USA. 1968

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The world looks like a multiplication-table, or a mathematical equation, which, turn it how you will, balances itself.

*The Complete Works of Ralph Waldo Emerson (Volume 2)*

Essays: First Series  
Chapter III (p. 102)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The mathematics is not there till we put it there.  
*The Philosophy of Physical Science*  
Chapter IX, Section I (p. 137)  
The Macmillan Company. New York, New York, USA. 1939

Proof is an idol before whom the pure mathematician tortures himself. In physics we are generally content to sacrifice before the lesser shrine of plausibility.

*The Nature of the Physical World*  
Chapter XV (p. 337)  
The Macmillan Company. New York, New York, USA. 1930

The solution goes on famously; but just as we have got rid of the other unknowns, behold!  $V$  disappears as well, and we are left with the indisputable but irritating conclusion —  $0 = 0$ . This is a favorite device that mathematical equations resort to, when we propound stupid questions.

*The Nature of the Physical World*  
Chapter II (p. 30)  
The Macmillan Company. New York, New York, USA. 1930

**Edwards, Harold M.**

No biographical data available

Mathematics, like philosophy, is virtually inseparable from its history.

In Lynn Arthur Steen  
*Mathematics Tomorrow*  
Read the Masters! (p. 108)  
Springer-Verlag. New York, New York, USA. 1981

**Edwards, Tyron** 1809–94

American theologian

The study of mathematics is like climbing up a steep and craggy mountain; when once you reach the top, it fully recompenses your trouble, by opening a fine, clear, and extensive prospect.

*The New Dictionary of Thoughts: A Cyclopaedia of Quotations* (p. 380)  
Standard Book Company. New York, New York, USA. 1948

The study of mathematics cultivates the reason; that of the languages, at the same time, the reason and the taste. The former gives the grasp and power to the mind; the latter both power and flexibility. The former by itself, would prepare us for a state of certainties, which nowhere exists; the later, for a state of probabilities which is that of common life. Each, by itself, does but an imperfect work: in the union of both, is the best discipline for the mind, and the best mental training for the world as it is.

*The New Dictionary of Thoughts: A Cyclopaedia of Quotations* (p. 380)  
Standard Book Company. New York, New York, USA. 1948

**Eilenberger, Gert**

No biographical data available

It isn't our sensory and perceptual activity that forces nature into a strait-jacket of mathematics, it is Nature, which, in the process of our evolutionary development, has impressed mathematics into our reason as a real, existing structure, inherent to herself.

In H.O. Peitgen and P.H. Richter  
*The Beauty of Fractals*  
Freedom, Science, and Aesthetics (p. 178)  
Springer-Verlag. New York, New York, USA. 1986

**Einstein, Albert** 1879–1955

German-born physicist

...the partial differential equation entered theoretical physics as a handmaid, but has gradually become mistress.

*The World As I See It* (p. 63)  
Philosophical Library. New York, New York, USA. 1949

Physics...is essentially an intuitive and concrete science. Mathematics is only a means for expressing the laws that govern phenomena.

In A.P. French  
*Einstein: A Centenary Volume*  
Excerpts from a memoir (p. 9)  
Harvard University Press. Cambridge, Massachusetts, USA. 1979

One reason why mathematics enjoys special esteem, above all other sciences, is that its laws are absolutely certain and indisputable, while those of all other sciences are to some extent debatable and in constant danger of being overthrown by newly discovered facts.

*Sidelights on Relativity* (p. 27)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1922

Pure mathematics is, in its way, the poetry of logical ideas.  
Professor Einstein Writes in Appreciation of a Fellow-Mathematician  
*New York Times*, May 5, 1935

God does not care about our mathematical difficulties; He integrates empirically.

In Leopold Infeld  
*Quest — An Autobiography*  
Book Three, Part VI (p. 279)  
Chelsea Publishing Company. New York, New York, USA. 1980

Experience remains, of course, the sole criterion of the physical utility of a mathematical construction.

*The World As I See It* (p. 36)  
Philosophical Library. New York, New York, USA. 1949

Do not worry about your difficulties in mathematics: I can assure you that mine are still greater.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side: New Glimpses from His Archives*  
Letter dated 7 January, 1943 (p. 8)  
Princeton University Press. Princeton, New Jersey, USA. 1979

Mathematics are well and good but nature keeps dragging us around by the nose.

In A.P. French  
*Einstein: A Centenary Volume*  
Chapter 4 (p. 113)  
Harvard University Press. Cambridge, Massachusetts, USA. 1979

At this point an enigma presents itself which in all ages has agitated inquiring minds. How can it be that mathematics, being after all a product of human thought which is independent of experience, is so admirably appropriate to the objects of reality?

*Sidelights on Relativity* (p. 28)

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

But there is another reason for the high repute of mathematics: it is mathematics that offers the exact natural sciences a certain measure of security which, without mathematics, they could not attain.

In E.T. Bell

*Men of Mathematics* (p. xvi)

Simon & Schuster. New York, New York, USA. 1937

If only I had more mathematics.

In Peter Michelmoré

*Einstein, Profile of the Man* (p. 261)

Dodd, Mead & Company New York, New York, USA. 1962

**Ellis, Havelock** 1859–1939

English sexuality researcher

The mathematician has reached the highest rung on the ladder of human thought.

*The Dance of Life*

Chapter III, Section V (p. 140)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

If mathematics were the only path of science.... Nature would have been illegible for Goethe....

*The Dance of Life*

Chapter III, Section V (p. 137)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

Here, we reach the sphere of mathematics, we are among processes which seem to some the most inhuman of all human activities and the most remote from poetry.

*The Dance of Life*

Chapter III, Section V (pp. 138–139)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Erdős, Paul** 1913–96

Hungarian mathematician

Every human activity, EXCEPT Mathematics, must come to an end.

In Bela Bollobas

To Prove and Conjecture: Paul Erdos and His Mathematics

*The American Mathematical Monthly*, Volume 105, Number 3, March 1998 (p. 209)

**Escher, M. C.** 1898–1972

Dutch graphic artist

By keenly confronting the enigmas that surround us, and by considering and analyzing the observations that I had made, I ended up in the realm of mathematics.

In Stanley Gudder

*A Mathematical Journey* (p. 94)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Eves, Howard W.** 1911–2004

American mathematician

Mathematics may be likened to a large rock whose interior composition we wish to examine. The older mathematicians appear as persevering stone cutters slowly attempting to demolish the rock from the outside with hammers and chisel. The later mathematicians resemble expert miners who seek vulnerable veins, drill into these strategic places, and then blast the rock apart with well placed internal charges.

*In Mathematical Circles* (Volume 2)

188 (p. 7)

Prindle, Weber & Schmidt. Boston, Massachusetts, USA. 1969

**Fischer, Martin H.** 1879–1962

German-American physician

The pure mathematician starts with an unknown and ends with an unknown.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 40)

C.C. Thomas. Springfield, Illinois, USA. 1944

It is unsafe to talk mathematics. Folks don't understand.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 3)

C.C. Thomas. Springfield, Illinois, USA. 1944

**Fairbairn, A. M.**

No biographical data available

The mathematics which have controlled and guided the Builder of the heavens are identical with the mathematics which the astronomer in his study deduces from the idea of space given his own thoughts, and which he proves by the processes of his own reason.

*The Philosophy of the Christian Religion* (p. 37)

The Macmillan Company. New York, New York, USA. 1902

**Farrar, John**

No biographical data available

...in mathematical science, and in it alone, man sees things precisely as God sees them, handles the very scale and compass with which the Creator planned and built the universe...

in Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter III (fn, p. 128)

Government Printing Office. Washington, D.C. 1890

**Feynman, Richard P.** 1918–88

American theoretical physicist

To those who do not know Mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty of nature.... If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in.

*The Character of Physical Law*

Chapter 2 (p. 58)  
BBC. London, England. 1965

...there are many, many aspects of the world that mathematics is unnecessary for, such as love, and which are very delightful and wonderful to appreciate and to feel awed and mysterious about...

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 1 (p. 15)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

Now you may ask, “What is mathematics doing in a physics lecture?” We have several possible excuses: first, of course, mathematics is an important tool, but that would only excuse us for giving the formula in two minutes. On the other hand, in theoretical physics we discover that all our laws can be written in mathematical form; and that this has a certain simplicity and beauty about it. So, ultimately, in order to understand nature it may be necessary to have a deeper understanding of mathematical relationships. But the real reason is that the subject is enjoyable, and although we humans cut nature up in different ways, and we have different courses in different departments, such compartmentalization is really artificial, and we should take our intellectual pleasures where we find them.

*The Feynman Lectures on Physics* (Volume 1)  
Chapter 22–1 (p. 22–1)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

I believe sanity and realism can be restored to the teaching of Mathematical Statistics most easily and directly by entrusting such teaching largely to men and women who have had personal experience of research in the Natural Sciences.

Scientific Thought and the Refinement of Human Reasoning  
*Journal of the Operations Research Society of Japan*,  
Volume 3, 1960

**Fitch, G. D.**  
No biographical data available

Pure mathematics is a collection of hypothetical, deductive theories, each consisting of a definite system of primitive, undefined concepts or symbols and primitive, unproved, but self-consistent assumptions (commonly called axioms) together with their logically deducible

consequences followed by rigidly deductive processes without appeal to intuition.

In Henry P. Manning  
*The Fourth Dimension Simply Explained*  
Non-Euclidean Geometry of the Fourth Dimension (p. 58)  
Munn & Company, Inc. New York, New York, USA. 1910

**Forder, Henry G.** 1889–1981  
English mathematician

Our Geometry is an abstract Geometry. The reasoning could be followed by a disembodied spirit who had no idea of a physical point, just as a man blind from birth could understand the Electromagnetic Theory of Light.

*The Foundations of Euclidean Geometry* (p. 43)  
The University Press. Cambridge, England. 1927

**Forsyth, A. R.**  
No biographical data available

Mathematics is one of the oldest of the sciences; it is also one of the most active, for its strength is the vigor of perpetual youth.

Presidential Address British Association for the Advancement of Sciences,  
*Nature*, Section A, Volume 56, Number 1451, August 19, 1897 (p. 378)

**Frankland, A.**  
No biographical data available

I am convinced that the future progress of chemistry as an exact science depends very much upon the alliance with mathematics.

Extract of a Letter of Dr. Frankland to Mr. Sylvester  
*American Journal of Mathematics*, Volume 1, Number 4,  
1878 (p. 349)

**Franklin, Benjamin** 1706–90  
American printer, scientist and diplomat

There has not been any science so much esteemed and honored as this of mathematics, nor with so much industry and vigilance become the care of great men, and labored in by the potentates of the world, viz. emperors, kings, princes, etc.

In Thomas Woody (ed.)  
*Educational Views of Benjamin Franklin*  
On the Usefulness of Mathematics (pp. 231–232 )  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1931

What science can there be more noble, more excellent, more useful for men, more admirably high and demonstrative, than this of the mathematics?

*Educational Views of Benjamin Franklin*  
On the Usefulness of Mathematics (p. 233)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1931

**Franklin, W. S.**  
No biographical data available

If a healthy minded person takes an interest in science, he gets busy with his mathematics and haunts the laboratory.

In Henry Crew

*General Physics* (p. 54)

The Macmillan Company. New York, New York, USA. 1927

**Frege, Friedrich Ludwig Gottlob** 1848–1925

German logician

The idea of a strictly scientific method in mathematics, which I have attempted to realize, and which might indeed be named after Euclid, I should like to describe as follows. It cannot be demanded that everything be proved, because that is impossible; but we can require that all propositions used without proof be expressly declared as such, so that we can see distinctly what the whole structure rests upon. After that we must try to diminish the number of primitive laws as far as possible, by proving everything that can be proved. Furthermore, I demand — and in this I go beyond Euclid — that all methods of inference employed be specified in advance...

*The Fundamental Laws of Arithmetic* (Volume 1)

Foreword (p. vi)

Publisher undetermined

**Gardner, Martin** 1914–

American writer and mathematics games editor

Mathematics is not only real, but it is the only reality. The entire universe is made out of particles. Now what are the particles made out of? They're not made out of anything. The only thing you can say about the reality of an electron is to cite its mathematical properties. There's a sense in which matter has completely dissolved and what is left is just a mathematical structure.

*Focus — The Newsletter of the Mathematical Association of America*

December 1994

**Gassendi, Pierre** 1592–1655

French logician and philosopher

If we know anything we know it by mathematics; but those people have no concern for the true and legitimate science of things! they cling to trivialities!

In Pierre Duhem

*The Aim and Structure of Physical Theory*

Part II, Chapter II (p. 121)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist and astronomer

Mathematics is the Queen of the Sciences, and Arithmetic the Queen of Mathematics.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

**Germain, Sophie** 1545–1612

French mathematician

Let me be permitted to recall that the object of mathematics is not to investigate the causes that one can assign to natural phenomena. This science would lose both its character and credit if, renouncing the support of general well-confirmed facts, it sought within the realm of nebulous conjectures, a realm which has always been a fertile source of error for ways of satisfying the thirst for explanation.

In Louis L. Bucciarelli and Nancy Dwarsky

*Sophie Germain: An Essay in the History of the Theory of Elasticity*

Chapter 9 (p. 110)

D. Reidel Publishing Company. Dordrecht, Germany. 1980

**Gibbon, Edward** 1737–94

English historian

The mathematics are distinguished by a peculiar privilege, that is, in the course of ages, they may always advance and can never recede.

In *Great Books of the Western World* (Volume 41)

*The Decline and Fall of the Roman Empire*

Chapter LII, Section 59 (p. 299)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

I'm very well acquainted too with matters mathematical.

*The Pirates of Penzance, Act I*

Comic opera, 1879

**Glanvill, Joseph** 1636–80

English clergyman and philosopher

And for Mathematical Sciences, he that doubts their certainty hath need of a dose of Hellebore.

*The Vanity of Dogmatizing*

Chapter XXI (p. 209)

Printed for Henry Eversden. London, England. 1661

...the knowledge we have of the Mathematicks, hath no reason to elate us; since by them we know but numbers, and figures, creatures of our own, and are yet ignorant of our Maker's.

*The Vanity of Dogmatizing*

Chapter XXI (pp. 209–210)

Printed for Henry Eversden. London, England. 1661

**Gleason, Andrew M.**

Mathematician

Like the great temples of some religions, mathematics may be viewed only from the outside by those uninitiated into its mysteries.

*Evolution of an Active Mathematical Theory*

*Science*, Volume 145, Number 3631, 31 July 1964 (p. 457)

If we do run into a paradox, we can probably save the structure of mathematics by patching it.



In Bryan H. Bunch

*Mathematical Fallacies and Paradoxes*

Chapter 5 (p. 110)

Van Nostrand Reinhold Company. New York, New York, USA. 1982

**Godwin, William** 1756–1836

English political philosopher

Pure mathematics are concerned only with abstract propositions, and have nothing to do with the realities of nature. There is no such thing in actual existence as a mathematical point, line or surface. There is no such thing as a circle or square. But that is of no consequence. We can define them in words, and reason about them. We can draw a diagram, and suppose that line to be straight which is not really straight, and that figure to be a circle which is not strictly a circle. It is conceived therefore by the generality of observers, that mathematics is the science of certainty.

*Thoughts on Man*

On Astronomy

A.M. Kelley. New York, New York, USA. 1969

**Goodstein, Reuben L.** 1912–85

English mathematician

The function of mathematical logic is to reveal and codify the logical processes employed in mathematical reasoning and to clarify the concepts of mathematics; it is itself a branch of mathematics, employing mathematical symbolism and technique, a branch which has developed in its entirety during the past hundred years and which in its vigor and fecundity and the power and importance of its discoveries may well claim to be in the forefront of modern mathematics.

*Mathematical Logic* (p. 1)

Leicester University Press. Leicester, England. 1957

**Graham, L. A.**

No biographical data available

Sing a song of sixpence —

A mathman full of rye.

Four times twenty square feet

Multiplied by n

Gives the total ground he covers

While weaving an ellipse;

His path would have no area,

If he had no nips.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 7

Dover Publications, Inc. New York, New York, USA. 1959

**Graham, Ronald L.** 1935–

American mathematician

**Knuth, Donald E.** 1938–

American computer scientist

The ultimate goal of mathematics is to eliminate all need for intelligent thought.

*Concrete Mathematics: A Foundation for Computer Science*

Chapter 2.6 (p. 56)

Addison-Wesley Publishing. Reading, Massachusetts, USA. 1990

**Grassmann, Hermann** 1809–77

German polymath

Mathematics is the science of the connection of magnitudes. Magnitude is anything that can be put equal or unequal to another thing. Two things are equal when in every assertion each may be replaced by the other.

*Werke*

Stücke aus dem Lehrbuche der Arithmetik, Bd. 2 (p. 298)

Publisher undetermined. Leipzig, Germany. 1904

**Guillen, Michael**

Theoretical physicist

...mathematics is not a science — it is not capable of proving or disproving the existence of real things. In fact, a mathematician's ultimate concern is that his or her inventions be logical, not realistic.

*Bridges to Infinity: The Human Side of Mathematics*

Introduction (p. 4)

Jeremy P. Tarcher, Inc. Los Angeles, California. USA. 1983

**Guruprasad, Venkata**

No biographical data available

Math is a perfect expression, like ballet or shaolin martial art.

In Clifford A. Pickover

*Keys to Infinity*

Chapter 18 (p. 147)

John Wiley & Sons, Inc. New York, New York, USA. 1995

**Guy, Richard K.** 1916–

Mathematics professor

Mathematics often owes more to those who ask questions than to those who answer them. The solution of a problem may stifle interest in the area around it. But “Fermat’s Last Theorem”, because it is not yet a theorem, has generated a great deal of “good” mathematics, whether goodness is judged by beauty, by depth or by applicability.

*Unsolved Problems in Number Theory*

Preface to the First Edition (p. ix)

Springer-Verlag. New York, New York, USA. 2004

**Hadamard, Jacques** 1865–1963

French mathematician

The theory of integral equations, born yesterday, is already classical. It has been introduced in several university courses. There is no doubt — perhaps further improvements — that it will soon impose itself as of current use in mathematics. This is a rare piece of good fortune for a mathematical doctrine, for mathematical doctrines so often become museum exhibits.

In A. d’Abro

*The Decline of Mechanism*  
The Dim Past of Dusty Space (p. 118)  
Dover Publications, Inc. New York, New York, USA. 1951

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

The permeation of biology by mathematics is only the beginning, but unless the history of science is an inadequate guide, it will continue, and the investigations here summarized represent the beginning of a new branch of applied mathematics.

*The Causes of Evolution*  
Appendix (p. 215)  
Longmans, Green & Company. London, England. 1935

**Hall, G. Stanley** 1844–1924  
No biographical data available

Mathematics...the ideal and norm of all careful thinking.

*Educational Problems* (p. 393)  
D. Appleton & Company. New York, New York, USA. 1911

**Halmos, Paul R.** 1916–2006  
Hungarian-born American mathematician

Pure mathematics can be practically useful and applied mathematics can be artistically elegant.

In Lynn Arthur Steen  
*Mathematics Tomorrow*  
Applied Mathematics Is Bad Mathematics (p. 12)  
Springer-Verlag. New York, New York, USA. 1981

The only way to learn mathematics is to do mathematics.

*A Hilbert Space Problem Book*  
Preface (p. vii)  
Springer-Verlag. New York, New York, USA. 1982

Mathematics is abstract thought, mathematics is pure logic, mathematics is creative art. All these statements are wrong, but they are all a little right, and they are all nearer the mark than “mathematics is number” or “mathematics is geometric shapes.” For the professional pure mathematician, mathematics is the logical dovetailing of a carefully selected sparse set of assumptions along with their surprising conclusions via a conceptually elegant proof. Simplicity, intricacy, and above all, logical analysis are the hallmarks of mathematics.

*American Scientist*  
Mathematics as a Creative Art, Volume 56, Number 4, Winter 1968 (p. 380)

I remember one occasion when I tried to add a little seasoning to a review, but I wasn't allowed to. The paper was by Dorothy Maharam, and it was a perfectly sound contribution to abstract measure theory. The domains of the underlying measures were not sets but elements of more general Boolean algebras, and their range consisted not of positive numbers but of certain abstract equivalence classes. My proposed first sentence was: “The author discusses valueless measures in pointless spaces.”

*I Want to Be a Mathematician*

Chapter 7 (p. 120)  
Springer-Verlag. New York, New York, USA. 1985

...many people think of mathematics itself as a static art — a body of eternal truth that was discovered by a few ancient, shadowy figures, and upon which engineers and scientists can draw as needed.

Innovation in Mathematics  
*Scientific American*, Volume 199, Number 3, September 1958 (p. 66)

All of pure mathematics, it is said, comes from the real world, the way geometry, according to legend, comes from measuring the effect of the floods on the Nile. (If that's false, if geometry existed before it was needed, the argument begins on a shaky foundation. If it's true, the argument tends to prove only that applied mathematics cannot get along without pure [mathematics], as an ant-eater cannot get along without ants, but not necessarily the reverse.)

In Ian Stewart  
*The Problems of Mathematics*  
Chapter 20 (p. 223)  
Oxford University Press, Inc. Oxford, England. 1987

It saddens me that educated people don't even know that my subject exists.

Mathematics as a Creative Art  
*American Scientist*, Volume 56, Number 4, Winter 1968 (p. 380)

**Halsted, George Bruce** 1853–1922  
American mathematician

...mathematics, that giant pincers of scientific logic...

Biology and Mathematics  
*Science*, Volume 27, Number 554, Friday, August 11, 1905 (p. 162)

**Hankel, Hermann** 1839–73  
German mathematician

The purely formal sciences, logic and mathematics, deal with those relations which are, or can be, independent of the particular content or the substance of objects. To mathematics in particular fall those relations between objects which involve the concepts of magnitude, of measure and of number.

*Theorie der Complexen Zahlensysteme insbesondere der gemeinen imaginären Zahlen und der Hamilton'schen Quaternionen nebst ihrer geometrischen Darstellung* (p. 1)  
Leopold Voss, Leipzig, Germany. 1867

Mathematics pursues its own course unrestrained, not indeed with an unbridled license which submits to no laws, but rather with the freedom which is determined by its own nature and in conformity with its own being.

*Entwicklung der Mathematik In den letzten Jahrhunderten* (p. 16)  
Akademische Antrittsrede. Tübingen, Germany. 1884

In most sciences one generation tears down what another has built and what one has established another undoes. In mathematics alone each generation adds a new story to the old structure.

*Die Entwicklung der Mathematik In den letzten Jahrhunderten* (p. 25)  
Akademische Antrittsrede. Tübingen, Germany. 1884

If we compare a mathematical problem with an immense rock, whose interior we wish to penetrate, then the work of the Greek mathematicians appear to us like that of a robust stonecutter, who, with indefatigable perseverance, attempts to demolish the rock gradually from the outside by means of hammer and chisel; but the modern mathematician resembles an expert miner, who first constructs a few passages through the rock and then explodes it with a single blast, bringing to light its inner treasures.

*Die Entwicklung der Mathematik In den letzten Jahrhunderten* (p. 9)  
Akademische Antrittsrede. Tübingen, Germany. 1884

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

We may say, roughly, that a mathematical idea is “significant” if it can be connected, in a natural and illuminating way, with a large complex of other mathematical ideas.

*A Mathematician's Apology*  
Chapter 11 (p. 89)  
Cambridge University Press. Cambridge, England. 1967

**Harrington, Eldred**

No biographical data available

Mathematics is a wonderful tool but it is only a tool; it is not a god to be worshipped.

*An Engineer Writes About People and Places and Projects*  
Part VI (p. 196)  
Calvin Horn Publisher, Inc. Albuquerque, New Mexico, USA. 1967

**Harris, William Torrey** 1835–1909  
American educator

Mathematics in its pure form, as arithmetic, algebra, geometry, and the applications of the analytic method, as well as mathematics applied to matter and force, or statics and dynamics, furnishes us the peculiar study that gives to us, whether as children or as men, the command of Nature in this its quantitative aspect. Mathematics furnishes the instrument, the tool of thought which we wield in this realm.

*Psychologic Foundations of Education*  
Footnote (a) (pp. 325–26)  
D. Appleton & Company. New York, New York, USA. 1898

**Hauffman, Paul**

No biographical data available

That Mathematics could be a jewel may come as a surprise to those of us who struggled with multiplication tables as kids and now need help completing W-4 forms.

The Man Who Loves Only Numbers  
*The Atlantic Magazine*, Volume 260, Number 5, November, 1987

...mathematics is order and beauty at its purest, order that transcends the physical world.

The Man Who Loves Only Numbers  
*The Atlantic Magazine*, Volume 260, Number 5, November, 1987 (p. 66)

**Hayes, Brian**

American scientist, columnist, and author

...the collected literature of mathematics is treated as a sacred text to be guarded against corruption and dilution.

Aftermath  
*The Emmissary*, Fall 1999 (p. 14)

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Mathematics is an experimental science, and definitions do not come first, but later on.

On Operators in Physical Mathematics, Part II  
*Proceedings of the Royal Society of London*, Volume 54, 1893 (p. 121)

**Heinlein, Robert A.** 1907–88

American science fiction writer

Anyone who cannot cope with mathematics is not fully human. At best he is a tolerable subhuman who has learned to wear shoes, bathe, and not make messes in the house.

*Time Enough for Love*  
Intermission (p. 265)  
G.P. Putnam's Sons. New York, New York, USA. 1973

...mathematics can never prove anything. No mathematics has any content. All any mathematics can do is — sometimes — turn out to be useful in describing some aspects of our so-called “physical universe.” That is a bonus; most forms of mathematics are as meaning-free as chess.

*The Number of the Beast*  
Chapter V (pp. 45–46)  
Fawcett Columbine Books. New York, New York, USA. 1980

**Heller, Joseph** 1923–99

American writer

She was a crazy mathematics major from the Wharton School of Business who could not count to twenty-eight each month without getting into trouble.

*Catch-22*  
Chapter Eight (p. 72)  
Dell Publishing Company, Inc. New York, New York, USA. 1985

**Hempel, Carl G.** 1905–97

German philosopher of science

The most distinctive characteristic which differentiates mathematics from the various branches of empirical science, and which accounts for its fame as the queen of the sciences, is no doubt the peculiar certainty and necessity of its results.

In James R. Newman (ed.)  
*The World of Mathematics* (Volume 3)  
Geometry and Empirical Science (p. 1635)  
Simon & Schuster. New York, New York, USA. 1956

**Herbart, Johann Friedrich** 1776–1841

German philosopher and educator

The idea that aptitude for mathematics is rarer than aptitude for other subjects is merely an illusion which is caused by belated or neglected beginners.

In Stanley Gudder

*A Mathematical Journey* (p. ix)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

Everything that the greatest minds of all times have accomplished toward the comprehension of forms by means of concepts is gathered into one great science, mathematics.

*Werke*

Pestalozzi's Idee eines A B C der Anschauung, Bd. 1 (p. 163)

Druck und Verlag von Hermann Beyer & Sohne. Langensalza, Germany. 1890

Mathematics, the priestess of definiteness and clearness.

*Werke*

Pestalozzi's Idee eines A B C der Anschauung, Bd. 1 (p. 171)

Druck und Verlag von Hermann Beyer & Sohne. Langensalza, Germany. 1890

Mathematics is the predominant science of our time; its conquests grow daily, though without noise; he who does not employ it for himself, will some day find it employed against himself.

*Werke*

Bd. 5 (p. 105)

Druck und Verlag von Hermann Beyer & Sohne. Langensalza, Germany. 1890

## Hermes, Hans

No biographical data available

It may be permissible to compare mathematical research with the opening up of a mountain range. There will always be the people whose principal interest it will be to try their ability in advanced mountaineering. They will go for the most difficult summits. Others will see their aim in making the mountain range accessible as a whole, by building convenient roads along the valleys and across the passes. They will also reach the summits eventually, but mainly for the sake of the beautiful views, and, if possible, by cable car.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Introduction (p. 18)

The Macmillan Company. New York, New York, USA. 1967

There is one comforting conclusion which is easy for a real mathematician. Real mathematics has no effects on war. No one has yet discovered any warlike purpose to be served by the theory of numbers or relativity, and it seems very unlikely that anyone will do so for many years.

*A Mathematician's Apology*

Chapter 28 (p. 140)

Cambridge University Press. Cambridge, England. 1967

The fact is that there are few more "popular" subjects than mathematics. Most people have some appreciation of mathematics, just as most people can enjoy a pleasant

tune; and there are probably more people really interested in mathematics than in music. Appearances may suggest the contrary, but there are easy explanations. Music can be used to stimulate mass emotion, while mathematics cannot; and musical incapacity is recognized (no doubt rightly) as mildly discreditable, whereas most people are so frightened of the name of mathematics that they are ready, quite unaffectedly, to exaggerate their own mathematical stupidity.

*A Mathematician's Apology*

Chapter 10 (p. 86)

Cambridge University Press. Cambridge, England. 1967

For mathematics is, of all the arts and sciences, the most austere and the most remote, and a mathematician should be of all men the one who can most easily take refuge where, as Bertrand Russell says, "one...of our nobler impulses can best escape from the dreary exile of the actual world."

*A Mathematician's Apology*

Section 28 (p. 143)

Cambridge University Press. Cambridge, England. 1967

It is undeniable that a good deal of elementary mathematics — and I use the word "elementary" in the sense in which professional mathematicians use it, in which it includes, for example, a fair working knowledge of the differential and integral calculus — has considerable practical utility. These parts of mathematics are, on the whole, rather dull; they are the parts which have the least aesthetic value. The "real" mathematics of the "real" mathematicians, the mathematics of Fermat and Euler and Gauss and Abel and Riemann, is almost wholly "useless" (and this is as true of "applied" as of "pure" mathematics. It is not possible to justify the life of any genuine professional mathematician on the ground of the "utility" of his work.

*A Mathematician's Apology*

Chapter 21 (pp. 119–120)

Cambridge University Press. Cambridge, England. 1967

Beauty is the first test: there is no permanent place in the world for ugly mathematics.

*A Mathematician's Apology*

Chapter 10 (p. 85)

Cambridge University Press. Cambridge, England. 1967

I believe that mathematical reality lies outside us, that our function is to discover or observe it, and that the theorems which we prove, and which we describe grandiloquently as our "creations," are simply the notes of our observations.

*A Mathematician's Apology*

Chapter 22 (p. 123)

Cambridge University Press. Cambridge, England. 1967

It seems to me that no philosophy can possibly be sympathetic to a mathematician which does not admit, in one manner or another, the immutable and unconditional

validity of mathematical truth. Mathematical theorems are true or false; their truth or falsity is absolute and independent of our knowledge of them.

*A Mathematician's Apology*

Chapter 1 (p. 4)

Cambridge University Press. Cambridge, England. 1967

...I will say only that if a chess problem is, in the crude sense, "useless," then that is equally true of most of the best mathematics; that very little of mathematics is useful practically, and that the little [that is] is comparatively dull.

*A Mathematician's Apology*

Chapter 11 (p. 89)

Cambridge University Press. Cambridge, England. 1967

...I am interested in mathematics only as a creative art.

*A Mathematician's Apology*

Chapter 19 (p. 115)

Cambridge University Press. Cambridge, England. 1967

...pure mathematics is on the whole distinctly more useful than applied. For what is useful above all is technique, and mathematical technique is taught mainly through pure mathematics.

In great mathematics there is a very high degree of unexpectedness, combined with inevitability and economy.

*A Mathematician's Apology*

Chapter 26 (p. 134)

Cambridge University Press. Cambridge, England. 1967

### **Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Admission to [astronomy's] sanctuary, and to the privileges and feelings of a votary, is only to be gained by one means — sound and sufficient knowledge of mathematics, the greatest instrument of all exact inquiry, without which no man can ever make such advances in this or any other of the higher departments of science as can entitle him to form an independent opinion on any subject of discussion within their range.

*Outlines of Astronomy*

Part I, Introduction (p. 5)

Longman, Brown, Green & Longmans. London, England. 1849

### **Hersh Reuben** 1927–

American mathematician

Formalized mathematics, to which most philosophizing has been devoted in recent years, is in fact hardly to be found anywhere on earth or in heaven outside the texts and journals of symbolic logic.

In John D. Barrow

*Pi in the Sky: Counting, Thinking, and Being* (p. 140)

Clarendon Press. Oxford, England. 1992

### **Herstein, I. N.**

No biographical data available

In mathematics itself abstract algebra plays a dual role: that of a unifying link between disparate parts of mathematics

and that of a research subject with a highly active life of its own.... A subject that was once regarded as esoteric has become considered as fairly down-to-earth for a large cross section of scholars.

*Abstract Algebra* (p. vii)

The Macmillan Company. New York, New York, USA. 1986

Very early in our mathematical education — in fact in junior high school or early in high school — we are introduced to polynomials. For a seemingly endless amount of time we are drilled, to the point of utter boredom, in factoring them, multiplying them, dividing them, simplifying them. Faculty in factoring a quadratic becomes confused with genuine mathematical talent.

*Topics in Algebra*

Chapter 3 (p. 113)

Xerox College Publishing. Waltham, Massachusetts, USA, 1964

### **Hertz, Heinrich** 1857–94

German physicist

One cannot escape the feeling that these mathematical formulas have an independent existence and an intelligence of their own, that they are wiser than we are, wiser even than their discoverers, that we get more out of them than was originally put into them.

In Morris Kline

*Mathematics and the Search for Knowledge*

Chapter VII (p. 144)

Oxford University Press, Inc. New York, New York, USA. 1985

### **Hesse, Hermann** 1877–1962

German poet and novelist

You treat world history as a mathematician does mathematics, in which nothing but laws and formulas exist, no reality, no good and evil, no time, no yesterday, no tomorrow, nothing but an eternal, shallow, mathematical present.

*The Glass Bead Game*

Chapter 4

Holt, Rinehart & Winston. New York, New York, USA. 1969

### **Hilbert, David** 1862–1943

German mathematician

We hear within us the perpetual call: There is the problem. Seek its solution. You can find it by pure reason, for in mathematics there is no ignoramus.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2<sup>nd</sup> Series,

October 1901–July 1902

For mathematics hoch — hoch — hoch [hip, hip hooray]

*Hilbert — Courant*

Hilbert

Chapter XXIII (p. 202)

Springer-Verlag. New York, New York, USA. 1986

Mathematics is not a popular subject, even though its importance may be generally conceded. The reason for

this is to be found in the common superstition that mathematics is but a continuation, a further development, of the fine art of arithmetic, of juggling with numbers.

In D. Hilbert and S. Cohen-Vossen

*Geometry and the Imagination* (p. iv)

Chelsea Publishing Company. New York, New York, USA. 1952

Mathematics... is nothing more than a game played according to certain simple rules with meaningless marks on a paper.

In E.T. Bell

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 21)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Mathematics must be cherished and strengthened as a unified, vital branch in the broad river of science; it dares not trickle away in the sand.

*Hilbert — Courant*

Hilbert

Chapter XXV (p. 220)

Springer-Verlag. New York, New York, USA. 1986

Living mathematics rests on the fluctuation between the antithesis powers of intuition and logic, the individuality of “grounded” problems and the generality of far-reaching abstractions. We ourselves must prevent the development being forced to only one pole of the life-giving antithesis.

*Hilbert — Courant*

Hilbert

Chapter XXV (p. 220)

Springer-Verlag. New York, New York, USA. 1986

A mathematical problem should be difficult in order to entice us, yet not completely inaccessible, lest it mock at our efforts.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2<sup>nd</sup> Series,

October 1901–July 1902

[Mathematics] should be to us a guide post on the mazy paths to hidden truths, and ultimately a reminder of our pleasure in the successful solution.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2<sup>nd</sup> Series,

October 1901–July 1902

Mathematical science is in my opinion an indivisible whole, an organism whose vitality is conditioned upon the connection of its parts.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, 2<sup>nd</sup> Series,

October 1901–July 1902

### Hill, Thomas

No biographical data available

The mathematics are usually considered as being the very antipodes of Poesy. Yet Mathesis and Poesy are of the closest kindred, for they are both works of the imagination. ... [They are] the utterance of the same power of

imagination, only that in the one case it is addressed to the head, in the other, to the heart.

The Imagination in Mathematics

*North American Review*, Volume 85, July 1857 (pp. 229–230)

### Hobson, E. W. 1856–1933

English mathematician

Perhaps the least inadequate description of the general scope of modern Pure Mathematics — I will not call it a definition — would be to say that it deals with form, in a very general sense of the term; this would include algebraic form, functional relationship, the relations of order in any ordered set of entities such as numbers, and the analysis of the peculiarities of form of groups of operations.

Presidential Address British Association for the Advancement of Science

*Nature*, Volume 84, Number 2131, September 1, 1910 (p. 287)

### Hodges, Wilfrid

No biographical data available

Mathematics is not a topic that one can easily approach with a virgin mind.

*Building Models by Games* (p. 1)

Cambridge University Press. Cambridge, England. 1985

### Hoffman, Paul

No biographical data available

Mathematics is a discipline practised in every university in the world, and it is at least as broad a field as biology, in which one researcher tries to understand the AIDS virus while another studies the socialization of wombats.

*Archimedes' Revenge*

Introduction (p. 2)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

### Hogben, Lancelot 1895–1975

English zoologist

The history of mathematics is the mirror of civilization.

*Mathematics for the Million*

Chapter I (p. 36)

W.W. Norton & Company, Inc. New York, New York, USA. 1917

If mathematics is a game, there is no reason why people should play it if they do not want to. With football, it belongs to those amusements without which life would be endurable.

*Mathematics for the Millions*

Chapter I (p. 31)

W.W. Norton & Company, Inc. New York, New York, USA. 1917

If the rules of mathematics are rules of grammar, there is no stupidity involved when we fail to see that a mathematical truth is obvious.

*Mathematics for the Millions*

Chapter I (p. 32)

W.W. Norton & Company, Inc. New York, New York, USA. 1917

**Holgate, Thomas F.**

No biographical data available

Modern pure geometry differs from the geometry of earlier times not so much in the subjects dealt with as in the processes employed and the generality of the results obtained. Much of the material is old, but by utilizing the principle of projection and the theory of transversals, facts which were thought of as in no way related, prove to be simply different aspects of the same general truth. This generalizing tendency's the chief characteristic of modern geometry.

In J.W.A. Young (ed.)

*Monographs on the Topics of Modern Mathematics Relevant to the Elementary Field*

Modern Pure Geometry (p. 56)

Longmans, Green. New York, New York, USA. 1911

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

There is no elasticity in a mathematical fact; if you bring up against it, it never yields a hair's breadth; everything must go to pieces that comes in collision with it. What the mathematician knows being absolute, unconditional, incapable of suffering question, it should tend, in the nature of things, to breed a despotic way of thinking. So of those who deal with the palpable and often unmistakable facts of external nature; only to a less degree.

*The Autocrat of the Breakfast-Table*

Chapter III (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

Every probability — and most of our common, working beliefs are probabilities — is provided with buffers at both ends, which break the force of opposite opinions clashing against it...

*The Autocrat of the Breakfast-Table*

Chapter III (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Holmes, Jr., Oliver Wendell** 1841–1935

American jurist

The law embodies the story of a nation's development through many centuries, and it cannot be dealt with as if it contained only the axioms and corollaries of a book of mathematics.

*The Common Law*

Lecture I (p. 1)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1923

**Honsberger, Ross** 1929–

Mathematician

Mathematics abounds in bright ideas. No matter how long and hard one pursues her, mathematics never seems to run out of exciting surprises. And by no means are these gems to be found only in difficult work at an advanced level. All kinds of simple notions are full of ingenuity.

*Mathematical Morsels* (p. vii)

Mathematical Association of America. Washington, D.C. 1978

**Hopkinson, John** 1849–98

English physicist and electrical engineer

...we cannot get more out of the mathematical mill than we put into it, though we may get it in a form infinitely more useful for our purpose.

The Relation of Mathematics to Engineering

*Nature*, Volume 50, Number 1280, May 10, 1894 (p. 46)**Howison, G. H.**

No biographical data available

Mathematics is the science of the functional laws and transformations which enable us to convert figured extension and rated motion into number.

The Departments of Mathematics, and Their Mutual Relations

*Journal of Speculative Philosophy*, Volume 5, 1871 (p. 170)

Mathematics is that form of intelligence in which we bring the objects of the phenomenal world under the control of the conception of quantity.

The Departments of Mathematics, and Their Mutual Relations

*Journal of Speculative Philosophy*, Volume 5, 1871 (p. 164)**Hubbard, John**

No biographical data available

The Mathematicks too our thoughts employ,  
Which nobly elevate the Student's joy:  
The little Euclids round the table set  
And at their rigid demonstrations sweat.

In Florian Cajori

*The Teaching and History of Mathematics in the United States*

Chapter I (p. 30)

Government Printing Office. Washington, D.C. 1890

**Hudson, Hilda Phoebe** 1881–1965

Mathematician

To all of us who hold the Christian belief that God is truth, anything that is true is a fact about God, and mathematics is a branch of theology.

In E.T. Bell

*The Magic of Numbers*

Chapter 26 (p. 385)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

The two main divisions of mathematics, analysis and geometry, correspond with some exactness to the two great mysteries of the Christian faith, the Trinity and the Incarnation.

In E.T. Bell

*The Magic of Numbers*

Chapter 26 (p. 386)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

But however we think of heaven, it is hard to imagine astronomy and botany surviving as they are, and having much interest or importance there.... On the other hand it is just as hard to imagine pure mathematics not surviving.

The laws of thought, and especially of number, must hold good in heaven, whether it is a place or a state of mind; for they are independent of any particular sphere of existence, essential to Being itself, to God's being as well as ours, laws of His mind before we learned them. The multiplication table will hold good in heaven...

In E.T. Bell

*The Magic of Numbers*

Chapter 26 (pp. 385–386)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

### Huntley, Henry Edwin

No biographical data available

To the aesthetically minded mathematician much mathematics reads like poetry.

*The Divine Proportion: A Study in Mathematical Beauty*

Preface (p. vii)

Dover Publications. New York, New York, USA. 1970

### Huxley, Aldous 1894–1963

English writer and critic

I admit that mathematical science is a good thing. But excessive devotion to it is a bad thing.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 4) (p. 2027)

Simon & Schuster. New York, New York, USA. 1956

### Huxley, Thomas Henry 1825–95

English biologist

Mathematical training is almost purely deductive. The mathematician starts with a few simple propositions, the proof of which is so obvious that they are called self-evident, and the rest of his work consists of subtle deductions from them.

Scientific Education: Notes of an After Dinner Speech

*Macmillan's Magazine*, Volume XX, July 1869 (p. 182)

Mathematics may be compared to a mill of exquisite workmanship which grinds you stuff of any degree of fineness; but, nevertheless, what you get out depends on what you put in; and as the grandest mill in the world will not extract wheat-flour from peas-cods, so pages of formulae will not get a definite result out of loose data.

*Collected Essays* (Volume 8)

Geological Reform (p. 333)

Macmillan & Company Ltd. London, England. 1904

[Mathematics] is that [subject] which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation.

*Lay Sermons, Addresses and Reviews* (p. 169)

D. Appleton & Company. New York, New York, USA. 1872

### Issigonis, Sir Alec 1906–88

English automobile designer

All creative people hate mathematics. It's the most uncreative subject you can study.

*The Australian*, 5 October 1988

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

...it can hardly be disputed that nature and our conscious mathematical minds work according to the same laws.

*The Mysterious Universe*

Chapter V (p. 165)

The Macmillan Company. New York, New York, USA. 1932

The essential fact is simply that all the pictures which science now draws of nature, and which alone seem capable of according with observational fact, are mathematical pictures.

*The Mysterious Universe*

Chapter V (p. 150)

The Macmillan Company. New York, New York, USA. 1932

...nature seems very conversant with the rules of pure mathematics, as our mathematicians have formulated them in their studies, out of their own inner consciousness and without drawing to any appreciable extent on their experience of the outer world.

*The Mysterious Universe*

Chapter V (p. 154)

The Macmillan Company. New York, New York, USA. 1932

### Jevons, William Stanley 1835–82

English economist and logician

In abstract mathematical theorems, the approximation to truth is perfect.... In physical science, on the contrary, we treat of the least quantities which are perceptible.

In J.W. Mellor

*Higher Mathematics for Students of Chemistry and Physics* (p. 266)

Dover Publications. New York, New York, USA. 1955

### Jacobi, Karl Gustav Jacob 1804–51

German mathematician

Mathematics exists solely for the honour of the human mind.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

See What the Proof Proves (p. 24)

The Macmillan Company. New York, New York, USA. 1967

...mathematics is slow of growth and only reaches the truth by long and devious paths, that the way to its discovery must be prepared for long beforehand, and that then the truth will make its long-deferred appearance as if impelled by some divine necessity...

Cited in Ernst Mach

*Popular Scientific Lectures*

The Part Played by Accident in Invention and Discovery (p. 280)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

It must not be supposed...that it is to a gift of Nature that I owe such mathematical power as I possess. No, it has come by hard work, hard work. Not mere industry, but brain-splitting thinking — hard work; hard work that has often endangered my health.

In Sir Richard Arman Gregory



*Discovery; or, The Spirit and Service of Science*  
Chapter I (p. 5)  
Macmillan & Company Ltd. London, England. 1918

**Jeffers, Robinson** 1887–1962  
American poet

Science and mathematics  
Run parallel to reality, they symbolize it, they squint  
at it,  
They never touch it...  
In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 3)  
What's the Best Life for a Man? (p. 425)  
Stanford University Press. Stanford, California, USA. 1988

**Jeffreys, Sir Harold** 1891–1989  
English astronomer and geophysicist

We have to come back to something like ordinary language after all when we want to talk about mathematics!  
*Methods of Mathematical Physics*  
Chapter 1 (p. 2)  
At The University Press. Cambridge, England. 1962

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

The Mathematicians are well acquainted with the Difference between pure Science, which has to do only with Ideas, and the Application of its Laws to the Use of Life, in which they are constrained to submit to the Imperfections of Matter and the Influence of Accidents.  
*The Rambler* (Volume 1)  
No. 14, May 5, 1750 (p. 128)  
Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Johnston, Francis E.**  
Mathematician

...I do not wish to leave you with the impression that mathematics feels it necessary to justify her existence by an appeal to her usefulness. I should like to regard her as the "Queen of the Sciences," rather than as the handmaiden of the engineer.  
The Postulational Treatment of Mathematics  
*American Scientist*, Volume 33, Number 1, January 1945 (p. 54)

**Kac, Mark** 1914–84  
Polish mathematician

...there are those who believe that mathematics can sustain itself and grow without any further contact with anything outside itself, and those who believe that nature is still and always will be one of the main (if not the main) sources of mathematical inspiration. The first group is identified as "pure mathematicians" (though "purist" would be more adequate) while the second is, with equal inadequacy, referred to as "applied."  
Quoted in Robert W. Ritchie (ed.)  
*New Directions in Mathematics* (p. 60)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1963

**Kanigel, Robert** 1946–  
Scientific journalist

Mathematics...is mired in a language of symbols foreign to most of us, [it] explores regions of the infinitesimally small and the infinitely large that elude words, much less understanding. So specialized is mathematics today...that most mathematical papers appearing in most mathematics journals are indecipherable even to most mathematicians.  
*The Man Who Knew Infinity: A Life of the Genius Ramanujan*  
Prologue (p. 6)  
Charles Scribner's Sons. New York, New York, USA. 1991

...mathematics is not best learned passively; you don't sop it up like a romance novel. You've got to go out to it, aggressive, and alert, like a chess master pursuing checkmate.  
*The Man Who Knew Infinity: A Life of the Genius Ramanujan*  
Chapter Two (p. 44)  
Charles Scribner's Sons. New York, New York, USA. 1991

**Kant, Immanuel** 1724–1804  
German philosopher

First of all, we ought to observe, that mathematical propositions, properly so called, are always judgments *a priori*, and not empirical, because they carry along with them necessity, which can never be deduced from experience. If people should object to this, I am quite willing to confine my statements to pure mathematics, the very concept of which implies that it does not contain empirical, but only pure knowledge *a priori*.  
*In Great Books of the Western World* (Volume 42)  
*Critique of Pure Reason*  
Introduction, Section V (p. 720)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Mathematical judgments are always synthetical.  
*In Great Books of the Western World* (Volume 42)  
*Critique of Pure Reason*  
Introduction, Section V (p. 720)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But mathematics, certainly, does not play the smallest part in the charm and movement of the mind produced by music. Rather is it only the indispensable condition (*conditio sine qua non*) of that proportion of the combining as well as changing impressions which makes it possible to grasp them all in one and prevent them from destroying one another, and to let them, rather, conspire towards the production of a continuous movement and quickening of the mind by affections that are in unison with it, and thus towards a serene self-enjoyment.  
*The Critique of Judgment*  
Critique of Aesthetic Judgment, Section 53  
Hafner Publishing Company. New York, New York, USA. 1951

In every department of physical science there is only so much science, properly so-called, as there is mathematics.  
In Morris Kline  
*Mathematics and the Physical World*

Preface (p. vii)

Dover Publications, Inc. New York, New York, USA. 1981

**Kaplan, Abraham** 1918–93

American philosopher of science, author, and educator

Mathematics is not yet capable of coping with the naiveté of the mathematician himself.

In James Roy Newman (ed.)

*The World of Mathematics* (Volume 2)

Sociology Learns the Language of Mathematics (p. 1301)

Simon & Schuster. New York, New York, USA. 1956

**Karpinski, L. C.**

No biographical data available

As a professor of mathematics I am practically required by the ethics of the profession to be absent-minded, unmethodical, and inconsistent in many ways fatal to bibliographical excellence.

*Bibliography of Mathematical Works Printed in American Through 1850*

Preface (p. viii)

University of Michigan Press. Ann Arbor, Michigan, USA. 1940

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

Mathematics is an activity governed by the same rules imposed upon the symphonies of Beethoven, the paintings of DaVinci, and the poetry of Homer. Just as scales, as the laws of perspective, as the rules of metre seem to lack fire, the formal rules of mathematics may appear to be without lustre. Yet ultimately, mathematics reaches pinnacles as high as those attained by the imagination in its most daring reconnoiters. And this conceals, perhaps, the ultimate paradox of science. For in their prosaic plodding both logic and mathematics often outstrip their advance guard and show that the world of pure reason is stranger than the world of pure fancy.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 362)

Simon & Schuster. New York, New York, USA. 1940

Here, then, in mathematics we have a universal language, valid, useful, intelligible everywhere in place and in time — in banks and insurance companies, on the parchments of the architects who raised the Temple of Solomon, and on the blueprints of the engineers who, with their calculus of chaos, master the winds. Here is a discipline of a hundred branches, fabulously rich, literally without limit in its sphere of application, laden with honors for an unbroken record of magnificent accomplishment. Here is a creation of the mind, both mystic and pragmatic in appeal. Austere and imperious as logic, it is still sufficiently sensitive and flexible to meet each new need.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 358)

Simon & Schuster. New York, New York, USA. 1940

...it is to the definite integral that structural engineers must render thanks for the Golden Gate Bridge, for it rests on this even more than on concrete and steel.

*Mathematics and the Imagination*

Chance and Chanceability—The Calculus (p. 340)

Simon & Schuster. New York, New York, USA. 1940

In purging mathematical philosophy of metaphysics, there has been... a real gain. No longer is mathematics to be looked upon as a key to the truth with a capital T. It may now be regarded as a woefully incomplete, though enormously useful, Baedeker [travel guide] in a mostly uncharted land. Some of the landmarks are fixed; some of the vast network of roads is made understandable; there are guideposts for the bewildered traveler.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 360)

Simon & Schuster. New York, New York, USA. 1940

**Keller, Helen** 1880–1968

American author and lecturer

Now I feel as if I should succeed in doing something in mathematics, although I cannot see why it is so very important...The knowledge doesn't make life any sweeter or happier, does it?

*The Story of My Life*

Letter to Mrs. Laurence Hutton, May 29, 1898 (p. 242)

Grosset & Dunlap, Publishers. New York, New York, USA. 1905

...I've said goodbye to Mathematics forever, and I assure you, I was delighted to see the last of those horrid goblins!

*The Story of My Life*

Letter to Mr. John D. Wright, December 9, 1900 (p. 270)

Grosset & Dunlap, Publishers. New York, New York, USA. 1905

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Fourier's Theorem is not only one of the most beautiful results of modern analysis, but it may be said to furnish an indispensable instrument in the treatment of nearly every recondite question in modern physics.

In E.T. Bell

*Men of Mathematics* (p. 183)

Simon & Schuster. New York, New York, USA. 1937

Do not imagine that mathematics is harsh and crabbed, and repulsive to common sense. It is merely the etherealisation of common sense.

*Popular Lectures and Addresses* (Volume 1)

Presidential Address

Birmingham and Midland Institute

October 3, 1883 (p. 273)

Macmillan & Company Ltd. London, England. 1894

Mathematics is the only good metaphysics.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

A single curve, drawn in the manner of the curve of prices of cotton, describes all that the ear can possibly hear as a result of the most complicated musical performances.... That to my mind is a wonderful proof of the potency of mathematics.

In E.T. Bell

*Men of Mathematics* (p. xvi)

Simon & Schuster. New York, New York, USA. 1937

### Kepler, Johannes 1571–1630

German astronomer

If there is anything that can bind the heavenly mind of man to this dreary exile of our earthly home and can reconcile us with our fate so that one can enjoy living, — then it is verily the enjoyment of the mathematical sciences and astronomy.

In H.E. Huntley

*The Divine Proportion: A Study In Mathematical Beauty*

Introduction (p. 6)

Dover Publications. New York, New York, USA. 1970

### Keyser, Cassius Jackson 1862–1947

American mathematician

The validity of mathematical propositions is independent of the actual world — the world of existing subject-matters is logically prior to it, and would remain unaffected were it to vanish from being.

*The Pastures of Wonder*

The Realm of Mathematics (p. 99)

Columbia University Press. New York, New York, USA. 1929

The apodictic quality of mathematical thought, the certainty and correctness of its conclusions, are due, not to a special mode of ratiocination, but to the character of the concepts with which it deals. What is that distinctive characteristic? I answer: precision, sharpness, completeness of definition. But how comes your mathematician by such completeness? There is no mysterious trick involved; some ideas admit of such precision, others do not; and the mathematician is one who deals with those that do.

The Universe and Beyond

*Hibbert Journal*, Volume 3 (1904–1905) (p. 309)

Every major concern among the intellectual concerns of man is a concern of mathematics.

*Mole Philosophy and Other Essays*

Chapter XVII (p. 93)

E.P. Dutton & Company, Inc. New York, New York, USA. 1927

Mathematics is, in many ways, the most precious response that the human spirit has made to the call of the infinite and eternal.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

The Human Significance of Mathematics (p. 59)

Columbia University Press. New York, New York, USA. 1925

Mathematics, like any other cardinal activity of the human spirit, has an individuality of its own.

*Mathematics and the Question of Cosmic Mind with Other Essays*

The Meaning of Mathematics (p. 3)

Scripta Mathematica. New York, New York, USA. 1935

But for the unattainable ideal of logical perfection, we should be without the miracles of modern Mathematics.

*Mole Philosophy and Other Essays*

Chapter I (p. 3)

E.P. Dutton & Company, Inc. New York, New York, USA. 1927

It is customary to speak of mathematics, of pure mathematics, and of applied mathematics, as if the first were a genus owning the other two as species. The custom is unfortunate because it is misleading.

*Mole Philosophy and Other Essays*

Chapter XVIII (pp. 109–110)

E.P. Dutton & Company. New York, New York, USA. 1927

It can, you see, be said, with the same approximation to truth, that the whole of science, including mathematics, consists in the study of transformations or in the study of relations.

*Mathematical Philosophy: A Study of Fate and Freedom*

Chapter X (p. 168)

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

### King, Jerry P.

American mathematician

Mathematics is precise or it is nothing...

*The Art of Mathematics*

Introduction (p. 9)

Plenum Press. New York, New York, USA. 1992

...pure mathematics is mathematics for mathematics' sake and applied mathematics is mathematics for something else.

*The Art of Mathematics*

Chapter 2 (p. 26)

Plenum Press. New York, New York, USA. 1992

### Klein, Felix 1849–1925

German mathematician

There appears a fundamental principle which can serve to characterize all possible geometries.... Given any group of transformations in space which includes the principal group as a sub-group, then the invariant theory of this group gives a definite kind of geometry, and every possible geometry can be obtained in this way.

Translated by E.R. Hedrick and C.A. Noble

*Elementary Mathematics from an Advanced Standpoint*

Part Second, Chapter II, Section 6 (p. 133)

Dover Publications. New York, New York, USA. 1939

Mathematics in general is fundamentally the science of self evident things.

*Mathematics: Queen and Servant of Science*

Mathematical Truth (pp. 19–20)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

But it should always be required that a mathematical subject not be considered exhausted until it has become intuitively evident...

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 904)  
Oxford University Press, Inc. New York, New York, USA. 1972

In fact, mathematics has grown like a tree, which does not start at its tiniest rootlets and grow merely upward, but rather sends its roots deeper and deeper at the same time and rate that its branches and leaves are spreading upward... We see, then, that as regards the fundamental investigation in mathematics, there is no final ending, and therefore on the other hand, no first beginning...

Translated by E.R. Hedrick and C.A. Noble

*Elementary Mathematics from an Advanced Standpoint*  
Part First, Chapter I, Section 3 (p. 15)  
Dover Publications. New York, New York, USA. 1939

### **Kline, Morris** 1908–92

American mathematics professor and writer

The tantalizing and compelling pursuit of mathematical problems offers mental absorption, peace of mind amid endless challenges, repose in activity, battle without conflict, “refuge from the goading urgency of contingent happenings,” and the sort of beauty changeless mountains present to senses tried by the present-day kaleidoscope of events.

*Mathematics in Western Culture*

Chapter XXVIII (p. 470)

Oxford University Press, Inc. New York, New York, USA. 1953

When we consider the number of fields on which mathematics impinges and the number of these over which it already gives us mastery or partial mastery, we are tempted to call it a method of approach to the universe of physical, mental, and emotional experiences. It is distillation of highest purity that exact thought has extracted from man’s efforts to understand nature, to impart order to the confusion of events occurring in the physical world, to create beauty, and to satisfy the natural proclivity of the healthy brain to exercise itself.

*Mathematics in Western Culture*

Chapter XXVIII (pp. 471–472)

Oxford University Press, Inc. New York, New York, USA. 1953

We should drop the ideas that mathematics and what mathematics says about the world are indubitable truths. Today there is no agreement among mathematicians on fundamental principles... Mathematics is not the universally accepted, precise body of knowledge that it was thought to be 100 years ago when scholars believed that it revealed the design of the universe.

Mathematics: From Precision to Doubt in 100 Years

*U.S. News and World Report*, January 26, 1981

The developments in this century bearing on the foundations of mathematics are best summarized in a story. On the banks of the Rhine, a beautiful castle had been standing for centuries. In the cellar of the castle, an intricate network of webbing had been constructed by industrious

spiders who lived there. One day a strong wind sprang up and destroyed the web. Frantically, the spiders worked to repair the damage. They thought it was their webbing that was holding up the castle.

*Mathematics: The Loss of Certainty*

Chapter XII (p. 277)

Oxford University Press, Inc. New York, New York, USA. 1980

The conquest of new domains of mathematics proceeds somewhat as do military conquests. Bold dashes into enemy territory capture strongholds. These incursions must then be followed up and supported by broader, more thorough and more cautious operations to secure what has been only tentatively and insecurely grasped.

*Mathematical Thought from Ancient to Modern Times*

Chapter 19 (p. 400)

Oxford University Press, Inc. New York, New York, USA. 1972

Negative numbers were not accepted by all the Hindus. Even Bhaskara said, while giving 50 and  $-5$  as solutions of a problem, “The second value is in this case not to be taken, for it is inadequate; people do not approve of negative solutions.”

*Mathematics: The Loss of Certainty*

Chapter V (p. 110)

Oxford University Press, Inc. New York, New York, USA. 1980

Science provides the understanding of the universe in which we live. Mathematics provides the dies by which science is molded. Our world is to a large extent what mathematics says it is.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

The Meaning of Mathematics (p. 18)

Wadsworth, Inc. Belmont, California, USA. 1984

Perhaps the best reason for regarding mathematics as an art is not so much that it affords an outlet for creative activity as that it provides spiritual values. It puts man in touch with the highest aspirations and loftiest goals. It offers intellectual delight and the exaltation of resolving the mysteries of the universe.

*Mathematics: A Cultural Approach*

Chapter 31–4 (p. 671)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1962

The mere fact that there can be alternative geometries was in itself a shock. But the greater shock was that one could no longer be sure which geometry was true or whether any one of them was true... Mathematicians were in the position described by Mark Twain: “Man is the religious animal. He’s the only one who’s got the true religion — several of them.”

*Mathematics: The Loss of Certainty*

Chapter IV (p. 88)

Oxford University Press, Inc. New York, New York, USA. 1980

Mathematics then is a formidable and bold bridge between ourselves and the external world. Though it is

a purely human creation, the access it has given us to some domains of nature enable us to progress far beyond all expectations. Indeed it is paradoxical that abstractions so remote from reality should achieve so much. Artificial the mathematical account may be, a fairy tale perhaps, but one with a moral.

*Mathematics: A Cultural Approach*

Chapter 31–6 (p. 676)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1962

Bertrand Russell... wrote in *My Philosophical Development*, “Those who taught me the infinitesimal calculus did not know the valid proofs of its fundamental theorems and tried to persuade me to accept the official sophistries as an act of faith.”

*Mathematics: The Loss of Certainty*

Chapter VII (p. 162)

Oxford University Press, Inc. New York, New York, USA. 1980

As man’s greatest and most successful intellectual experiment, mathematics demonstrates manifestly how powerful our rational faculty is. It is the finest expression of man’s intellectual strength. His reason has, for example, far outstripped his imagination. He can think about stars so distant that only numbers convey any meaning about spaces which cannot be pictured, and about electrons too small to be seen with the most powerful microscopes.

*Mathematics: A Cultural Approach*

Chapter 31–15 (p. 674)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1962

If potential application is the goal, then as the great physical chemist Josiah Willard Gibbs remarked, the pure mathematician can do what he pleases, but the applied mathematician must be at least partially sane.

*Mathematics: The Loss of Certainty*

Chapter XIII (p. 285)

Oxford University Press, Inc. New York, New York, USA. 1980

...mathematics has determined the direction and content of much philosophic thought, has destroyed and rebuilt religious doctrines, has supplied substance to economic and political theories, has fashioned major painting, musical, architectural, and literary styles, has fathered our logic, and has furnished the best answers we have to fundamental questions about the nature of man and his universe. As the embodiment and most powerful advocate of the rational spirit, mathematics has invaded domains ruled by authority, custom, and habit, and supplanted them as the arbiter of thought and action. Finally, as an incomparably fine human achievement mathematics offers satisfactions and aesthetic values at least equal to those offered by any other branch of our culture.

*Mathematics in Western Culture*

Preface (p. ix)

Oxford University Press, Inc. New York, New York, USA. 1953

### **Koyré, Alexandre** 1892–1964

Russian-born French philosopher

Nature responds only to questions posed in mathematical language, because nature is the domain of measure and order.

In H. Floris Cohen

*The Scientific Revolution: A Historiographical Inquiry*

Chapter Two (p. 77)

The University of Chicago Press. Chicago, Illinois, USA. 1994

### **Lakatos, Imre** 1922–74

Hungarian-born philosopher

Mathematics has been trivialized, derived from indubitable, trivial axioms in which only absolutely clear trivial terms figure, and from which truth pours down in clear channels.

*Mathematics, Science and Epistemology* (Volume 2)

Chapter 1 (p. 10)

Cambridge University Press. Cambridge, England. 1978

Mathematics does not grow through a monotonous increase of the number of indubitably established theorems, but through the incessant improvement of guesses by speculation and criticism.

In Michael Guillen

*Bridges to Infinity: The Human Side of Mathematics*

Part I, A Certain Treasure (p. 19)

Jeremy P. Tarcher, Inc. Los Angeles, California.

USA. 1983

### **Lamb, Sir Horace** 1848–1934

English applied mathematician

A traveler who refuses to pass over a bridge until he has personally tested the soundness of every part of it is not likely to go far; something must be risked, even in mathematics.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 468)

Oxford University Press, Inc. New York, New York, USA. 1972

### **Langer, R. E.**

No biographical data available

Rich in its past, dynamic in the present, prodigious for the future, replete with simple and yet profound ideas and methods, surely mathematics can give something to anyone’s culture.

The Things I Should Have Done, I Did Not Do

*The American Mathematical Monthly*, Volume 59, Number 7,

August–September 1952 (p. 445)

### **Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

All the effects of nature are only the mathematical consequences of a small number of immutable laws.

In E.T. Bell

*Men of Mathematics* (p. 172)

Simon & Schuster. New York, New York, USA. 1937

**Lasserre, Francois**

No biographical data available

Ask a philosopher “What is philosophy?” or a historian “What is history?” and they will have no difficulty in giving an answer. Neither of them, in fact, can pursue his own discipline without knowing what he is searching for. But ask a mathematician “What is mathematics?” and he may justifiably reply that he does not know the answer but that does not stop him from doing mathematics.

In John D. Barrow

*Pi in the Sky: Counting, Thinking, and Being* (p. 1)

Clarendon Press. Oxford, England. 1992

**Lec, Stanislaw** 1909–66

Polish poet and aphorist

I don't agree with mathematics; the sum total of zeros is a frightening figure.

Translated by Jacek Galazka

*More Unkempt Thoughts* (p. 26)

Funk & Wagnalls. New York, New York, USA. 1968

**LeCam, Lucien**

No biographical data available

[In statistics] you have the fact that the concepts are not very clean. The idea of probability, of randomness, is not a clean mathematical idea. You cannot produce random numbers mathematically. They can only be produced by things like tossing dice or spinning a roulette wheel. With a formula, any formula, the number you get would be predictable and therefore not random. So as a statistician you have to rely on some conception of a world where things happen in some way at random, a conception which mathematicians don't have.

In D. Albers, G. Alexanderson and C. Reid (eds.)

*More Mathematical People*

Lucien LeCam (p. 174)

Harcourt Brace Jovanovich. New York, New York, USA. 1990

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

All things in the whole wide world happen mathematically.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Introduction (p. 14)

The Macmillan Company. New York, New York, USA. 1967

**Lemoine, Emile**

No biographical data available

A mathematical truth is neither simple nor complicated in itself, it is.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

**Lemon, Harvey Brace**

Physicist

...it appears that we may be led to the discovery of new facts not only by direct experimentation, but also through the somewhat mysterious rites and rituals of the symbolism of pure mathematics. In this fact alone would mathematics as a leading science find ample justification in the mind of the experimental investigator — were such justification at all necessary.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Atomic Structure (p. 101)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Leslie, John** 1766–1832

Scottish mathematician

The study of mathematics holds forth two capital objectives; while it traces the beautiful relations of figure and quantity, it likewise accustoms the mind to the invaluable exercise of patient attention and accurate reasoning. Of these distinct objects the last is perhaps the most important in a course of liberal education. For this purpose, the geometry of the ancients is the most powerfully recommended, as bearing the stamp of that acute people, and displaying the finest specimens of logical deduction. Some of the propositions, indeed, might be reached by a sort of algebraic calculation; but such an artificial mode of procedure gives only an apparent facility, and leaves no clear or permanent impression on the mind.

*Elements of Geometry, Geometrical Analysis, and Plane Trigonometry*

Preface (pp. v–vi)

Printed by James Ballentyne & Company. Edinburgh, Scotland. 1809

**Levitt, Norman**

American mathematician

The dictum that everything that people do is “cultural” licenses the idea that every cultural critic can meaningfully analyze even the most intricate accomplishments of art and science.... It is distinctly weird to listen to pronouncements on the nature of mathematics from the lips of someone who cannot tell you what a complex number is!

The Flight from Science and Reason

*Science*, October 11, 1996 (p. 183)

**Libchaber, Albert** 1934–

Chaos theorist

A physicist would ask me, How does this atom come here and stick there? And what is the sensitivity to the surface? And can you write the Hamiltonian of the system? And if I tell him, I don't care, what interests me is this shape, the mathematics of the shape and the evolution, the bifurcation from this shape to that shape to this shape, he will tell me, that's not physics, you are doing mathematics.

In James Gleick

*Chaos: Making a New Science*

The Experimenter (pp. 210–211)

The Viking Press. New York, New York, USA. 1987

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

Mathematics is truly a splendid science, but mathematicians often are not worth a nickel...very often the so-called mathematician expects to be considered a deep thinker; yet the greatest blockheads are among them, unfit for any kind of occupation which requires contemplation if it cannot be done directly through that easy combination of symbols, which is more the work of routine than of thought.

*Tag and Donnerung*

Aphorismen (p. 305)

Publisher undetermined

**Lieber, Lillian R.**

Mathematician

When we learn to drive a car we are able to “go places” easily and pleasantly instead of walking to them with a great deal of effort. And so you will see that the more Mathematics we know the EASIER life becomes, for it is a TOOL with which we can accomplish things that we could not do at all with our bare hands. Thus Mathematics helps our brains and hands and feet, and can make a race of supermen out of us.

*The Education of T.C. Mits*

Part I, Chapter IV (p. 45)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1944

**Lindley, David** 1956–

English astrophysicist and author

The lure of mathematics is hard to resist. When, by dint of great effort and ingenuity, a previously vague, ill-formed idea is encapsulated in a neat mathematical formulation, it is impossible to suppress the feeling that some profound truth has been discovered.

*The End of Physics: The Myth of a Unified Theory*

Prologue (p. 13)

Basic Books. New York, New York, USA. 1993

Physicists, however, are scavengers of mathematics; they take what they need, adapt it to their purposes, and discard the rest.

*The End of Physics: The Myth of a Unified Theory*

Prologue (p. 5)

Basic Books. New York, New York, USA. 1993

**Lindsay, R. Bruce**

No biographical data available

Of one thing we may be sure: physics without mathematics will forever be incomprehensible.

On the Relation of Mathematics and Physics

*Scientific Monthly*, Volume 59, December 1944 (p. 460)**Lobachevskii, Nikolai Ivanovich** 1792–1856

Russian mathematician

There is no branch of mathematics however abstract which may not some day be applied to phenomena of the real world.

In Stanley Gudder

*A Mathematical Journey* (p. 36)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Locke, John** 1632–1704

English philosopher and political theorist

Mathematical proofs, like diamonds, are hard as well as clear, and will be touched with nothing but strict reasoning.

In Stanley Gudder

*A Mathematical Journey* (p. 20)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

And thus all mathematical demonstrations, as well as first principles, must be received as native impressions on the mind; which I fear they will scarce allow them to be, who find it harder to demonstrate a proposition than assent to it when demonstrated. And few mathematicians will be forward to believe that all the diagrams they have drawn were but copies of those innate characters which nature had engraven upon their minds.

In *Great Books of the Western World* (Volume 35)*An Essay Concerning Human Understanding*

Book I, Chapter I, Section 22 (p. 101)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

And thus many are ignorant of mathematical truths, not out of any imperfection of their faculties, or uncertainty in the things themselves, but for want of application in acquiring, examining, and by due ways comparing those ideas.

*The Works of John Locke in Nine Volumes*

Book IV, Chapter III, Section 30

Rivington. London, England. 1824

I doubt not but it will be easily granted, that the knowledge we have of mathematical truths is not only certain, but real knowledge; and not the bare empty vision of vain, insignificant chimeras of the brain.

*The Works of John Locke in Nine Volumes*

Book IV, Chapter IV, Section 6

Rivington. London, England. 1824

...the study of mathematics would show...the necessity there is in reasoning, to separate all the distinct ideas, and to see the habitudes that all those concerned in the present inquiry have to one another, and to lay by those which relate not to the proposition in hand, and wholly to leave them out of the reckoning.

*An Essay Concerning Human Understanding and a Treatise on the Conduct of the Understanding*

A Treatise on the Conduct of the Understanding

Section 7 (p. 494)

James Kay, June &amp; Company. Philadelphia, Pennsylvania, USA. 185–

...would you have a man reason well, you must use him to it betimes; exercise his mind observing the connexion of ideas, and following them in train. Nothing does this

better than mathematics, which therefore, I think should be taught to all who have the time and opportunity; not so much to make them mathematicians, as to make them reasonable creatures; for though we all call ourselves so, because we are born to it, if we please; yet we may truly say, nature gives to us but the seeds of it...and we are... no farther than industry and application have carried us.

*An Essay Concerning Human Understanding and a Treatise on the Conduct of the Understanding*

A Treatise on the Conduct of the Understanding

Section 6 (p. 492)

James Kay, June & Company. Philadelphia, Pennsylvania, USA. 185–

**Lowell, Percival** 1855–1916

American astronomer

The science of mathematics...might be called the most imaginative product of human thought; for it is simply one vast imagination based upon a few so-called axioms, which are nothing more or less than the results of experience. It is nonetheless imaginative because the discoveries always accord subsequently with fact, since man was not aware of them beforehand. Nor are its inevitable conclusions inevitable to any save those possessed of the mathematician's prophetic insight.

In William Graves Hoyt

*Lowell and Mars*

Chapter 2 (p. 20)

University of Arizona Press. Tucson, Arizona, USA. 1976

**Lucas, William F.**

No biographical data available

Although some older art, music or wines may be better than the newer, it is rather unlikely that this would often apply to science or mathematics.

In Lynn Arthur Steen

*Mathematics Tomorrow*

Growth and New Intuitions: Can We Meet the Challenge? (p. 65)

Springer-Verlag. New York, New York, USA. 1981

**MacLane, Saunders** 1909–2005

American mathematician

Mathematics, springing from the soil of basic human experience with numbers and data and space and motion, builds up a far-flung architectural structure composed of theorems which reveal insights into the reasons behind appearances and of concepts which relate totally disparate concrete ideas.

Of Course and Courses

*The American Mathematical Monthly*, Volume 61, Number 3, March

1954 (p. 152)

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Strange as it may sound, the power of mathematics rests on its evasion of all unnecessary thought and on its wonderful saving of mental operations.

In E.T. Bell

*Men of Mathematics* (p. xvi)

Simon & Schuster. New York, New York, USA. 1937

The student of mathematics often finds it hard to throw off the uncomfortable feeling that his science, in the person of his pencil, surpasses him in intelligence, — an impression which the great Euler confessed he often could not get rid of. This feeling finds a sort of justification when we reflect that the majority of the ideas we deal with were conceived by others, often centuries ago. In a great measure it is really the intelligence of other people that confronts us in science.

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 196)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

Mathematics may be defined as the economy of counting. There is no problem in the whole of mathematics which cannot be solved by direct counting. But with the present implements of mathematics many operations of counting can be performed in a few minutes, which, without mathematics, would take a lifetime.

In J.W. Mellor

*Higher Mathematics for Students of Chemistry and Physics* (p. 184)

Dover Publications. New York, New York, USA. 1955

**Mann, Thomas** 1875–1955

German-born American novelist

I tell them that if they will occupy themselves with the study of mathematics they will find in it the best remedy against the lusts of the flesh.

*The Magic Mountain*

Chapter VI

Choler and Worse (p. 417)

Alfred A. Knopf. New York, New York, USA. 1966

**Maxwell, James Clerk** 1831–79

Scottish physicist

Thus, all the mathematical sciences are founded on relations between physical laws and laws of numbers.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 1) (p. 156)

At The University Press. Cambridge, England. 1890

**Mazur, Barry** 1937–

American mathematician

The wonderful thing about mathematics is that, in the end as well as in the beginning, it can depend upon no authority other than one's own (your own) mind; its verification comes from thinking alone, an activity open to anyone. If we have no theoretical equipment, we use the mathematical eyes and ears with which we were born and just experiment with our guesses to see whether we have faith in them.

*Imagining Numbers*

Part II, Chapter 10, Section 57 (p. 188)

Farrar Straus & Girox. New York, New York, USA. 2003



**McDuff, Dusa** 1945–  
Mathematician

Gel'fand amazed me by talking of mathematics as though it were poetry. He once said about a long paper bristling with formulas that it contained the vague beginnings of an idea which he could only hint at and which he had never managed to bring out more clearly. I had always thought of mathematics as being much more straightforward: a formula is a formula, and an algebra is an algebra, but Gel'fand found hedgehogs lurking in the rows of his spectral sequences!

*Mathematical Notices*, Volume 38, Number 3, March 1991 (p. 186)

**Mellor, J. W.**  
Chemist

Higher Mathematics is the art of reasoning about numerical relations between natural phenomena; and the several sections of Higher Mathematics are different modes of viewing these relations.

*Higher Mathematics for Students of Chemistry and Physics*

Prologue

New York, New York, USA. 1902

**Mencke, J. B.** 1674–1732  
Poet

[Mathematics] guides our minds in an orderly way, and furnishes us simple and rational principles by means of which ambiguities are clarified, disorder is converted into order, and complexities are analyzed into their component parts.

*The Charlatantry of the Learned*

Lecture II (p. 152)

Alfred A. Knopf. New York, New York, USA. 1937

[Mathematics] includes much that will neither hurt one who does not know it nor help one who does.

*The Charlatantry of the Learned*

Lecture II (p. 152)

Alfred A. Knopf. New York, New York, USA. 1937

**Mendés, Michel**

No biographical data available

A talk in mathematics should be one of four things: beautiful, deep, surprising...or short.

Remark, ca. 1986

**Merz, John Theodore** 1840–1922  
English industrial chemist and philosopher

In every case, the awakening touch has been the mathematical spirit, the attempt to count, to measure, or to calculate. What to the poet or the seer may appear to be the very death of all his poetry and all his visions — the cold touch of the calculating mind, — this has proved to be the spell by which knowledge has been born, by which new sciences have been created, and hundreds of

definite problems put before the minds and into the hands of diligent students. It is the geometrical figure, the dry algebraical formula, which transforms the vague reasoning of the philosopher into a tangible and manageable conception; which represents, though it does not explain, the things and processes of nature: this clothes the fruitful, but otherwise indefinite, ideas in such a form that the strict logical methods of thought can be applied, that the human mind can in its inner chamber evolve a train of reasoning the result of which corresponds to the phenomena of the outer world.

*A History of the European Thought in the Nineteenth Century*  
Volume 1

The Astronomical View of Nature (p. 314)

William Blackwood & Sons. Edinburgh, Scotland. 1907

**Meyer, Walter**

No biographical data available

In a time when much of the world's geography has been explored, and space exploration is restricted to astronauts, mathematics offers fertile ground for exploring the unknown.

Missing Dimensions of Mathematics

*Humanistic Mathematics Network Journal*, Number 11, February, 1995

**Mill, John Stuart** 1806–73

English political philosopher and economist

The character of necessity ascribed to the truths of mathematics and even the peculiar certainty attributed to them is an illusion.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 861)

Oxford University Press, Inc. New York, New York, USA. 1972

The peculiarity of the evidence of mathematical truths is that all the argument is on one side. There are no objections, and no answers to objections.

In *Great Books of the Western World* (Volume 43)

*On Liberty*

Of the Liberty of Thought and Discussion (p. 284)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Miller, G. A.**

No biographical data available

Mathematics is the science of saving thought.

*The American Mathematical Monthly*

Definition of the Term "Mathematics", Volume 15, Number 11, November 1908 (p. 197)

**Minto, Walter** 1753–96

Scottish-American mathematician

Mathematical Knowledge is generally supposed to be acquired with difficulty. I can assure you, however, that the difficulty arises rather from want of attention than from want of sagacity in those who make the attempt.

*An Inaugural Oration on the Progress and Importance of the Mathematical Sciences.*

Princeton, preceding the Annual Commencement 1788 (p. 46)  
Printed by Isaac Collins. Trenton, New Jersey, USA. 1788

The mathematical sciences, independently of their application to any particular purpose, are of the utmost consequence to the student.

*An Inaugural Oration on the Progress and Importance of the Mathematical Sciences.*

Princeton, preceding the Annual Commencement 1788 (p. 30)  
Printed by Isaac Collins, 1788

### Mirowski, P.

No biographical data available

...mathematics does not come to us written indelibly on Nature's Tablets, but rather is the product of a controlled search governed by metaphorical considerations, the premier instance being the heuristics of the conservation principles.

*More Heat than Light: Economics as Social Physics: Physics as Nature's Economics*

Chapter 1 (p. 7)

Cambridge University Press. Cambridge, England. 1989

### Mittag-Leffler, Gosta 1846–1927

Swedish mathematician

The mathematician's best work is art... a high and perfect art, as daring as the most secret dreams of imagination, clear and limpid. Mathematical genius and artistic genius touch each other.

In Havelock Ellis

*The Dance of Life*

Chapter III, Section V (p. 139)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

### Modjeski, Ralph

No biographical data available

Mathematics is to an engineer what anatomy is to a surgeon, what chemistry is to an apothecary, what drill is to an army officer. It is indispensable.

The Teaching of Mathematics to Students of Engineering

*Science*, New Series, Volume 28, Number 710, August 7, 1908 (p. 161)

### Monbodo, Lord James Burnett 1714–99

Scottish anthropologist

Those who have studied mathematics much, and no other science, are apt to grow so fond of them, as to believe that there is no certainty in any other science, nor any other axioms than those of Euclid.

*Edinburgh Review*, Volume 52, January 1836 (p. 248)

### Mordell, Louis Joel 1888–1972

English mathematician

...what is mathematics? It has so many different aspects that the difficulties in trying to give a definition are similar to those encountered in trying to determine whether some living organisms are animal or vegetable.

*Reflections of a Mathematician*

Chapter I (pp. 1–2)

Canadian Mathematical Congress. 1959

Mathematical study and research are very suggestive of mountaineering. Whymper made several efforts before he climbed the Matterhorn in the 1860s and even then it cost the life of four of his party. Now, however, any tourist can be hauled up for a small cost, and perhaps does not appreciate the difficulty of the original ascent. So in mathematics, it may be found hard to realise the great initial difficulty of making a little step which now seems so natural and obvious, and it may not be surprising if such a step has been found and lost again.

*Three Lectures on Fermat's Last Theorem* (p. 4)

Chelsea Publishing Company. New York, New York, USA. 1980

### Morse, Harold Marston 1892–1977

American mathematician

But mathematics is the sister, as well as the servant, of the arts and is touched with the same madness and genius.

In Stanley Gudder

*A Mathematical Journey* (p. 81)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

### Moultrie, John 1799–1874

English poet

There's nothing in the world (that is in Trinity)

To make us poets happy; —

I detest

Your Hebrew, Greek and heathenish Latinity,

And Mathematics are a bore at best.

*Poems*

Sir Launfal, xii

William Pickering. London, England. 1838

### Muses, Charles

No biographical data available

Mathematics penetrates, as nothing else can, both the nature of the observable world and that of the mind that perceives the world by means of the body and its senses. Mathematics assumes a fundamental place in science, which represents nothing else than our attempt to understand the world we experience (including our bodies and minds). Mathematics can do this because it provides a language by which we can explore, and describes precisely and profoundly, any possible set of characteristics or relationships — sometimes more accurately than words alone would allow.

*Science Digest*, April, Volume 83, Number 4, 1978 (p. 33)

### Newman, James Roy 1911–66

Mathematician and mathematical historian

Mathematics is an activity governed by the same rules imposed upon the symphonies of Beethoven, the paintings of DaVinci, and the poetry of Homer. Just as scales, as the laws of perspective, as the rules of metre seem

to lack fire, the formal rules of mathematics may appear to be without lustre. Yet ultimately, mathematics reaches pinnacles as high as those attained by the imagination in its most daring reconnoiters. And this conceals, perhaps, the ultimate paradox of science. For in their prosaic plodding both logic and mathematics often outstrip their advance guard and show that the world of pure reason is stranger than the world of pure fancy.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 362)

Simon & Schuster. New York, New York, USA. 1940

Here, then, in mathematics we have a universal language, valid, useful, intelligible everywhere in place and in time — in banks and insurance companies, on the parchments of the architects who raised the Temple of Solomon, and on the blueprints of the engineers who, with their calculus of chaos, master the winds. Here is a discipline of a hundred branches, fabulously rich, literally without limit in its sphere of application, laden with honors for an unbroken record of magnificent accomplishment. Here is a creation of the mind, both mystic and pragmatic in appeal. Austere and imperious as logic, it is still sufficiently sensitive and flexible to meet each new need.

*Mathematics and the Imagination*

Mathematics and the Imagination (p. 358)

Simon & Schuster. New York, New York, USA. 1940

### **Newman, M. H. A.**

No biographical data available

That mathematical theory is a lasting object to believe in few can doubt. Mathematical language is difficult but imperishable. I do not believe that any Greek scholar of today can understand the idiomatic undertones of Plato's dialogues, or the jokes of Aristophanes, as thoroughly as mathematicians can understand every shade of meaning in Archimedes' works.

What Is Mathematics?

*Mathematical Gazette*, Volume 43, Number 345, October 1959 (p. 167)

### **Nietzsche, Friedrich** 1844–1900

German philosopher

Mathematics is merely the means to a general and ultimate knowledge of man.

Translated by Walter Kaufmann

*The Gay Science*

Third Book

Aphorism 246

Vintage Books. New York, New York, USA. 1974

...mathematics...would certainly have not originated if it had been known from the beginning that there is no exactly straight line in nature, no real circle, no absolute measure.

Translated by Marion Faber

*Human, All Too Human: A Book for Free Spirits*

Section 1, Number 11 (p. 19)

University of Nebraska Press. Lincoln, Nebraska, USA. 1984

### **Noll, Walter**

Mathematician

I believe the coordinate-free approach fosters the cultivation of intuition, a scarce commodity in relativity because the phenomena this theory is intended to describe are as yet rather remote from our daily experience.

Euclidean Geometry and Minkowskian Chronometry

*The American Mathematical Monthly*, February 1964 (p. 129)

### **Nordenholt, George F.**

No biographical data available

Smart creative workers are those who are quick to see the limitations of mathematical calculations.

A Graduate Can Measure a Bottle

Editorial

*Product Engineering*, April 1953

...mathematics is not, never was, and never will be, anything more than a particular kind of language, a sort of shorthand of thought and reasoning.

Translated by Joseph McAbe

*Einstein and the Universe: A Popular Exposition of the Famous Theory*

Chapter 1 (p. 32)

T. Fisher Unwin Ltd. London, England. 1922

### **Nordmann, Charles** 1881–1940

French astronomer

Mathematical truths and scientific discoveries have an intrinsic value, and this must be judged and appreciated impartially, whoever their author may chance to be.

Translated by Joseph McAbe

*Einstein and the Universe: A Popular Exposition of the Famous Theory*

Chapter 1 (p. 18)

T. Fisher Unwin Ltd. London, England. 1922

### **Norfolk, Timothy S.**

No biographical data available

It is as if mathematics were the vegetables of the academic dinner: Everyone knows that they are good for you, but no one forces you to eat them.

It's Time to Stop

*FOCUS*, February 1997 (pp. 14–15)

### **Northrop, Eugene**

No biographical data available

Consider mathematics as a discipline in itself — that is to say, as a body of concepts and methods which constitute a way of thinking. Surely mathematics is such a discipline. It deals almost exclusively with premises and conclusions, and with deductive reasoning, which is one of the more important methods of drawing conclusions from premises. Moreover, clarity and precision of definitions and assumptions, and rigor in reasoning, can be more nearly attained and more simply studied in mathematics than in the other disciplines. Is this not the real place of mathematics in a liberal education — not simply

as a subject matter, or as a discipline applicable only to its own subject matter, but as a discipline which is applicable to almost every intellectual activity of man?

Mathematics in a Liberal Education

*The American Mathematical Monthly*

Volume 52, Number 3, March 1945 (p. 133)

**O. Henry (William Sydney Porter)** 1862–10

American short story writer and journalist

His mathematics carried with it a momentary qualm and a lesson. The thought had not occurred to him that the thought could possibly occur to me not to ride at his side on that red road to revenge and justice. It was the higher calculus. I was booked for the trail. I began to eat more beans.

*Tales of O. Henry*

A Technical Error (p. 1059)

Doubleday & Company, Inc. Garden City, New York, USA. 1953

**O'Brien, Katharine**

Mathematician

Said an upside-down A to an inside-out E,

“*Universal's* the epithet measuring me.

Your scope is so small

Compared with *For all* —

*There is no more than of form of To be.*”

V and E

*The Mathematical Magazine*, Volume 55, Number 1, January 1982 (p. 41)

**Oldham, Richard Dixon** 1858–1936

English geologist

Many theories of the earth have been propounded at different times: the central substance of the earth has been supposed to be fiery, fluid, solid, and gaseous in turn, till geologists have turned in despair from the subject and become inclined to confine their attention to the outermost crust of the earth, leaving its center as a playground for mathematicians.

The Constitution of the Interior of the Earth as Revealed by Earthquakes

*The Quarterly Journal of the Geological Society of London*, Volume 62,

August 1906 (p. 456)

**Oman, John** 1860–1939

English Presbyterian theologian

Beauty...is a conspicuous element in the abstract completeness aimed at in the higher mathematics...

*The Natural and the Supernatural*

Value and Validity (p. 211)

The Macmillan Company. New York, New York, USA. 1931

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Today, it is not only that our kings do not know mathematics, but our philosophers do not know mathematics and — to go a step further — our mathematicians do not know mathematics.

The Tree of Knowledge

*Harper's Magazine*, Volume 217, Number 1301, October 1958 (p. 55)

**Page, Ray**

No biographical data available

...Today our world of automation revolves around science and science in turn rests on mathematics.

*Quote, the Weekly Digest*, May 14, 1967 (p. 380)

**Pagels, Heinz R.** 1939–88

American physicist and science writer

As I realized what the abstract mathematics of quantum theory was actually saying, the world became a very strange place indeed. I became uncomfortable. I would like to share that discomfort with you.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part I, Chapter 3 (pp. 63–64)

Simon & Schuster. New York, New York, USA. 1982

**Papert, Seymour** 1928–

South African mathematician

Mathematical work does not proceed along the narrow logical path of truth to truth to truth, but bravely or gropingly follows deviations through the surrounding marshland of propositions which are neither simply and wholly true nor simply and wholly false.

*Mindstorms: Children, Computers and Powerful Ideas*

Epilogue (p. 195)

Basic Books, Inc. New York, New York, USA. 1980

**Papperitz, E.** 1897–1938

No biographical data available

The object of pure mathematics is those relations which may be conceptually established among any conceived elements whatsoever by assuming them contained in some ordered manifold; the law of order of this manifold must be subject to our choice; the latter is the case in both of the only conceivable kinds of manifolds, in the discrete as well as in the continuous.

*Jahresbericht der Deutschen Mathematiker-Vereinigung*

Über das System der rein mathematischen Wissenschaften,

Bd. 1 (p. 36)

**Pascal, Blaise** 1623–62

French mathematician and physicist

There is a great difference between the spirit of Mathematics and the spirit of Observation. In the former, the principles are palpable, but remote from common use; so that from want of custom it is not easy to turn our head in that direction; but if it be thus turned ever so little, the principles are seen fully confessed, and it would argue a mind incorrigibly false to reason inconsequentially on principles so obtrusive that it is hardly possible to overlook them.

*Edinburgh Review*, Volume 52, January 1836 (p. 241)

For it is to judgment that perception belongs, as science belongs to intellect. Intuition is the part of judgment, mathematics of intellect.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 4

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...dull minds are never either intuitive or mathematical.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 1

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Pearson, Karl** 1857–1936

English mathematician

I believe the day must come when the biologist will — without being a mathematician — not hesitate to use mathematical analysis when he requires it.

Mathematics and Biology

*Nature*, Volume 63, Number 1629, January 17, 1901 (p. 275)

### **Peirce, Benjamin** 1809–80

American mathematician, astronomer, and educator

Mathematics is not the discoverer of laws, for it is not induction; neither is it the framer of theories, for it is not hypothesis; but it is the judge over both, and it is the arbiter to which each must refer its claims; and neither law can rule nor theory explain without the sanction of mathematics.

Linear Associative Algebra

*American Journal of Mathematics*, Volume 4, 1881 (p. 97)

Mathematics is the science which draws necessary conclusions.

Linear Associative Algebra

*American Journal of Mathematics*, Volume 4, 1881 (p. 97)

### **Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

Mathematics is the most abstract of all the sciences. For it makes no external observations, nor asserts anything as a real fact. When the mathematician deals with facts, they become for him mere “hypotheses”; for with their truth he refuses to concern himself. The whole science of mathematics is a science of hypotheses; so that nothing could be more completely abstracted from concrete reality.

The Regenerated Logic

*The Monist*, Volume 7, Number 1, October 1896 (p. 23)

...metaphysics has always been the ape of mathematics.

The Architecture of Theories

*The Monist*, Volume 1, Number 2, January 1891 (p. 174)

### **Peterson, Ivars**

Mathematics writer

To most outsiders, modern mathematics is unknown territory. Its borders are protected by dense thickets of technical terms; its landscapes are a mass of indecipherable

equations and incomprehensible concepts. Few realize that the world of modern mathematics is rich with vivid images and provocative ideas.

*The Mathematical Tourist: Snapshots of Modern Mathematics*

Preface (p. xiii)

W.H. Freeman & Company. New York, New York, USA. 1988

...mystery is an inescapable ingredient of mathematics. Mathematics is full of unanswered questions, which far outnumber known theorems and results. It's the nature of mathematics to pose more problems than it can solve. Indeed, mathematics itself may be built on small islands of truth comprising the pieces of mathematics that can be validated by relatively short proofs. All else is speculation.

*Islands of Truth: A Mathematical Mystery Cruise*

Preface (p. xvi)

W.H. Freeman & Company. New York, New York, USA. 1990

### **Philips, J. D.**

No biographical data available

Students must learn that mathematics is the most human of endeavors. Flesh and blood representatives of their own species engaged in a centuries long creative struggle to uncover and to erect this magnificent edifice. And the struggle goes on today. On the very campuses where mathematics is presented and received as an inhuman discipline, cold and dead, new mathematics is created. As sure as the tides.

Mathematics as an Aesthetic Discipline

*Humanistic Mathematics Network Journal*, Number 12, October 1995

### **Picard, Charles Emile** 1856–1941

French mathematician

I am not unaware of the difficulties of the task [explaining analysis] which I am undertaking. Activity in mathematical thinking today is such that it is perhaps presumptuous to attempt to sketch, in so vast an area, the present state of the science. The portrait, even if it is a good likeness, is fated, in parts at least, to become dated quickly. But that does not matter so long as I propose merely to be useful as a guide to those who wish to acquaint themselves with modern analysis and who fear that, alone, they may lose their way in the multiplicity of papers which fill the learned scientific periodicals.

*Traite d'analyse*

Preface

Gauthier-Villars et fils. Paris, France. 1893–1901

### **Pickover, Clifford A.**

American author, editor and columnist

I do not know if God is a mathematician, but mathematics is the loom upon which God weaves the fabric of the universe.

*The Loom of God: Mathematical Tapestries at the Edge of Time*

Introduction (p. 27)

Plenum Press. New York, New York, USA. 1997

**Pieri, Mario** 1860–1913  
Italian mathematician

Mathematics is the hypothetico-deductive science.

In Cassius J. Keyser

*The Pastures of Wonder: The Realm of mathematics and the Realm of Science*

The Realm of Mathematics (p. 24)

Columbia University Press. New York, New York, USA. 1929

**Pierpont, James** ?–1938

We who stand on the threshold of a new century can look back on an era of unparalleled progress. Looking into the future an equally bright prospect greets our eyes; on all sides fruitful fields of research invite our labor and promise easy and rich returns. Surely this is the golden age of mathematics!

The History of Mathematics in the Nineteenth Century

*Bulletin of the American Mathematical Society*, 2<sup>nd</sup> Series, Volume 11, 1904–1905 (p. 159)

**Poe, Edgar Allan** 1809–49  
American short story writer

As poet and mathematician, he would reason well; as mere mathematician, he could not have reasoned at all, and thus would have been at the mercy of the Prefect.

*Seven Tales*

The Purloined Letter (p. 231)

Schocken Books. New York, New York, USA. 1971

The word “Verse” is used here as the term most convenient for expressing, and without pedantry, all that is involved in the consideration of rhythm, rhyme, meter, and versification...the subject is exceedingly simple; one tenth of it, possibly, may be called ethical; nine tenths, however, appertains to the mathematics.

Quoted in Stanley Gudder

*A Mathematical Journey* (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Poiani, Eileen L.**  
Mathematician

Like it or not, mathematics opens career doors, so it’s downright practical to be prepared.

In Lynn Arthur Steen

*Mathematics Tomorrow*

The Real Energy Crisis (p. 158)

Springer-Verlag. New York, New York, USA. 1981

Mathematics plays the critical filter role not only at the college level, but also in the work force.

In Lynn Arthur Steen

*Mathematics Tomorrow*

The Real Energy Crisis (p. 160)

Springer-Verlag. New York, New York, USA. 1981

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

We have had prophets of evil. They blithely reiterate that all problems capable of solution have already been solved and that nothing is left but gleaning. Happily the case of the past reassures us. Often it was thought all problems were solved or at least an inventory was made of all admitting solutions. And then the sense of the word solution enlarged, and insoluble problems became the most interesting of all, and others unforeseen presented themselves.... The pessimists thus found themselves always outflanked, always forced to retreat, so that at present

I think there are no more.

In G.B. Halsted (trans.)

*The Foundations of Science*

Science and Method, Book I

Chapter II (p. 369)

The Science Press. New York, New York, USA. 1913

Need we add that mathematicians themselves are not infallible?

*The Foundations of Science*

Science and Method, Book I

Chapter III (p. 384)

The Science Press. New York, New York, USA. 1913

The true method of forecasting the future of mathematics lies in the study of its history and its present state.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 123)

Government Printing Office. Washington, D.C. 1910

Mathematics has a triple end. It is to furnish an instrument for the study of nature. But that is not all. It has a philosophic end, and I dare say it, an esthetic end.... Those skilled in mathematics find in it pleasure akin to those which painting and music give. They admire the delicate harmony of numbers and of forms; they marvel when a new discovery opens an unexpected perspective; and is this pleasure not esthetic, even though the senses have no part in it?

*Sur les rapports de l’analyse pur et de la physique mathématique*

Report to the Zurich International Congress of Mathematics,

1897 (p. 82)

How does it happen that there are people who do not understand mathematics? If mathematics invokes only the rules of logic, such as are accepted by all normal minds; if its evidence is based on principles common to all men, and that none could deny without being mad, how does it come about that so many persons are here refractory?

*The Foundations of Science*

Science and Method, Book I

Chapter III (p. 383)

The Science Press. New York, New York, USA. 1913

I do not know whether or not I have said somewhere that mathematics is the art of giving the same name to different things.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 128)  
Government Printing Office, Washington, D.C. 1910

...mathematical verities flow from a small number of self-evident propositions by a chain of impeccable reasonings; they impose themselves not only on us, but on nature itself. They fetter, so to speak, the Creator and only permit him to chose between some relatively few solutions. A few experiments then will suffice to let us know what choice he has made. From each experiment a number of consequences will follow by a series of mathematical deductions, and in this way each of them will reveal to us a corner of the universe. This, to the minds of most people, and to students who are getting their first ideas of physics, is the origin of certainty in science.

*The Foundations of Science*  
Science and Hypothesis, Introduction (p. 27)  
The Science Press. New York, New York, USA. 1913

The genesis of mathematical discovery is a problem which must intensely inspire the psychologist with the keenest interest. For this is the process in which the human mind seems to borrow least from the exterior world, in which it acts, or appears to act, only by itself and on itself, so that by studying the process of geometric thought we may hope to arrive at what is most essential in the human mind.

*The Foundations of Science*  
Science and Method, Book I  
Chapter III (p. 383)  
The Science Press. New York, New York, USA. 1913

...what is mathematical discovery? It does not consist in making new combinations with mathematical entities already known. Any one could do that, but the combinations so made would be infinite in number and most of them absolutely without interest. To create consists precisely in not making useless combinations and in making those which are useful and which are only a small minority. Invention is discernment, choice.

*The Foundations of Science*  
Science and Method, Book I  
Chapter III (p. 386)  
The Science Press. New York, New York, USA. 1913

It may be surprising to see emotional sensibility invoked a propos of mathematical demonstrations which, it would seem, can interest only the intellect. This would be to forget the feeling of mathematical beauty, of the harmony of numbers and forms, of geometric elegance. This is a true esthetic feeling that all real mathematicians know, and surely it belongs to emotional sensibility.

*The Foundations of Science*  
Science and Method, Book I  
Chapter III (p. 391)  
The Science Press. New York, New York, USA. 1913

**Poisson, Simeon-Denis** 1781–1840  
French mathematician

The engineer should receive a complete mathematical education, but for what should it serve him? To see the different aspects of things and to see them quickly; he has no time to hunt mice.

*The Foundations of Science*  
Science and Method, Book II (p. 438)  
The Science Press. New York, New York, USA. 1913

Life is good for only two things, discovering mathematics and teaching mathematics.

Filler  
*Mathematical Magazine*, Volume 64, Number 1, February 1991 (p. 44)

**Polanyi, Michael** 1891–1976  
Hungarian-born English scientist, philosopher, social scientist

While applied mathematics is object-directed, pure mathematics has no outside object; being concerned with objects of its own creation, it may be described as “object creating.”

*Personal Knowledge*  
Chapter 5, Section 2 (p. 76)  
Harper & Row, Publishers. New York, New York, USA. 1962

We should declare instead candidly that we dwell on mathematics and affirm its statements for the sake of its intellectual beauty, which betokens the reality of its conceptions and the truth of its assertions. For if this passion were extinct, we would cease to understand mathematics; its conceptions would dissolve and its proofs carry no conviction. Mathematics would become pointless and would lose itself in a welter of insignificant tautologies and of Heath Robinson operations, from which it could no longer be distinguished.

*Personal Knowledge*  
Chapter 6, Section 11 (p. 192)  
Harper & Row, Publishers. New York, New York, USA. 1962

Nowhere is intellectual beauty so deeply felt and fastidiously appreciated in its various grades and qualities as in mathematics, and only the informal appreciation of mathematical value can distinguish what is mathematics from a welter of formally similar, yet altogether trivial statements and operations.

*Personal Knowledge*  
Chapter 6, Section 10 (p. 188)  
Harper & Row, Publishers. New York, New York, USA. 1962

Modern mathematics can be kept alive only by a large number of mathematicians cultivating different parts of the same system of values: a community which can be kept coherent only by the passionate vigilance of universities, journals and meetings, fostering these values and imposing the same respect for them on all mathematicians.

*Personal Knowledge*  
Chapter 6, Section 11 (p. 192)  
Harper & Row, Publishers. New York, New York, USA. 1962

All these difficulties are but consequences of our refusal to see that mathematics cannot be defined without

acknowledging its most obvious feature: namely, that it is interesting.

*Personal Knowledge*

Chapter 6, Section 10 (p. 188)

Harper & Row, Publishers. New York, New York, USA. 1962

### **Pollak, Henry O.**

No biographical data available

Mathematical activity — like all of Gaul — may be divided into three areas: Education, Research, and Applications...much of the strength of the mathematical fabric comes from the interaction among these three.

The Role of Industrial Members in the Mathematical Association of America

*The American Statistician*, American Mathematical Monthly (p. 551)

Volume 68, June–July 1961

### **Pólya, George** 1887–1985

Hungarian mathematician

The traditional mathematics professor of the popular legend is absentminded. He usually appears in public with a lost umbrella in each hand. He prefers to face a blackboard and to turn his back on the class. He writes a, he says b, he means c, but it should be d.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The Traditional Mathematics Professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

Mathematics is being lazy. Mathematics is letting the principles do the work for you so that you do not have to do the work yourself.

In Marion Walter and Tom O'Brien article

*Mathematics Teaching*

Memories of George Polya, Volume 116, September 1986 (p. 4)

### **Poovey, Mary**

No biographical data available

Mathematics is abused by “consultants” to lend speculations an aura of objectivity and precision that they do not possess.

International Congress of Mathematics 2002

Beijing, August 22, 2002

### **Pope, Alexander** 1688–1744

English poet

See *Mystery to Mathematics fly!*

*The Complete Poetical Works* (Volume 4)

The Duncaid, Book IV, I 647

Houghton Mifflin Company. New York, New York, USA. 1903

### **Pratter, Frederick**

No biographical data available

Music and higher mathematics share some obvious kinship. The practice of both requires a lengthy apprenticeship, talent, and no small amount of grace. Both seem to spring from some mysterious workings of the mind. Logic and system are essential for both, and yet

each can reach a height of creativity beyond the merely mechanical.

How Music and Math Seek Truth in Beauty

*Christian Science Monitor*, May 24, 1995

### **Price, Bartholomew** 1818–98

English mathematician and educator

Mathematics is the most powerful instrument, which we possess, for this purpose [to trace into their farthest results those general laws which an inductive philosophy has supplied]: in many sciences a profound knowledge of mathematics is indispensable for a successful investigation. In the most delicate researches into the theories of light, heat, and sound it is the only instrument; they have properties which no other language can express; and their argumentative processes are beyond the reach of other symbols.

*Treatise on Infinitesimal Calculus* (Volume 3) (p. 5)

Oxford University Press, Inc. Oxford, England. 1868

### **Pringsheim, Alfred** 1850–1941

German mathematician

It is true that mathematics, owing to the fact that its whole content is built up by means of purely logical deduction from a small number of universally comprehended principles, has not unfittingly been designated as the science of the self-evident. Experience however, shows that for the majority of the cultured, even of scientists, mathematics remains the science of the incomprehensible.

*Jahresbericht der Deutschen Mathematiker Vereinigung*

Ueber Wert und angeblichen Unwert der Mathematik, 1904 (p. 357)

### **Proclus** 411–485

Greek philosopher

This, therefore, is mathematics: she reminds you of the invisible form of the soul; she gives life to her own discoveries; she awakens the mind and purifies the intellect; she brings light to our intrinsic ideas; she abolishes oblivion and ignorance which are ours by birth.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 24)

Oxford University Press, Inc. New York, New York, USA. 1972

### **Quine, Willard Van Orman** 1908–2000

American logician and philosopher

Irrefragability, thy name is mathematics.

*The Ways of Paradox and Other Essays*

Chapter 3 (p. 24)

Random House, Inc. New York, New York, USA. 1966

### **Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

Examples...which might be multiplied *ad libitum* show how difficult it often is for an experimenter to interpret his results without the aid of mathematics.



In E.T. Bell

*Men of Mathematics* (p. xvi)

Simon & Schuster. New York, New York, USA. 1937

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Thus it would seem that wherever we infer from perceptions, it is only structure that we can validly infer; and structure is what can be expressed by mathematical logic, which includes mathematics.

*The Analysis of Matter*

Chapter XXIV (p. 254)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

...none of the raw material of the world has smooth logical properties, but whatever appears to have such properties is constructed artificially to have them.

*The Principles of Mathematics*

Preface (p. xi)

W.W. Norton & Company, Inc. New York, New York, USA. 1938

...logic is concerned with the real world just as truly as zoology [is]...

*Introduction to Mathematical Philosophy*

Chapter XVI (p. 169)

Dover Publications, Inc. New York, New York, USA. 1993

**Recordé, Robert** 1510?–58

English mathematician and writer

Beside the mathematical arts there is no infallible knowledge, except it be borrowed from them.

In Morris Kline

*Mathematics and the Physical World*

Chapter 9 (p. 130)

Dover Publications, Inc. New York, New York, USA. 1981

**Rees, Mina** 1902–97

American mathematician

In dealing with academics, it is absolutely superb to be able to say you're a mathematician! Nobody dares to say mathematics is not important or not significant.... No discipline surpasses mathematics in pure academic prestige.

In Donald J. Albers and G.L. Alexanderson (eds.)

*Mathematical People*

Mina Rees (p. 260)

Birkhäuser. Boston, Massachusetts, USA. 1985

**Reid, Thomas** 1710–96

Scottish philosopher

The science [mathematics], once fairly established on the foundation of a few axioms and definitions, as upon a rock, has grown from age to age, so as to become the most solid fabric that human reason can boast.

*Essays on the Intellectual Power of Man* (4<sup>th</sup> edition)

Chapter III (p. 348)

Printed for John Bell. London, England. 1785

In mathematics [sophistry] had no place from the beginning: Mathematicians having had the wisdom to define

accurately the terms they use, and to lay down, as axioms, the first principles on which their reasoning is grounded. Accordingly we find no parties among mathematicians, and hardly any disputes.

*Essays on the Intellectual Powers of Man*

Essay I, Chapter I (p. 1)

Printed for John Bell. London, England. 1785

**Richardson, Moses**

No biographical data available

...I propose the following, if not as a definition, then at least as a partial description; mathematics is persistent intellectual honesty.

Mathematics and Intellectual Honesty

*The American Mathematical Monthly*, Volume 59, Number 2, February

1952 (p. 73)

**Röntgen, Wilhelm Conrad** 1845–1923

German physicist

The physicist in preparing for his work need three things, mathematics, mathematics, and mathematics.

*The Mathematical Gazette*, Volume 22, Number 252, December 1938,

1225

**Rosenbaum, R. A.**

No biographical data available

Mathematical abstraction, to be considered significant, must someday pass the test of generality, of applicability, of relatedness. Mathematics too long divorced from reality, it has been said, becomes baroque, decadent, and sterile.

Mathematics, the Artistic Science

*The Mathematics Teacher*, Volume 55, Number 7, November 1962

(p. 533)

**Rota, Gian-Carlo** 1932–1999

Italian-born American mathematician

We thought that the generalization of the notion of space had ended with topoi, but we were mistaken. We probably know less about space now than we pretended to know fifty years ago. As mathematics progresses, our understanding of it regresses.

*Indiscrete Thoughts*

Chapter XX (p. 220)

Birkhäuser. Boston, Massachusetts, USA. 1997

Very little mathematics has direct applications — though fortunately most of it has plenty of indirect ones.

*Indiscrete Thoughts*

Chapter XX (p. 213)

Birkhäuser. Boston, Massachusetts, USA. 1997

Mathematics is the study of analogies between analogies. All science is. Scientists want to show that things that don't look alike are really the same. That is one of their innermost Freudian motivations. In fact, that is what we mean by understanding.

*Indiscrete Thoughts*

Chapter XX (p. 214)

Birkhäuser. Boston, Massachusetts, USA. 1997

Mathematics is a cruel profession. Solving a mathematical problem is for most mathematicians an arduous and lengthy process which may take years, even a lifetime. The final conquest of the truth comes, if ever, inevitably tinged with disillusion, soured by the realization of the ultimate irrelevance of all intellectual endeavor.

*Indiscrete Thoughts*

Chapter V (p. 60)

Birkhäuser. Boston, Massachusetts, USA. 1997

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

**Pringsheim, Alfred** 1850–1941

German mathematician

We often hear that mathematics consists mainly of “proving theorems.” Is a writer’s job mainly that of “writing sentences?”

In Philip J. Davis and Reuben Hersh

*The Mathematical Experience*

Introduction (p. xviii)

Birkhäuser. Boston, Massachusetts, USA. 1981

**Rózsa, Péter** 1905–77

Hungarian mathematician

The eternal lesson is that Mathematics is not something static, closed, but living and developing. Try as we may to constrain it into a closed form, it finds an outlet somewhere and escapes alive.

*Playing with Infinity: Mathematical Explorations and Excursions*

Chapter 22 (p. 265)

Dover Publications, Inc. New York, New York, USA. 1961

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

To create a healthy philosophy you should renounce metaphysics but be a good mathematician.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon &amp; Schuster. New York, New York, USA. 1937

There was a footpath leading across fields to New Southgate, and I used to go there alone to watch the sunset and contemplate suicide. I did not, however, commit suicide, because I wished to know more of mathematics.

*The Autobiography of Bertrand Russell*

Chapter II (p. 53)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1967

Pure mathematics consists entirely of asseverations to the effect that, if such and such a proposition is true of anything, then such and such another proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what

the anything is, of which it is supposed to be true.... If our hypothesis is about anything, and not about some one or more particular things, then our deductions constitute mathematics. Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true.

*Mysticism and Logic and Other Essays*

Chapter V (p. 75)

Longmans, Green &amp; Company. London, England. 1925

Pure Mathematics is the class of all propositions of the form “p implies q,” where p and q are propositions containing one or more variables, the same in the two propositions, and neither p or q contains any constants except logical constants. And logical constants are all notions definable in terms of a class of the following: Implication, the relation of a term to a class of relation, and such further notions as may be involved in the general notion of propositions of the above form. In addition to these, Mathematics uses a notion which is not a constituent of the propositions which it considers — namely, the notion of truth.

*Principles of Mathematics* (2<sup>nd</sup> edition)

Chapter I (p. 1)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1938.

The nineteenth century which prides itself upon the invention of steam and evolution, might have derived a more legitimate title to fame from the discovery of pure mathematics.

Recent Work on the Principles of Mathematics

*International Monthly*, Volume 4, July–December 1901 (p. 83)

The world of mathematics, which you condemn, is really a beautiful world; it has nothing to do with life and death and human sordidness, but is eternal, cold and passionless. To me pure mathematics is one of the highest forms of art; it has a sublimity quite special to itself, and an immense dignity derived from the fact that its world is exempt from change and time. I am quite serious in this.... [M]athematics is the only thing we know of that is capable of perfection; in thinking about it we become Gods.

In N. Griffin (ed.)

*The Selected Letters of Bertrand Russell* (Volume 1)

Letter Number 98 (p. 224)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1922

The true spirit of delight, the exaltation, the sense of being more than Man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry.

*Mysticism and Logic and Other Essays*

Chapter IV (p. 60)

Longmans, Green &amp; Company. London, England. 1925

Mathematics, rightly viewed, possess not only truth, but supreme beauty — a beauty cold and austere, like that of a sculpture...

*Mysticism and Logic and Other Essays*  
Chapter IV (p. 60)  
Longmans, Green & Company. London, England. 1925

It was formerly supposed that Geometry was the study of the nature of the space in which we live, and accordingly it was urged, by those who held that what exists can only be known empirically, that Geometry should really be regarded as belonging to applied mathematics. But it has gradually appeared, by the increase of non-Euclidean systems, that Geometry throws no more light upon the nature of space than Arithmetic throws upon the population of the United States.

*Mysticism and Logic and Other Essays*  
Chapter V (p. 92)  
Longmans, Green & Company. London, England. 1925

But mathematics takes us...into the region of absolute necessity, to which not only the actual world, but every possible world, must conform...

*Mysticism and Logic and Other Essays*  
Chapter IV (p. 69)  
Longmans, Green & Company. London, England. 1925

I like mathematics because it is not human and has nothing particular to do with this planet or with the whole accidental universe — because like Spinoza's God, it won't love us in return.

Letter To Lady Ottoline Morrell, March 1912  
Source undetermined

...the rules of logic are to mathematics what those of structure are to architecture.

*Mysticism and Logic and Other Essays*  
Chapter IV (p. 61)  
Longmans, Green & Company. London, England. 1925

...mathematics is the manhood of logic...

*Introduction to Mathematical Philosophy*  
Chapter XVIII (p. 194)  
Dover Publications, Inc. New York, New York, USA. 1993

### **Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

If all the arts aspire to the condition of music, all the sciences aspire to the condition of mathematics.

*Some Turns of Thought in Modern Philosophy: Five Essays*  
Chapter III (p. 80)  
Charles Scribner's Sons. New York, New York, USA. 1933

...mathematics is like music, freely exploring the possibilities of form. And yet, notoriously, mathematics holds true of things; hugs and permeates them far more closely than does confused and inconstant human perception; so that the dream of many exasperated critics of human error has been to assimilate all science to mathematics, so as to make knowledge safe by making it, as Locke wished, direct perception of the relations between ideas...

*The Realm of Truth: Book Third of Realms of Being*

Chapter I (pp. 2–3)  
Constable & Company Ltd. London, England. 1937

### **Sarton, George** 1884–1956

Belgian-born American scholar and writer

Mathematics gives to science its innermost unity and cohesion, which can never be entirely replaced with props and buttresses or with roundabout connections, no matter how many of these may be introduced.

*The Study of The History of Mathematics*  
The Study of the History of Mathematics (p. 4)  
Dover Publications, Inc. New York, New York, USA. 1936

A mathematical congress of today reminds one of the Tower of Babel, for few men can follow profitably the discussions of sections other than their own, and even there they are sometimes made to feel like strangers.

*The Study of the History of Mathematics*  
The Study of the History of Mathematics (p. 14)  
Dover Publications, Inc. New York, New York, USA. 1936

### **Sawyer, Walter Warwick** 1911–

Mathematician

The scientist who uses mathematics should be aware that much new mathematical knowledge is being discovered; nearly all of it will be irrelevant to his research, but he should keep his eyes open for the small piece that may be of great value to him.

Algebra  
*Scientific American*, Volume 211, Number 3, September 1964 (p. 78)

Any part of modern mathematics is the end-product of a long history. It has drawn on many other branches of earlier mathematics, it has extracted various essences from them and has been reformulated again and again in increasingly general and abstract forms. Thus a student may not be able to see what it is all about, in much the same way that a caveman confronted with a vitamin pill would not easily recognize it as food.

*A First Look at Numerical Functional Analysis*  
Chapter 1 (p. 1)  
Clarendon Press. Oxford, England. 1978

In other arts, if we see a pattern we can admire its beauty; we may feel that it has significant form, but we cannot say what the significance is. And it is much better not to try... But in mathematics it is not so. In mathematics, if a pattern occurs, we can go on to ask, Why does it occur? What does it signify? And we can find answers to these questions. In fact, for every pattern that appears, a mathematician feels he ought to know why it appears.

*Prelude to Mathematics* (p. 23)  
Penguin Books. Baltimore, Maryland, USA. 1957

A point that should be borne in mind is that, generally speaking, higher mathematics is simpler than elementary mathematics. To explore a thicket on foot is a troublesome business; from an aeroplane the task is easier.

*Prelude to Mathematics* (p. 11)  
Penguin Books. Baltimore, Maryland, USA. 1957

### Schlieter, Dean

No biographical data available

Go down deep enough into anything and you will find mathematics.

In Margaret Joseph  
The Future of Geometry  
*The Mathematics Teacher*, January 1936, Volume XXIX, Number 1 (p. 29)

### Schrödinger, Erwin 1887–1961

Austrian theoretical physicist

“Mathematics” appears to be at the bottom of everything, since we find it unexpectedly where we have not put it in.

*Nature and the Greeks*  
Chapter III (p. 38)  
At the University Press. Cambridge, England. 1954

...I do not refer to the mathematical difficulties, which eventually are always trivial, but rather to the conceptual difficulties.

*Science and the Human Temperament*  
Chapter VIII (p. 189)  
W.W. Norton & Company, Inc. New York, New York, USA. 1935

### Schubert, Hermann Cäsar Hannibal 1848–1911

Enumerative geometerist

Whenever, therefore, a controversy arises in mathematics, the issue is not whether a thing is true or not, but whether the proof might not be conducted more simply in some other way, or whether the proposition demonstrated is sufficiently important for the advancement of the science as to deserve especial enunciation and emphasis, or finally, whether the proposition is not a special case of some other and more general truth which is just as easily discovered.

*Mathematical Essays and Recreations*  
On the Nature of Mathematical Knowledge (p. 28)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1917

The intrinsic character of mathematical research and knowledge is based essentially on three properties: first, on its conservative attitude towards old truths and discoveries of mathematics; secondly, on its progressive mode of development, due to the incessant acquisition of new knowledge on the basis of the old; and thirdly, on its self-sufficiency and its consequent absolute independence.

*Mathematical Essays and Recreations*  
On the Nature of Mathematical Knowledge (p. 27)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1917

...the three positive characteristics that distinguish mathematical knowledge from other knowledge... may be briefly expressed as follows; first, mathematical knowledge bears more distinctly the imprint of truth on all its results than any other kind of knowledge; secondly, it is always a sure

preliminary step to the attainment of other correct knowledge; thirdly, it has no need of other knowledge.

*Mathematical Essays and Recreations*  
On the Nature of Mathematical Knowledge (p. 35)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1917

### Schützenberger, Marcel-Paul 1927–96

French mathematician

Ere long mathematics will be as useful to the chemist as the balance.

In J.W. Mellor  
*Higher Mathematics for Students of Chemistry and Physics* (p. xvii)  
Dover Publications. New York, New York, USA. 1955

### Seneca (Lucius Annaeus Seneca) 4 BCE–65 AD

Roman playwright

The mathematical is, so to speak, a superficial science; it builds on a borrowed site, and the principles by aid of which it proceeds, are not its own...

*Edinburgh Review*, Volume 52, January 1836 (p. 221)

### Serge, Lang 1927–

Mathematician

I think rather that one does mathematics because one likes to do this sort of thing, and also, much more naturally, because when you have a talent for something, usually you don't have any talent for something else, and you do whatever you have talent for, if you are lucky enough to have it. I must also add that I do mathematics also because it is difficult, and it is a very beautiful challenge for the mind. I do mathematics to prove to myself that I am capable of meeting this challenge, and win it.

*The Beauty of Doing Mathematics: Three Public Dialogues*  
What Does A Mathematician Do and Why? (p. 5)  
Springer-Verlag. New York, New York, USA. 1985

### Shadwell, Thomas 1642?–92

English dramatist and poet

Wood to La. Vaine. “Tis true, Madame, Sir Positive and Poet Ninny are excellent men, and brave Bully-Rocks; but they must grant, that neither of e'm understand Mathematicks but myself.

*The Complete Works of Thomas Shadwell* (Volume 1)  
The Sullen Lovers, Act IV (p. 71 )  
The Fortune Press. London, England. 1927

### Shakespeare, William 1564–1616

English poet, playwright, and actor

Music and poesy used to quicken you;  
The mathematics and metaphysics,  
Fall to them as you find your stomach serves you;  
No profit grows where is no pleasure ta'en:

In brief, sir, study what you most affect.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume One)  
The Taming of the Shrew

Act I, Scene i, l. 36  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I do present you with a man of mine,  
Cunning in music and mathematics,  
To instruct her fully in those sciences,  
Whereof, I know, she is not ignorant.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume One)  
The Taming of the Shrew  
Act II, Scene i, l. 55  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shapley, Harlow** 1885–1972  
American astronomer

A hypothesis or theory is clear, decisive, and positive, but it is believed by no one but the man who created it. Experimental findings, on the other hand, are messy, inexact things, which are believed by everyone except the man who did the work.

*Review of Scientific Instruments*  
Volume 6, 1922 (p. 96)

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

You propound a complicated mathematical problem: give me a slate and half an hour's time, and I can produce a wrong answer.

In Evan Esar  
*20,000 Quips and Quotes* (p. 509)  
Doubleday. Garden City, New York, USA. 1968

It is a monstrous thing to force a child to learn Latin or Greek or mathematics on the ground that they are an indispensable gymnastic for the mental powers. It would be monstrous even if it were true.

*The Bodley Head Bernard Shaw: Collected Plays With their Prefaces* (Volume 4)  
Misalliance  
Preface

...the more reasonable a student was in mathematics, the more unreasonable she was in the affairs of real life, concerning which few trustworthy postulates have yet been ascertained.

*An Unsocial Socialist*  
Chapter VI (p. 117)  
Brentano's, New York, New York, USA, 1904

**Shaw, James B.** 1866–1948  
American mathematician

Mathematics is, on the artistic side, a creation of new rhythms, orders, designs and harmonies, and on the knowledge side, is a systematic study of the various rhythms, orders, designs and harmonies. We may condense this into the statement that mathematics is, on the one side, the qualitative study of the structure of beauty, and on the other side is the creator of new artistic forms of beauty. The mathematician is at once creator and critic.

In W.L. Schaaf (ed.)  
*Mathematics: Our Great Heritage*  
Mathematics — The Subtle Fine Art (p. 50)  
Harper & Brothers. New York, New York, USA. 1948

...because mathematics contains truth, it extends its validity to the whole domain of art and the creatures of the constructive imagination. Because it contains freedom, it guarantees freedom to the whole realm of art. Because it is not primarily utilitarian, it validates the joy of imagination for the pure pleasure of imagination.

*Lectures on the Philosophy of Mathematics* (pp. 194–195)  
The Open Court Publishing Company. Chicago, Illinois. 1918

**Siegel, Eli** 1902–78  
American philosopher, poet, critic, and founder of Aesthetic Realism

Within all conflagrations mathematical things are related.

*Damned Welcome*  
Aesthetic Realism, Maxims, Part One, #356 (p. 78)  
Definition Press. New York, New York, USA. 1972

**Simmons, George F.**  
No biographical data available

There is an old Armenian saying, “He who lacks a sense of the past is condemned to live in the narrow darkness of his own generation.” Mathematics without history is mathematics stripped of its greatness: for, like the other arts — and mathematics is one of the supreme arts of civilization — it derives its grandeur from the fact of being a human creation.

*Differential Equations with Applications and Historical Notes*  
Preface (p. ix)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

Mathematical rigor is like clothing; in its style it ought to suit the occasion, and it diminishes comfort and restricts freedom of movement if it is either too loose or too tight.

Filler  
*The Mathematical Intelligencer*, Volume 13, Number 1, Winter 1991 (p. 69)

**Slosson, Edwin E.** 1865–1929  
American chemist and journalist

Translating mathematics into ordinary language is like translating music. It cannot be done. One could describe in detail a sheet of music and tell the shape of each note and where it is placed on the staff, but that would not convey any idea of how it would sound when played. So, too, I suppose that even the most complicated equation could be described in common words, but it would be so verbose and involved that nobody could get the sense of it.

*Chats on Science*  
Chapter LXXIV (pp. 226–227)  
G. Bell & Sons Ltd. London, England. 1924

**Smith, David Eugene** 1860–1945  
Mathematician

One thing that mathematics early implants, unless hindered from so doing, is the idea that here, at last, is an immortality that is seemingly tangible — the immortality of a mathematical law.

*The Poetry of Mathematics and Other Essays*

Religio Mathematici (pp. 31–32)

Scripta Mathematica. New York, New York, USA. 1934

I know of nothing which acts as such a powerful antidote that which I ventured to call “opinionatedness,” as a study of mathematics.

*The Poetry of Mathematics and Other Essays*

Religio Mathematici (p. 35)

Scripta Mathematica. New York, New York, USA. 1934

...I would rather be a dreamer without mathematics, than a mathematician without dreams.

*The Poetry of Mathematics and Other Essays*

Religio Mathematici (p. 30)

Scripta Mathematica. New York, New York, USA. 1934

### Smith, W. B.

No biographical data available

Mathematics is the universal art apodictic.

In Columbia University

*Lectures on Science, Philosophy and Art 1907–1908* (p. 13)

New York, New York, USA. 1908

### Somerville, Mary 1780–1872

English mathematician

There is a wide distinction between the degree of mathematical acquirement necessary for making discoveries, and that which is requisite for understanding what other have done.

*The Connection of the Physical Sciences* (9<sup>th</sup> edition)

Introduction (pp. 2–3)

John Murray. London, England. 1858

That the study of mathematics and their application to astronomy are full of interest will be allowed by all who have devoted their time and attention to these pursuits; and they only can estimate the delight of arriving at truth, whether it be in the discovery of a world, or of a new property of numbers.

*Mechanism of the Heavens*

Preliminary Dissertation (p. 2)

John Murray. London, England. 1831

### Speiser, A.

No biographical data available

...mathematics has liberated itself from language; and one who knows the tremendous labor put into this process and its ever-recurring surprising success, cannot help feeling that mathematics nowadays is more efficient in its particular sphere of the intellectual world than, say, the modern languages in their deplorable condition of decay or even music are on their fronts.

In Hermann Weyl

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 65)

Princeton University Press. Princeton, New Jersey, USA. 1949

Already the pronounced tendency toward tediousness, which seems to be inherent in elementary mathematics, might plead for its late origin, since the creative mathematician would prefer to pay his attention to the interesting and beautiful problems.

In Dirk, J. Struik

*A Concise History of Mathematics*

Chapter I (p. 15)

Dover Publications, Inc. New York, New York, USA. 1967

### Spencer-Brown, George 1923–

English mathematician and polymath

That mathematics, in common with other art forms, can lead us beyond ordinary existence, and can show us something of the structure in which all creation hangs together, is no new idea. But mathematical texts generally begin the story somewhere in the middle, leaving the reader to pick up the thread as best he can.

*Laws of Form*

A Note on the Mathematical Approach (p. v)

George Allen & Unwin Ltd. London, England. 1969

### Spengler, Oswald 1880–1936

German philosopher

The mathematic, then, is an art. As such it has its styles and style periods. It is not, as the layman and the philosopher (who is in this matter a layman too) imagine, substantially unalterable, but subject like every art to unnoticed changes from epoch to epoch. The development of the great arts ought never to be treated without an (assuredly not unprofitable) side-glance at contemporary mathematics.

*The Decline of the West* (Volume 1)

Chapter II, Section iv (p. 62)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

And so the development of the new mathematic consists of a long, secret, and finally victorious battle against the notion of magnitude.

*The Decline of the West* (Volume 1)

Chapter II, Section ix (p. 76)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

Gothic cathedrals and Doric temples are mathematics in stone.

*The Decline of the West* (Volume 1)

Chapter II, Section ii (p. 58)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

...mathematics, accessible in its full depth only to the very few, holds a quite peculiar position amongst the creation of the mind. It is a science of the most rigorous kind, like logic but more comprehensive and very much fuller; it is a true art, along with sculpture and music,

as needing the guidance of inspiration and as developing under great conventions of form...

*The Decline of the West* (Volume 1)

Chapter II, Section ii (p. 56)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

### Stabler, E. Russell

No biographical data available

Mathematics is the science of number and space. It starts from a group of self-evident truths and by infallible deduction arrives at incontestable conclusions... the facts of mathematics are absolute, unalterable, and eternal truths.

An Interpretation and Comparison of Three Schools of Thought in the Foundations of Mathematics

*The Mathematics Teacher*, Volume 26, January 1935 (p. 6)

### Stallone, Sylvester 1946–

American actor

If you hang around with nice people you get nice friends, hang around with smart people and you get smart friends, hang around with yo-yos and you get yo-yos for friends. It's simple mathematics.

*Rocky*

Film (1976)

### Steinbeck, John 1902–68

American novelist

...I drove up the mountain and found a dairy, bought some milk, and asked permission to camp under an apple tree. The dairy man had a Ph.D. in mathematics, and he must have had some training in philosophy. He liked what he was doing and didn't want to be anywhere else — one of the very few contented people I met in my whole journey.

*Travels with Charley: In Search of America*

Part Two (pp. 25–26)

The Viking Press. New York, New York, USA. 1962

### Steinmetz, Charles Proteus 1865–1923

German-American electrical engineer and inventor

Mathematics is the most exact science, and its conclusions are capable of absolute proof. But this is so only because mathematics does not attempt to draw absolute conclusions. All mathematical truths are relative, conditional.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

### Sterne, Laurence 1713–68

English novelist and humorist

[My Uncle Toby] proceeded next to Galileo and Torricellius, wherein, by certain Geometrical rules, infallibly laid down, he found the precise part to be a "Parabola" — or else an "Hyperbola," — and that the parameter, or "*latus*

*rectum*," of the conic section of the said path, was to the quantity and amplitude in a direct ratio, as the whole line to the sine of double the angle of incidence, formed by the breech upon the horizontal line; — and that the semiparameter, — stop! my dear uncle Toby — stop!

Quoted in James R. Newman

*The World of Mathematics* (Volume 2)

Mathematics of Motion (p. 734)

Simon & Schuster. New York, New York, USA. 1956

### Stewart, Dugald 1753–1828

Scottish philosopher

...the study of [mathematics] is peculiarly calculated to strengthen the power of steady and concatenated thinking — a power which, in all the pursuits of life, whether speculative or active, is one of the most valuable endowments we can possess. This command of attention, however, it may be proper to add, is to be acquired, not by the practice of modern methods, but by the study of the Greek geometry...

*The Collected Works of Dugald Stewart* (Volume 4)

Part Third, Chapter I, Section 3 (p. 201)

T & T Clark. Edinburgh, Scotland. 1877

In Pure Mathematics, where all the various truths are necessarily connected with each other, (being all necessarily connected with those hypotheses which are the principles of the science), an arrangement is beautiful in proportion as the principles are few; and what we admire perhaps chiefly in the science, is the astonishing variety of consequences which may be demonstrably deduced from so small a number of premises.

*The Elements of the Philosophy of the Human Mind*

Part 3, Chapter 1, Section 3

Eastburn, Kirk & Company. New York, New York, USA. 1814

### Stewart, Ian 1945–

English mathematician and science writer

To criticize mathematics for its abstraction is to miss the point entirely. Abstraction is what makes mathematics work. If you concentrate too closely on too limited an application of a mathematical idea, you rob the mathematician of his most important tools: analogy, generality, and simplicity. Mathematics is the ultimate in technology transfer.

*Does God Play Dice: The New Mathematics of Chaos*

Chapter 17 (p. 363)

Blackwell Publishing Ltd. Malden, Massachusetts, USA. 2002

Not all ideas are mathematics; but all good mathematics must contain an idea.

*From Here to Infinity*

The Nature of Mathematics (p. 6)

Oxford University Press, Inc. Oxford, England. 1996

Mathematics is not just a collection of isolated facts: it is more like a landscape; it has an inherent geography that

its users and creators employ to navigate through what would otherwise be an impenetrable jungle.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*  
Chapter 3 (p. 38)  
Basic Books. New York, New York, USA. 1995

Mathematics is not a long-dead subject preserved in dusty tomes, in which all the questions have been solved and all the answers are listed at the back of the book. It is a vibrant, lively, ever-growing subject: Indeed, more new mathematics is being created today than ever before. Further, this new mathematics is not just ever-more-complicated answers to bigger and bigger sums. It lies on a far higher conceptual level. Mathematics is the study of patterns, regularities, rules, and their consequences — the science of significant form — and nowhere is form more significant than in biology.

*Life's Other Secret: The New Mathematics of the Living World*  
Chapter 2 (pp. 29–30)  
John Wiley & Sons, Inc. New York, New York, USA. 1998

Many pages have been expended on polemics in favor of rigor over intuition, or of intuition over rigor.

Both extremes miss the point: the power of mathematics lies precisely in the combination of intuition and rigor.

*Concepts of Modern Mathematics*  
Chapter 1 (p. 4)

Dover Publications, Inc. New York, New York, USA. 1995

Mathematics is much like the Mississippi. There are sideshoots and dead ends and minor tributaries; but the mainstream is there, and you can find it where the current — the mathematical power — is strongest. Its delta is research mathematics: it is growing, it is going somewhere (but it may not always be apparent where), and what today looks like a major channel may tomorrow clog up with silt and be abandoned. Meanwhile a minor trickle may suddenly open out into a roaring torrent. The best mathematics always enriches the mainstream, sometimes by diverting it in an entirely new direction.

*From Here to Infinity*

The Nature of Mathematics (p. 11)

Oxford University Press, Inc. Oxford, England. 1996

Mathematics is to nature as Sherlock Holmes is to evidence.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*  
Chapter 1 (p. 2)  
Basic Books. New York, New York, USA. 1995

...mathematics is the science of patterns, and nature exploits just about every pattern that there is.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*  
Chapter 2 (p. 18)

Basic Books. New York, New York, USA. 1995

**Stone, Marshall H.** 1903–89

American mathematician

...science is reasoning; reasoning is mathematics; and, therefore, science is mathematics.

Mathematics and the Future of Science

*Bulletin of the American Mathematical Association*, Volume 63, Number 2 March 1957 (p. 61)

**Struik, Dirk J.** 1894–2000

Dutch mathematician

Mathematics is a vast adventure of ideas; its history reflects some of the noblest thoughts of countless generations.

*A Concise History of Mathematics*

Introduction (p. 1)

Dover Publications, Inc. New York, New York, USA. 1967

Mathematics is of profound significance in the universe, not because it exhibits principles that we obey, but because it exhibits principles that we impose.

In William L. Schaaff (ed.)

*Mathematics: Our Great Heritage*

Aspects of Science (p. 12)

Harper & Brothers. New York, New York, USA. 1948

**Sullivan, John William Navin** 1886–1937

Mathematician

...a history of mathematics is largely a history of discoveries which no longer exist as separate items, but are merged into some more modern generalization, these discoveries have not been forgotten or made valueless. They are not dead, but transmuted.

*The History of Mathematics in Europe*

Introduction (p. 10)

Oxford University Press, Inc. New York, New York, USA. 1925

**Swann, William Francis Gray** 1884–1962

Anglo-American physicist

...the mathematical physicist...obtains much prestige from the physicists because they are impressed with the amount of mathematics he knows, and much prestige from the mathematicians, because they are impressed with the amount of physics he knows.

*The Architecture of the Universe*

Chapter I (p. 14)

The Macmillan Company. New York, New York, USA. 1934

**Swift, Jonathan** 1667–1745

Irish-born English writer

The knowledge I had in mathematicks gave me great assistance in acquiring their [the Laputans'] phraseology, which depended much upon that science and musick; and in the latter I was not unskilled. Their ideas are perpetually conversant in lines and figures. If they would, for example, praise the beauty of a woman, or any other animal, they describe it by rhombs, circles, parallelograms, ellipses, and other geometrical terms, or by words of art drawn from music, needless here to repeat. I observed in the king's kitchen all sorts of mathematical and musical instruments, after the figures of which they cut up the joynts that were served to his Majesty's table.

In *Great Books of the Western World* (Volume 36)



*Gulliver's Travels*

Part III, Chapter II (p. 97)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Sylvester, James Joseph** 1814–97

English mathematician

There are three ruling ideas, three so to say, spheres of thought, which pervade the whole body of mathematical science, to some one or other of which, or to two or all three of them combined, every mathematical truth admits of being referred; these are the three cardinal notions, of Number, Space and Order.

Arithmetic has for its object the properties of number in the abstract. In algebra, viewed as a science of operations, order is the predominating idea. The business of geometry is with the evolution of the properties of space, or of bodies viewed as existing in space...

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

A Probationary Lecture on Geometry, Delivered before the Gresham Committee and the Members of the Common Council of the City of London, 4 December, 1854 (p. 5)

University Press. Cambridge, England. 1904–1912

Number, place, and combination...the three intersecting but distinct spheres of thought to which all mathematical ideas admit of being referred.

*Philosophical Magazine*, Volume 24, (1844) (p. 285)

Time was when all the parts of the subject were dissevered, when algebra, geometry, and arithmetic either lived apart or kept up cold relations of acquaintance confined to occasional calls upon one another; but that is now at an end; they are drawn together and are constantly becoming more and more intimately related and connected by a thousand fresh ties, and we may confidently look forward to a time when they shall form but one body with one soul.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to the British Association (p. 659)

University Press. Cambridge, England. 1904–1912

Some people have been found to regard all mathematics, after the 47<sup>th</sup> proposition of Euclid, as a sort of morbid secretion, to be compared only with the pearl said to be generated in the diseased oyster...

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to the British Association

Execer British Association Report (1869) (p. 658)

University Press. Cambridge, England. 1904–1912

The object of pure Physic is the unfolding of the laws of the intelligible world; the object of pure Mathematic that of the unfolding the laws of human intelligence.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

On a Theorem Connected with Newton's Rule (p. 424) (p. 424)

University Press. Cambridge, England. 1904–1912

The world of ideas which it [mathematics] discloses or illuminates, the contemplation of divine beauty and order

which it induces, the harmonious connection of its parts, the infinite hierarchy and absolute evidence of the truths with which mathematical science is concerned, these, and such like, are the surest grounds of its title of human regard, and would remain unimpaired were the plan of the universe unrolled like a map at our feet, and the mind of man qualified to take in the whole scheme of creation at a glance.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to Section "A" of the British Association (p. 659)

University Press. Cambridge, England. 1904–1912

May not Music be described as the Mathematic of Sense, Mathematics as Music of the Reason?

Algebraical Researches, Containing a Disquisition on Newton's Rule for the Discovery of Imaginary Roots

*Philosophical Transactions of the Royal Society*, Volume 154, 1864

Little could Plato have imagined, when indulging his instinctive love of the true and beautiful for their own sakes, he entered upon these refined speculations and reveled in a world of his own creation, that he was writing the grammar of the language in which it [mathematics] would be demonstrated in after ages that the pages of the universe are written.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

A Probationary Lecture on Geometry (p. 7)

University Press. Cambridge, England. 1904–1912

May not Music be described as the Mathematic of sense, Mathematic as the Music of the reason? the soul of each the same! Thus the musician feels Mathematic, the mathematician thinks Music — Music the dream, Mathematic the working life — each to receive its consummation from the other when the human intelligence, elevated to its perfect type, shall shine forth glorified in some future Mozart-Dirichlet or Beethoven-Gauss — a union already not indistinctly foreshadowed in the genius and labours of a Helmholtz!

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

On Newton's Rule for the Discovery of Imaginary Roots (fn, p. 419)

University Press. Cambridge, England. 1904–1912

Mathematics is not a book confined within a cover and bound between brazen clasps, whose contents it needs only patience to ransack; it is not a mine whose treasures may take long to reduce into possession, but which fill only a limited number of veins and lodes; it is not a soil, whose fertility can be exhausted by the yield of successive harvests, it is not a continent or an ocean, whose area can be mapped out and its contour defined: it is limitless as that space which it finds too narrow for its applications; its possibilities are as infinite as the worlds which are forever crowding in and multiplying upon the astronomer's gaze; it is as incapable of being within assigned boundaries or being reduced to definitions of permanent validity, as the consciousness, the life, which seems to slumber in each monad, in every atom of matter, in each

leaf and bud and cell, and is forever ready to burst forth into new forms of vegetable and animal existence.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)  
An Inquiry into Newton's Rule for the Discovery of Imaginary Roots  
(p. 77)  
University Press. Cambridge, England. 1904–1912

I think it would be desirable that this form of word [mathematics] should be reserved for the applications of the science, and that we should use mathematic in the singular to denote the science itself, in the same way as we speak of logic, rhetoric, or (own sister to algebra) music.

*Collected Mathematical Papers*  
Presidential Address to the British Association, Exeter British Association Report (1869), Volume 2 (p. 659)

I think that young chemists desirous of raising their science to its proper rank would act wisely in making themselves master betimes of the theory of algebraic forms. What mechanics is to physics, that I think is algebraic morphology, founded at option on the theory of partitions or ideal elements, or both, is destined to be to the chemistry of the future...invariants and isomerism are sister theories.

*American Journal of Mathematics*, Volume 1, 1878 (p. 126)

I know, indeed, and can conceive of no pursuit so antagonistic to the cultivation of the oratorical faculty...as the study of Mathematics. An eloquent mathematician must, from the nature of things, ever remain as rare a phenomenon as a talking fish, and it is certain that the more anyone gives himself up to the study of oratorical effect the less will he find himself in a fit state to mathematics.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)  
Address  
Johns Hopkins University, 22 February, 1877 (p. 72)  
University Press. Cambridge, England. 1904–1912

...I think it would be desirable that this form of the word [mathematics] should be reserved for the application of the science, and that we should use mathematic in the singular to denote the science itself, in the same way as we speak of logic, rhetoric, or (own sister to algebra) music.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
Presidential Address to Section "A" of the British Association (p. 659)  
University Press. Cambridge, England. 1904–1912

...there is no study in the world which brings into more harmonious action all the faculties of the mind than the one [mathematics] of which I as the humble representative and advocate. There is none other which prepares so many agreeable surprises for its followers, more wonderful than the transformation scene of a pantomime, or, like this, seems to raise them, by successive steps of initiation to higher and higher states of conscious intellectual being.

*Nature*

A Plea for the Mathematician, Volume 1, Thursday, January 6, 1870 (p. 261)

**Synge, John L.** 1897–1995  
Irish mathematician and physicist

Logic is the railway track along which the mind glides easily. It is the axioms that determine our destination by setting us on this track or the other, and it is in the matter of choice of axioms that applied mathematics differs most fundamentally from pure. Pure mathematics is controlled (or should we say "uncontrolled?") by a principle of ideological isotropy: any line of thought is as good as another, provided that it is logically smooth. Applied mathematics on the other hand follows only those tracks which offer a view of natural scenery; if sometimes the track dives into a tunnel it is because there is prospect of scenery at the far end.

Postcards on Applied Mathematics  
*The American Mathematical Monthly*, Volume 46, Number 3, March 1939 (p. 156)

Mathematics begins in bewilderment and ends in bewilderment.

*Kandelman's Krim* (p. 17)  
Jonathan Cape. London, England. 1957

**Szego, Gábor** 1895–1985  
Hungarian mathematician

Mathematics is a human activity almost as diverse as the human mind itself.

In Jozef Kurschak  
*Hungarian Problem Book I* (p. 6)  
Mathematical Association of America. Washington, D.C. 1963

**Teller, Edward** 1908–2003  
Hungarian-born American nuclear physicist

**Sylvester, James Joseph** 1814–97  
English mathematician

Science attempts to find logic and simplicity in nature. Mathematics attempts to establish order and simplicity in human thought.

*The Pursuit of Simplicity* (p. 17)  
Pepperdine University Press. Malibu, California, USA. 1980

**Thom, René** 1923–2002  
French mathematician

Just as, when learning to speak, a baby babbles in all the phonemes of all the languages of the world, but after listening to its mother's replies soon learns to babble in only the phenomena of its mother's language, so we mathematicians babble in all possible branches of mathematics, and ought to listen to mother nature in order to find out which branches of mathematics are natural.

In John Ziman  
*Reliable Knowledge*  
Chapter 2 (p. 18, fn 14)  
Cambridge University Press. Cambridge, England. 1978

**Thomas, Lewis** 1913–93  
American physician and biologist

The universal language of the future, in the view of the tiny minority who now use it for their lives, will be mathematics. It could be so. Certainly, no other human endeavor can present so powerful an argument for a long survival in the centuries ahead, nor so solid a case for having already influenced and changed, largely for the better, the human condition. Among the sciences, mathematics has advanced more rapidly and at the same time penetrated the human mind more profoundly than any other field. I would include, most conspicuously, physics, for all the showiness of its accomplishments, and even cosmophysics; these disciplines would still be studying Galileo were it not for events that have happened in just the last three centuries in pure mathematics.

*Et Cetera, Et Cetera: Notes of a Word-Watcher*  
Chapter 38 (p. 161)  
Little, Brown & Company. Boston, Massachusetts, USA. 1990

**Thompson, Sir D’Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

...the zoologist or morphologist has been slow, where the physiologist has long been eager, to invoke the aid of the physical or mathematical sciences; and the reasons for this difference lie deep.... Even now the zoologist has scarce begun to dream of defining in mathematical language even the simplest organic forms.

*On Growth and Form* (Volume 1)  
Chapter I (p. 2)  
At the University Press. Cambridge, England. 1951

The harmony of the world is made manifest in Form and Number, and the heart and soul and all the poetry of Natural Philosophy are embodied in the concept of mathematical beauty.

*On Growth and Form* (Volume 1)  
Epilogue (pp. 1096–1097)  
At The University Press. Cambridge, England. 1951

**Sylvester, James Joseph** 1814–97  
English mathematician

Mathematics is the only true metaphysics.

In S. P. Thompson  
*The Life of William Thomson Baron Kelvin of Largs* (Volume 2)  
Views and Opinions (p. 1139)

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The most distinct and beautiful statements of any truth must take at last the mathematical form. We might so simplify the rules of moral philosophy, as well as of arithmetic, that one formula would express them both.

*The Writings of Henry David Thoreau* (Volume 1)  
A Week on the Concord and Merrimac Rivers  
Friday (p. 478)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

We have heard much about the poetry of mathematics, but very little of it has yet been sung. The ancients had a juster notion of their poetic value than we. The most distinct and beautiful statements of any truth must take at last the mathematical form.

*The Writings of Henry David Thoreau* (Volume 1)  
A Week on the Concord and Merrimac Rivers  
Friday (p. 477)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Mathematics should be mixed not only with physics but with ethics...

*The Writings of Henry David Thoreau* (Volume 1)  
A Week on the Concord and the Merrimack Rivers  
Friday (p. 478)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Thurston, William Paul** 1946–  
American mathematician

Mathematics is a huge and highly interconnected structure... Think of a tinker toy set. The key is the pieces which have holes, allowing you to join them with rods to form interesting and highly interconnected structures. No interesting mathematical topic is self-contained or complete: rather it is full of “holes,” or natural questions and ideas not readily answered by techniques native to the topic. These holes often give rise to connections between the given topic and other topics that seem at first unrelated. Mathematical exposition often conceals these holes, for the sake of smoothness — but what good is a tinker toy set if the holes are all filled in with modeling clay?

*Three-Dimensional Geometry and Topology*  
Reader’s Advisory (p. ix)  
Princeton University Press. Princeton, New Jersey, USA. 1997

As one reads mathematics, one needs to have an active mind, asking questions, forming mental connections between the current topic and other ideas from other contexts, so as to develop a sense of the structure, not just familiarity with a particular tour through the structure.

*Three-Dimensional Geometry and Topology*  
Reader’s Advisory (p. ix)  
Princeton University Press. Princeton, New Jersey, USA. 1997

I think mathematics is a vast territory. The outskirts of mathematics are the outskirts of mathematical civilization. There are certain subjects that people learn about and gather together. Then there is a sort of inevitable development in those fields. You get to the point where a certain theorem is bound to be proved, independent of any particular individual, because it is just in the path of development.

In D. Albers, G. Alexanderson and C. Reid (eds.)  
*More Mathematical People*  
William P. Thurston (p. 332)  
Harcourt Brace Jovanovich. New York, New York, USA. 1990

**Todhunter, Isaac** 1820–84  
English mathematician

Nor do I know any study which can compete with mathematics in general in furnishing matter for severe and continued thought. Metaphysical problems may be even more difficult; but then they are far less definite, and, as they rarely lead to any precise conclusion, we miss the power of checking our own operations, and of discovering whether we are thinking and reasoning or merely fancying and dreaming.

*Conflict of Studies and Other Essays*

The Conflict of Studies (p. 13)

Macmillan & Company. London, England. 1873

Another great and special excellence of mathematics is that it demands earnest voluntary exertion. It is simply impossible for a person to become a good mathematician by the happy accident of having been sent to a good school; this may give him a preparation and a start, but by his own individual efforts alone can he reach an eminent position.

*Conflict of Studies and Other Essays*

The Conflict of Studies (p. 11)

Macmillan & Company. London, England. 1873

**Tolstoy, Leo** 1828–1910  
Russian writer

“Mathematics are most important, madam! I don’t want to have you like our silly ladies. Get used to it and you’ll like it,” and he patted her cheek. “It will drive all the nonsense out of your head.”

In *Great Books of the Western World* (Volume 51)

*War and Peace*

Book One, Chapter XXV (p. 48)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

A modern branch of mathematics having acquired the art of dealing with the infinitely small can now yield solutions in other more complex problems of motion which used to appear insoluble. The modern branch of mathematics, unknown to the ancients, when dealing with problems of motion admits the conception of the infinitely small, and so conforms to the chief condition of motion (absolute continuity) and thereby corrects the inevitable error which the human mind cannot avoid when it deals with separate elements of motion instead of examining continuous motion.

In *Great Books of the Western World* (Volume 51)

*War and Peace*

Book Eleven, Chapter I (p. 469)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Trevelyan, George Otto** 1838–1928  
English historian

He gave himself diligently to mathematics, which he liked “vastly.” “I believe they are useful,” he writes, “and I am sure they are entertaining, which is alone enough to recommend them to me.”

*The Early History of Charles James Fox*

Chapter II (p. 50)

Longmans, Green & Company. London, England. 1901

**Trudeau, Richard J.**

No biographical data available

Pure mathematics is the world’s best game. It is more absorbing than chess, more of a gamble than poker, and lasts longer than Monopoly. It’s free. It can be played anywhere — Archimedes did it in a bathtub. It is dramatic, challenging, endless, and full of surprises.

*Dots and Lines*

Chapter 1 (p. 9)

The Kent State University Press. Kent, Ohio, USA. 1973

**Tucker, Albert W.**

No biographical data available

On one occasion during World War II...Lefschetz and I and Oskar Zariski...traveled into New York together on the train. Lefschetz and Zariski were talking about a certain paper, which had recently appeared in algebraic geometry, which they thought was a very good paper. Lefschetz remarked that he wasn’t sure if he would classify the paper as algebra or topology.... So Zariski, to tease Lefschetz a bit, asked, “How do you draw the line between algebra and topology?” Quick as a flash, Lefschetz came back with, “Well, if it’s just turning the crank, it’s algebra, but if it’s got an idea in it, it’s topology!”

*Two-Year Coll. Math. J.*

Solomon Lefschetz, *A Reminiscence*, Volume 14 (June 1983) (p. 227)

**Tukey, John W.** 1915–2000

American statistician

Just as there is an applied mathematics of games, genetics, and mechanics, so there should be an applied mathematics (at least in terms of concepts, perhaps with techniques and operations) of the applications of mathematics. When there is, mathematicians will be able to teach the applications of mathematics.

*The Teaching of Concrete Mathematics*

*The American Mathematical Monthly*, Volume 65, Number 1, January 1958 (p. 8)

**Turnbull, Herbert Westren** 1885–1961

English mathematician

Mathematics transfigures the fortuitous concourse of atoms into the tracery of the finger of God.

*The Great Mathematicians* (p. 141)

New York University Press. New York, New York, USA. 1961

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

We could use up two Eternities in learning all that is to be learned about our own world, and the thousands of nations that have risen, and flourished, and vanished

from it. Mathematics alone would occupy me eight million years.

In Albert Bigelow Paine  
*Mark Twain: A Biography* (Volume 2)  
Chapter CL (p. 777)  
Harper & Brothers Publishers. New York, New York, USA. 1912

I had been to school...and could say the multiplication table up to six times seven is thirty-five, and I don't reckon I could ever get any further than that if I was to live forever. I don't take no stock in mathematics, anyway.

In Mark Twain  
*The Adventures of Huckleberry Finn*  
Chapter IV (p. 10)  
Grosset & Dunlap Publishers. New York, New York, USA. 1948

**Ulam, Stanislaw** 1909–84  
Polish-born mathematician

Do not lose your faith. A mighty fortress is our mathematics. Mathematics will rise to the challenge, as it always has.

In Heinz R. Pagels  
*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*  
Chapter 3 (p. 94)  
Simon & Schuster. New York, New York, USA. 1988

In many cases, mathematics is an escape from reality. The mathematician finds his own monastic niche and happiness in pursuits that are disconnected from external affairs. Some practice it as if using a drug. Chess sometimes plays a similar role. In their unhappiness over the events of this world, some immerse themselves in a kind of self-sufficiency in mathematics.

*Adventures of a Mathematician*  
Chapter 6 (p. 120)  
Charles Scribner's Sons. New York, New York, USA. 1976

**Veblen, Oswald** 1880–1960  
American mathematician

...the abstract mathematical theory has an independent, if lonely existence of its own. But when a sufficient number of its terms are given physical definitions it becomes a part of a vital organism concerning itself at every instant with matters full of human significance. Every theorem can be given the form 'if you do so and so, such and such will happen.'

Remarks on the Foundation of Geometry  
*Bulletin of the American Mathematical Society*, Volume 35, 1935 (p. 135)

**Veblen, Oswald** 1880–1960  
American mathematician

**Whitehead, J. H. C.** 1904–60  
English mathematician

Any mathematical science is a body of theorems deduced from a set of axioms. A geometry is a mathematical science. The question then arises why the name geometry is given to some mathematical sciences and not to others.

It is likely that there is no definite answer to this question, but that a branch of mathematics is called a geometry because the name seems good, on emotional and traditional grounds, to a sufficient number of competent people.

*The Foundation of Differential Geometry* (p. 17)  
University Press. Cambridge, England 1932

**Venn, John** 1834–1923  
English logician

Without consummate mathematical skill, on the part of some investigators at any rate, all the higher physical problems would be sealed to us; and without competent skill on the part of the ordinary student no idea can be formed of the nature and cogency of the evidence on which the solution rest. Mathematics are not merely a gate through which we may approach if we please, but they are the only mode of approach to large and important districts of thought.

*Symbolic Logic*  
Introduction (p. xxix)  
Macmillan & Company. London, England. 1881

**Viereck, George S.** 1884–1962  
German American poet and writer

**Eldridge, Paul** 1888–1982  
American novelist, poet and writer

We are two parallel lines drawn very close to each other.... So close indeed that no third line, however thin, could be drawn between them.

Will the two parallel lines ever meet?

Yes, In infinity.

Ali Hasan! I exclaimed, had you ever dreamed that there was so much poetry and pathos and sorrow in mathematics?

*My First Two Thousand Years: The Autobiography of the Wandering Jew*  
Chapter XLIV (p. 218)  
Sheridan House. New York, New York, USA. 1963

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

When we cannot use the compass of mathematics or the torch of experience...it is certain that we cannot take a single step forward.

In Morris Kline  
*Mathematical Thought from Ancient to Modern Times* (p. 614)  
Oxford University Press, Inc. New York, New York, USA. 1972

Mathematics must subdue the flights of our reason; they are the staff of the blind; no one can take a step without them; and to them and experience is due all that is certain in physics.

*Oeuvres Complètes*  
t. 35 (p. 219)  
Publisher undetermined

All certainty which does not consist in mathematical demonstration is nothing more than the highest probability; there is no other historical certainty.

*The Portable Voltaire*

Philosophical Dictionary, Concatenation of Events (p. 223)

The Viking Press. New York, New York, USA. 1959

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The mathematician is perfect only in so far as he is a perfect being, in so far as he perceives the beauty of truth; only then will his work be thorough, transparent, comprehensive, pure, clear, attractive, and even elegant.

In JoAnne S. Growney

Are Mathematics and Poetry Fundamentally Similar?

*The American Mathematical Monthly*, Volume 99, Number 2, February 1992 (p. 131)

The saying that no one who is unacquainted with, or a stranger to, geometry, should enter the school of the philosopher, does not mean that a man must be a mathematician in order to become a sage.

*Criticisms, Reflections, and Maxims of Goethe* (p. 207)

Walter Scott Publishing Company. London, England. 1897

Mathematics, like dialectics, is an instrument of the inner higher sense, while in practice it is an art like rhetoric. For both of these, nothing has value but form; content is immaterial. Whether mathematics is adding up pennies or guineas, whether rhetoric is defending truth or falsehood, makes no difference to either.

Translated by Krishna Winston

*Wilhelm Meister's Journeyman Years* (p. 311)

Princeton University Press. Princeton, New Jersey, USA. 1995

Mathematicians are like Frenchmen: whatever you say to them they translate into their own language and forthwith it is something entirely different.

*The Maxims and Reflections of Goethe*

Macmillan & Company Limited. London, England. 1908

Mathematics is like dialectics, an organ of the inner higher mind. Practicing it is an art similar to eloquence. In both, nothing is of value but the form; towards the contents the user are indifferent. Whether mathematics calculates pennies or guineas, and whether rhetoric defends the true or the false, is quite outside the sphere of their interests.

In Walter R. Fuchs

*Mathematics For the Modern Mind*

See What the Proof Proves (p. 24)

The Macmillan Company. New York, New York, USA. 1967

I have heard myself accused of being an opponent, an enemy of mathematics, which no one can value more highly than I, for it accomplishes the very thing whose achievement has been denied me.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

A thorough advocate in a just cause, a penetrating mathematician facing the starry heavens, both alike bear the semblance of divinity.

In JoAnne S. Growney

Are Mathematics and Poetry Fundamentally Similar?

*The American Mathematical Monthly*, Volume 99, Number 2, February 1992 (p. 131)

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

We see in the science of mathematics the conscious logical activity of the human mind in its purest and most perfect form. While we are impressed with the arduous labor of its procedure and the difficulty of forming and comprehending its abstract conceptions, we at the same time learn to confide in the security, reach, and fruitfulness of its reasonings.

In Leo Koenigsberger

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

The Investigations of Hermann von Helmholtz on the Fundamental Principles of Mathematics and Mechanics (p. 93)

Government Printing Office. Washington, D.C. 1898

Mathematics and music! the most glaring possible opposites of human thought! and yet connected, mutually sustained!

*Popular Lectures on Scientific Subjects*

Lecture III (p. 62)

D. Appleton & Company. New York, New York, USA. 1885

[In mathematics] we behold the conscious logical activity of the human mind in its purest and most perfect form. Here we learn to realize the laborious nature of the process, the great care with which it must proceed, the accuracy which is necessary to determine the exact extent of the general propositions arrived at, the difficulty of forming and comprehending abstract concepts; but here we learn also to place confidence in the certainty, scope and fruitfulness of such intellectual activity.

*Vorträge und Reden*

Ueber das Verhältniss der Naturwissenschaften zur Gesamtheit der Wissenschaft, Bd. 1, 1896 (p. 176)

Publisher undetermined

**von Neumann, John** 1903–57

Hungarian-American mathematician

...in mathematics you don't understand things. You just get used to them.

In G. Zukav

*The Dancing Wu Li Masters: An Overview of the New Physics*

Part One

I Clutch My Ideas

Chapter 1 (fn, p. 226)

William Morrow. New York, New York, USA. 1979

...mathematics is not an empirical science, or at least that it is practiced in a manner which differs in several decisive respects from the techniques of the empirical sciences.

*Collected Works* (Volume 1)  
The Works of the Mind, The Mathematician (p. 6)  
Pergamon Press. New York, New York, USA. 1961–1963

There are two ways to teach mathematics. One is to take real pains toward creating understanding visual aids, that sort of thing. The other is the old British system of teaching until you're blue in the face.

*New York Times*, September 39, 1956

Mathematics is nourished by dreamers — as it nourishes them...

*The World of Mathematics* (Volume 1)  
The Rhine Papyrus (p. 170)  
Simon & Schuster. New York, New York, USA. 1956

...much of the best mathematical inspiration comes from experience and that it is hardly possible to believe in the existence of an absolute, immutable concept of mathematical rigor, dissociated from all human experience.

*Collected Works* (Volume 1)  
The Works of the Mind, The Mathematician (p. 6)  
Pergamon Press. New York, New York, USA. 1961–1963

...at a great distance from its empirical source, or after much "abstract" inbreeding, a mathematical subject is in danger of degeneration. At the inception the style is usually classical; when it shows signs of becoming baroque, then the danger signal is up.... In any event, whenever this stage is reached, the only remedy seems to me to be the rejuvenating return to the source: the reinjection of more or less directly empirical ideas. I am convinced that this was a necessary condition to conserve freshness and vitality of the subject and that this will remain equally true in the future.

*Collected Works* (Volume 1)  
The Works of the Mind, The Mathematician (p. 6, 9)  
Pergamon Press. New York, New York, USA. 1961–1963

After all, classical mathematics was producing results which were both elegant and useful, and, even though one could never again be absolutely certain of its reliability, it stood on at least as sound a foundation as, for example, the existence of the electron. Hence, if one was willing to accept the sciences, one might as well accept the classical system of mathematics.

*Collected Works* (Volume 1)  
The Works of the Mind, The Mathematician (p. 6)  
Pergamon Press. New York, New York, USA. 1961–1963

Mathematics falls into a great number of subdivisions, differing from one another widely in character, style, aims, and influence. It shows the very opposite of the extreme concentration of theoretical physics. A good theoretical physicist may today still have a working knowledge of more than half of his subject. I doubt that any mathematician now living has much of a relationship to more than a quarter.

In Cecil M. DeWitt and John A. Wheeler  
*Battelle Recontres* 67 (p. ix)

It is commonplace that mathematics is an excellent school of thinking, that it conditions you to logical thinking, that after having experienced it you can somehow think more validly than otherwise. I don't know whether all these statements are true, the first one is probably least doubtful. However, I think it has a very great importance in thinking in an area which is not so precise. I feel that one of the most important contributions of mathematics to our thinking is, that it has demonstrated an enormous flexibility in the formation of concepts, a degree of flexibility to which it is very difficult to arrive in a nonmathematical mode.

In John A. Taub (ed.)  
*John von Neumann Collected Works*  
Volume VI, The Role of Mathematics in The Sciences and Society (p. 482)  
Pergamon. New York, New York, USA. 1963

**von Schlegel, Friedrich** 1772–1829  
German philosopher, critic, and writer

Mathematics is, as it were, a sensuous logic, and relates to philosophy as do the arts, music, and plastic art to poetry.

*Dialogue on Poetry and Literary Aphorisms*  
Selected Aphorisms from the Athenaeum  
Aphorism 365 (p. 147)  
The Pennsylvania State University Press, University Park, Pennsylvania, USA. 1968

**Vooley, Hollis R.**  
No biographical data available

Mathematics is loved by many, disliked by a few, admired and respected by all. Because of their immense power and reliability, mathematical methods inspire confidence in persons who comprehend them and awe in those who do not.

In Samuel Rapport and Helen Wright (eds.)  
*Mathematics*  
Forward (p. ix)  
New York University Press. New York, New York, USA. 1963

**Waismann, Friedrich** 1896–1959  
Austrian mathematician, physicist, and philosopher

We could compare mathematics so formalized to a game of chess in which the symbols correspond to the chessmen; the formulae, to definite positions of the men on the board; the axioms, to the initial positions of the chessmen; the directions for drawing conclusions, to the rules of movement; a proof, to a series of moves which leads from the initial position to a definite configuration of the men.

*Introduction to Mathematical Thinking: The Formation of Concepts in Modern Mathematics*  
Chapter 6 (pp. 76–77)  
Frederick Ungar Publishing Company. New York, New York, USA. 1951

**Wall, Hubert Stanley** 1902–71  
American mathematician

Mathematics is a creation of the mind. To begin with, there is a collection of things, which exist only in the mind, assumed to be distinguishable from one another; and there is a collection of statements about these things, which are taken for granted. Starting with the assumed statements concerning these invented or imagined things, the mathematician discovers other statements, called theorems, and proves them as necessary consequences. This, in brief, is the pattern of mathematics. The mathematician is an artist whose medium is the mind and whose creations are ideas.

*Creative Mathematics* (p. 3)

University of Texas Press. Austin, Texas, USA. 1963

**Walton, Izaak** 1593–1683

English writer

For Angling may be said to be so like the Mathematics, that it can never be fully learnt...

*The Complete Angler*

The Epistle to the Reader (p. 7)

T.N. Foulis. London, England. 1913

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

Theology, Mr. Fortune found, is a more accommodat-ing subject than mathematics; its technique of exposition allows greater latitude. For instance when you are graveled for matter there is always the moral to fall back upon. Comparisons too may be drawn, leading cases cited, types and antetypes analysed and anecdotes introduced. Except for Archimedes mathematics is singularly naked of anecdotes.

*Mr. Fortune's Maggot*

Mr. Fortune's Maggot (p. 111)

New York Review of Books. New York, New York, USA. 1927

**Weaver, Warren** 1894–1978

American mathematician

There is a common tendency to consider mathematics so strange, subtle, rigorous, difficult and deep a subject that if a person is a mathematician he is of course a "great mathematician" — their being, so to speak, no small giants. This is very complimentary, but unfortunately not necessarily true.

*Scientific American*

Lewis Carroll: Mathematician, Volume 194, Number 4, April 1956 (p. 116)

**Webster, John** 1580?–1625?

English playwright

Bosola: Didst thou never study mathematics?

Old Lady: What's that, sir?

Bosola: Why, to know the trick how to make many lines met in one centre.

*The Duchess of Malfi*

Act II, Scene ii

Chatto & Windus. London, England. 1958

**Weil, André** 1906–98

French mathematician

When a branch of mathematics ceases to interest any but the specialists, it is very near its death, or at any rate dangerously close to paralysis, from which it can be rescued only by being plunged back into the vivifying source of the science.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May 1950 (p. 304)

God exists since mathematics is consistent, and the Devil exists since we cannot prove it.

In John D. Barrow

*The World within The World* (p. 254)

Clarendon Press. Oxford, England. 1988

Mathematics has this peculiarity, that it is not understood by non-mathematicians.

*Oeuvres Scientifiques*

Organisation et désorganisation en mathématique, Volume II (p. 465)

Springer-Verlag. New York, New York, USA. 191980

**Weil, Simone** 1909–43

French philosopher and mystic

Mathematics alone make us feel the limits of our intelligence. For we can always suppose in the case of an experiment that it is inexplicable because we don't happen to have all the data. In mathematics we have all the data...and yet we don't understand. We always come back to the contemplation of our human wretchedness. What force is in relation to our will, the impenetrable opacity of mathematics is in relation to our intelligence.

Translated by Arthur Wills

*The Notebooks of Simone Weil* (Volume 2) (p. 511)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian and sociologist

The Martians seem to have calculated their descent with amazing amazing subtlety — their mathematical learning is evidently far in excess of ours...

*Seven Famous Novels by H.G. Wells*

The War of the Worlds

Book I, Chapter 1 (pp. 266–267)

Alfred A. Knopf. New York, New York, USA. 1934

...the new mathematics is a sort of supplement to language, affording a means of thought about form and quantity and a means of expression, more exact, compact, and ready than ordinary language. The great body of physical science, a great deal of the essential facts of financial science, and endless social and political problems are only accessible and only thinkable to those who have had a sound training in mathematical analysis, and the time may not be very remote when it will be understood that for complete initiation as an efficient citizen of



one of the new great complex world wide states that are now developing, it is as necessary to be able to compute, to think in averages and maxima and minima, as it is now to be able to read and to write.

*Mankind In the Making*

Chapter VI (p. 204)

Chapman & Hall. London, England. 1906

### Westaway, Frederic William

No biographical data available

Mathematics, like all other subjects, has now to take its turn under the microscope and reveal to the world any weaknesses there may be in its foundations.

In E.T. Bell

*Men of Mathematics* (p. 555)

Simon & Schuster. New York, New York, USA. 1937

### Weyl, Hermann 1885–1955

German mathematician

You should not expect me to describe the mathematical way of thinking much more clearly than one can describe, say, the democratic way of life.

In K. Chandrasekhar

*Hermann Weyl*

Hermann Weyl Memorabilia (p. 84)

Springer-Verlag. Berlin, Germany. 1986

The stringent precision attainable for mathematical thought has led many authors to a mode of writing which must give the reader the impression of being shut up in a brightly illuminated cell where every detail sticks out with the same dazzling clarity, but without relief. I prefer the open landscape under the clear sky with its depth of perspective, where the wealth of sharply defined nearby details gradually fades away towards the horizon.

*The Classical Groups; Their Invariants and Representations*

Preface

Princeton University Press. Princeton, New Jersey, USA. 1946

Without the concepts, methods and results found and developed by previous generations right down to Greek antiquity one cannot understand either the aims or the achievements of mathematics in the last fifty years.

In Morris Kline

*Mathematical Thought From Ancient to Modern Times* (p. 101)

Oxford University Press, Inc. New York, New York, USA. 1972

The axiomatic approach has often revealed inner relations between, and has made for unification of methods within, domains that apparently lie far apart. This tendency of several branches of mathematics to coalesce is another conspicuous feature in the modern development of our science, and one that goes side by side with the apparently opposite tendency of axiomatization. It is as if you took a man out of a milieu in which he had lived not because it fitted him but from ingrained habits and prejudices, and then allowed him, after thus setting him free, to form associations in better accordance with his true inner nature.

A Half-Century of Mathematics

*The American Mathematical Monthly*, Volume 58, Number 8, October 1951 (p. 524)

Only he who knows what mathematics is, and what its function in our present civilization, can give sound advice for the improvement of our mathematical teaching.

*Collected Works* (Volume 1)

Opposite Weyl Photograph

No Hilbert will be able to assure us of consistency forever; we must be content if a simple axiomatic system of mathematics has met the test of our elaborate mathematical experiments so far.... A truly realistic mathematics should be conceived, in line with physics, as a branch of the theoretical construction of the one real world, and should adopt the same sober and cautious attitude toward hypothetical extensions of its foundations as is exhibited by physics.

*Philosophy of Mathematics and Natural Science*

Appendix A (p. 235)

Princeton University Press. Princeton, New Jersey, USA. 1949

The problems of mathematics are not isolated problems in a vacuum; there pulses in them the life of ideas which realize themselves in concerto through our human endeavors in our historical existence, but forming an indissoluble whole transcend any particular science.

In K. Chandrasekhar

*Hermann Weyl*

Hermann Weyl Memorabilia (p. 84)

Springer-Verlag. Berlin, Germany. 1986

The states of affairs with which mathematics deals are, apart from the very simplest ones, so complicated that it is practically impossible to bring them into full givenness in consciousness and in this way to grasp them completely.

Translated by Stephen Pollard and Thomas Bole

*The Continuum: A Critical Examination of the Foundation of Analysis*

Chapter 1 (p. 17)

The Thomas Jefferson University Press. Kirksville, Missouri, USA. 1987

Kierkegaard once said religion deals with what concerns man unconditionally. In contrast (but with equal exaggeration) one may say that mathematics talks about the things which are of no concern at all to man. Mathematics has the inhuman quality of starlight, brilliant and sharp, but cold. But it seems an irony of creation that man's mind knows how to handle things the better the farther removed they are from the center of his existence. Thus we are cleverest where knowledge matters least: in mathematics, especially in number theory.

*The American Mathematical Monthly*

A Half-century of Mathematics, Volume 58, Number 8, October 1951 (p. 523)

Mathematics is the science of the infinite, its goal the symbolic comprehension of the infinite with human, that is finite, means.

*The Open World: Three Lectures In the Metaphysical Implications of Science*

Lecture I (p. 7)

Yale University Press. New Haven, Connecticut, USA. 1932

Mathematizing may well be a creative activity of man, like language or music, of primary originality, whose historical decisions defy complete objective rationalizations.

Obituary for David Hilbert

*Royal Society Biographies*, Volume 4, 1944

In mathematics the inquiry into the genuineness or non-genuineness of the inner working of our entire western culture urges towards a more rigorous decision than can be attained in the other hazier fields of knowledge.

Gravitation and the Electron, Mathematical Lectures

*The Rice Institute Pamphlet*, Volume 16, Number 4 (p. 246)

In these days the angel of topology and the devil of abstract algebra fight for the soul of each individual mathematical domain.

In Morris Kline

*Mathematical Thought From Ancient to Modern Times* (p. 924)

Oxford University Press, Inc. New York, New York, USA. 1972

...it is the function of mathematics to be at the service of the natural sciences.

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 61)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Whetham, Sir William Cecil Dampier** 1867–1952

English scientific writer

...mathematics is but the higher development of symbolic logic.

*The Recent Development of Physical Science* (p. 34)

P. Blakiston's Son & Company. Philadelphia, Pennsylvania, USA. 1904

**Whewell, William** 1794–1866

English philosopher and historian

The peculiar character of mathematical truth is that it is necessarily and inevitably true; and one of the most important lessons which we learn from our mathematical studies is a knowledge that there are such truths, and a familiarity with their form and character.

This lesson is not only lost, but read backward if the student is taught that there is no such difference [between necessary truths and empirical facts], and that mathematical truths themselves are learned by experience.

*Principles of English University Education*

Thoughts on the Study of Mathematics

John W. Parker. London, England. 1838

...the ideas which these sciences [Geometry, Theoretical Arithmetic and Algebra] involve extend to all objects and changes which we observe in the external world; and hence the consideration of mathematical relations forms a large portion of many of the sciences which treat of the

phenomena and laws of external nature, as Astronomy, Optics, and Mechanics. Such sciences are hence often termed Mixed Mathematics, the relations of space and number being, in these branches of knowledge, combined with principles collected from special observation; while Geometry, Algebra, and the like subjects, which involve no result of experience, are called Pure Mathematics.

*The Philosophy of the Inductive Sciences Founded Upon Their History* (Volume 1)

Part I, Book 2, Chapter I, Section 4 (p. 83)

John W. Parker. London, England. 1847

**White, William Frank**

No biographical data available

Mathematics is the science of definiteness, the necessary vocabulary of those who know.

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays*

(p. 7)

Open Court Publishing Company, La Salle, Illinois, USA. 1942

Mathematics, the science of the ideal, becomes the means of investigating, understanding and making known the world of the real. The complex is expressed in terms of the simple. From one point of view mathematics may be defined as the science of successive substitutions of simpler concepts for more complex...

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays*

(p. 215)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

He must be a "practical" man who can see no poetry in mathematics.

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays*

(p. 208)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The ideal of mathematics should be to erect a calculus to facilitate reasoning in connection with every province of thought, or of external experience, in which the succession of thoughts, or of external experience, in which the succession of thoughts, or of events, can be definitely ascertained and precisely stated. So that all serious thought which is not philosophy, or inductive reasoning, or imaginative literature, shall be mathematics developed by means of a calculus.

*A Treatise on Universal Algebra, with Applications*

Preface (p. viii)

Hafner Publishing Company. New York, New York, USA. 1960

The first acquaintance which most people have with mathematics is through arithmetic.... Arithmetic, therefore, will be a good subject to consider in order to discover, if possible, the most obvious characteristic of the science. Now, the first noticeable fact about arithmetic is that it applies to everything, to tastes and to sounds, to

apples and to angels, to the ideas of the mind and to the bones of the body.

*An Introduction to Mathematics*

Chapter 1 (p. 2)

Oxford University Press, Inc. New York, New York, USA. 1958

The essence of applied mathematics is to know what to ignore.

In R. A. Fisher Presidential Address

*Sankhya*

Presidential Address, First Indian Statistical Conference, 1938, Volume 4, 1938 (p. 16)

No part of Mathematics suffers more from the triviality of its initial presentation to beginners than the great subject of series...the general ideas are never disclosed and thus the examples, which exemplify nothing, are reduced to silly trivialities.

*An Introduction to Mathematics*

Chapter 14 (p. 144)

Oxford University Press, Inc. New York, New York, USA. 1958

In order that a mathematical science of any importance may be founded upon conventional definitions, the entities created by them must have properties which bear some affinity to the properties of existing things.

*A Treatise on Universal Algebra, with Applications*

Preface (p. vii)

Hafner Publishing Company. New York, New York, USA. 1960

Philosophers, when they have possessed a thorough knowledge of mathematics, have been among those who have enriched the science with some of its best ideas. On the other hand it must be said that, with hardly an exception, all the remarks on mathematics made by those philosophers who have possessed but a slight or hasty or late-acquired knowledge of it are entirely worthless, being either trivial or wrong.

*An Introduction to Mathematics*

Chapter 9 (pp. 81–82)

Oxford University Press, Inc. New York, New York, USA. 1958

The study of mathematics is apt to commence in disappointment. The important applications of the science, the theoretical interest of its ideas, and the logical rigor of its methods, all generate the expectation of a speedy introduction to processes of interest. We are told that by its aid the stars are weighed and the billions of molecules in a drop of water are counted. Yet, like the ghost of Hamlet's father, this great science eludes the efforts of our mental weapons to grasp it.

*An Introduction to Mathematics*

Chapter 1 (p. 1)

Oxford University Press, Inc. New York, New York, USA. 1958

The science of Pure Mathematics, in its modern developments, may claim to be the most original creation of the human spirit.

*Science and the Modern World*

Chapter II (p. 29)

The Macmillan Company. New York, New York, USA. 1929

The whole of Mathematics consists in the organization of a series of aids to the imagination in the process of reasoning.

*A Treatise on Universal Algebra, with Applications*

Chapter I (p. 12)

Hafner Publishing Company. New York, New York, USA. 1960

Mathematics in its widest significance is the development of all types of formal, necessary, deductive reasoning.

*A Treatise on Universal Algebra, with Applications*

Preface (p. vi)

Hafner Publishing Company. New York, New York, USA. 1960

I will not go so far as to say that to construct a history of thought without profound study of the mathematical ideas...is like omitting Hamlet from the play which is named after him. That would be claiming too much. But it is certainly analogous to cutting out the part of Ophelia. This simile is singularly exact. For Ophelia is quite essential to the play, she is very charming, — and a little mad. Let us grant that the pursuit of mathematics is a divine madness of the human spirit, a refuge from the goading urgency of contingent happenings, and the sort of beauty changeless mountains present to senses tried by the present-day kaleidoscope of events.

*Science and the Modern World*

Chapter II (p. 31)

The Macmillan Company. New York, New York, USA. 1929

It is a safe rule to apply that, when a mathematical or philosophical author writes with a misty profundity, he is talking nonsense.

*An Introduction to Mathematics*

Chapter 15 (p. 170)

Oxford University Press, Inc. New York, New York, USA. 1958

...the anxious precision of modern mathematics is necessary for accuracy...it is necessary for research. It makes for clearness of thought and for fertility in trying new combinations of ideas. When the initial statements are vague and slipshod, at every subsequent stage of thought, common sense has to step in to limit applications and to explain meanings. Now in creative thought common sense is a bad master. Its sole criterion for judgment is that the new ideas shall look like the old ones, in other words it can only act by suppressing originality.

*An Introduction to Mathematics*

Chapter 11 (p. 116)

Oxford University Press, Inc. New York, New York, USA. 1958

...there is no more common error than to assume that, because prolonged and accurate mathematical calculations have been made, the application of the result to some fact of nature is absolutely certain.

*An Introduction to Mathematics*

Chapter 3 (p. 16)

Oxford University Press, Inc. New York, New York, USA. 1958

All mathematical calculations about the course of nature must start from some assumed law of nature.... Accordingly,

however accurately we have calculated that some event must occur, the doubt always remains — Is it true?

*An Introduction to Mathematics*

Chapter 3 (p. 16)

Oxford University Press, Inc. New York, New York, USA. 1958

**Wiener, Norbert** 1894–1964

American mathematician

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

The enormous usefulness of mathematics in the natural sciences is something bordering on the mysterious.

The Unreasonable Effectiveness of Mathematics in the Natural Sciences  
*Communications on Pure and Applied Mathematics*, Volume XIII, Number 1, February 1960 (p. 2)

The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift, which we neither understand nor deserve.

The Unreasonable Effectiveness of Mathematics in the Natural Sciences  
*Communications on Pure and Applied Mathematics*, Volume XIII, Number 1, February 1960 (p. 14)

...mathematics is the science of skillful operations with concepts and rules invented just for this purpose.

The Unreasonable Effectiveness of Mathematics in the Natural Sciences  
*Communications on Pure and Applied Mathematics*, Volume XIII, Number 1, February 1960 (p. 2)

**Wilder, Raymond L.** 1896–1982

American mathematician

...mathematics is what we make it; not by each of us acting without due regard for what constitutes mathematics in our culture, but by seeking to build up new theories in the light of the old, and to solve outstanding problems generally recognized as valuable for the progress of mathematics as we know it. Until we make it, it fails to “exist.” And, having been made, it may at some future time even fail to be “mathematics” any longer.

*Introduction to the Foundations of Mathematics*

Chapter XII (p. 284)

John Wiley & Sons, Inc. New York, New York, USA. 1952

**Wiles, Andrew** 1953–

English-born American research mathematician

Mathematics...is a bit like discovering oil... But mathematics has one great advantage over oil, in that no one has yet...found a way that you can keep using the same oil forever.

*Notices of the American Mathematical Society*, May 1997 (p. 588)

**Willerding, Margaret F.**

No biographical data available

It is strange but true that most of the greatest strides in mathematics were made at a time and in an atmosphere

when the need for mathematics was the least. Mathematics flourishes when it is free to follow any course it desires and when there is no pressure for practical results limiting its scope and freedom.

The Uselessness of Mathematics

*School Science and Mathematics*, Part II, Volume LXVIII, Number 6, June 1968 (p. 495)

**Williams, Charles**

No biographical data available

Love was even more mathematical than poetry; it was the pure mathematics of the spirit.

*Descent into Hell*

Chapter Four (p. 69)

William B. Eerdmans. Grand Rapids, Michigan, USA. 1979

**Williams, Horatio B.**

American neurophysiologist

Once a statement is cast into mathematical form it may be manipulated in accordance with [mathematical] rules and every configuration of the symbols will represent facts in harmony with and dependent on those contained in the original statement. Now this comes very close to what we conceive the action of the brain structures to be in performing intellectual acts with the symbols of ordinary language. In a sense, therefore, the mathematician has been able to perfect a device through which a part of the labor of logical thought is carried on outside the central nervous system with only that supervision which is requisite to manipulate the symbols in accordance with the rules.

Mathematics and the Biological Sciences

*Bulletin of the American Mathematical Society*, Volume 38, May–June 1927 (p. 291)

**Winsor, Frederick**

No biographical data available

Three jolly sailors from Blaydon-on-Tyne

They went to sea in a bottle by Klein.

Since the sea was entirely inside the hull

The scenery seen was exceedingly dull.

*The Space Child's Mother Goose*

Simon & Schuster. New York, New York, USA. 1958

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

There is no religious denomination in which the misuse of metaphysical expressions has been responsible for so much sin as it has in mathematics.

Translated by Peter Winch

*Culture and Value* (p. 1e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

With my full philosophical rucksack I can only climb slowly up the mountain of mathematics.

Translated by Peter Winch

*Culture and Value* (p. 2e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

...mathematics is a MOTLEY of techniques and proofs.

*Remarks on the Foundations of Mathematics*

Appendix II, 46 (p. 84e)

The MIT Press. Cambridge, Massachusetts, USA. 1967

A mathematical proof must be perspicuous.

*Remarks on the Foundations of Mathematics*

Appendix II, 1 (p. 65e)

The MIT Press. Cambridge, Massachusetts, USA. 1967

**Woolf, Virginia** 1882–1941

English novelist and essayist

When she was rid of the pretense of paper and pen, phrase-making and biography, she turned her attention in a more legitimate direction, though, strangely enough, she would rather have confessed her wildest dreams of hurricane and prairie than the fact that, upstairs, alone in her room, she rose early in the morning or sat up late at night to...work at mathematics. No force on earth would have made her confess that. Her actions when thus engaged were furtive and secretive, like those of some nocturnal animal.... Perhaps the uncommonly nature of the science made her instinctively wish to conceal her love of it. But the more profound reason was that in her mind mathematics were directly opposed to literature. She would not have cared to confess how infinitely she preferred the exactitude, the star-like impersonality, of figures to the confusion, agitation, and vagueness of the finest prose.

*Night and Day* (pp. 45–46)

Hogarth Press. London, England. 1950

**Wright, Frank Lloyd** 1867–1959

American architect

Toward the end of the last century, many physicists felt that the mathematical description of physics was getting ever more complicated. Instead, the mathematics involved has become ever more abstract, rather than more complicated. The mind of God appears to be abstract but not complicated. He also appears to like group theory.

*Fearful Symmetry*

Chapter 9 (p. 132)

Macmillan Publishing Company, New York, New York, USA. 1986

You can study mathematics all your life and never do a bit of thinking.

In Robert B. Heywood (ed.)

*The Works of The Mind*

The Architect (pp. 57–58)

The University of Chicago Press. Chicago, Illinois, USA. 1947

...mathematics in co-ordinated Form is architecture.

*Frank Lloyd Wright: An Autobiography*

Hollyhock House in Hollywood (p. 227)

Duell, Sloan & Pearce. New York, New York, USA. 1943

**Wright, Thomas** 1711–86

English cosmologist

...I will try by some less mathematical Method than that of mere Numbers, to imprint an Idea in your Mind of the true Extent of the solar System.

*An Original Theory or New Hypothesis of the Universe*

Letter the Eighth (p. 68)

Printed for the Author. London, England. 1750

**Young, John Wesley**

Mathematician

A mathematical science is any body of propositions which is capable of an abstract formulation and arrangement in such a way that every proposition of the set after a certain one is a formal logical consequence of some or all the preceding propositions. Mathematics consists of all such mathematical sciences.

*Lectures on Fundamental Concepts of Algebra and Geometry*

(p. 122)

Lecture XXI (p. 222)

The Macmillan Company. New York, New York, USA. 1911

Mathematics is a type of thought which seems ingrained in the human mind, which manifests itself to some extent with even the primitive races, and which is developed to a high degree with the growth of civilization.... A type of thought, a body of results, so essentially characteristic of the human mind, so little influenced by environment, so uniformly present in every civilization, is one of which no well-informed mind today can be ignorant.

*The Teaching of Mathematics*

Chapter II (p. 14)

Longmans, Green & Company. London, England. 1929

**Zeilberger, Doron**

Israeli-American mathematician

Mathematics is infinitely wide, while the language that describes it is finite. It follows from the pigeonhole principle that there exist distinct concepts that are referred to by the same name. Mathematics is also infinitely deep and sometimes entirely different concepts turn out to be intimately and profoundly related.

Closed form (pun intended!)

*Contemporary Mathematics*, Volume 143, 1988

**Zelazny, Roger** 1937–55

American writer of fantasy and science fiction

An ellipse is fine for as far as it goes,

But modesty, away!

If I'm going to see Beauty without her clothes

Give me hyperbolas any old day.

*Doorways in the Sand*

Chapter 4 (p. 41)

Harper & Row, Publishers. New York, New York, USA. 1976

**MATHEMATICIAN**

**Adams, Henry Brooks** 1838–1918

American man of letters

Mathematicians practice absolute freedom.

*A Letter to American Teachers of History*

Chapter II (p. 169)

Press of J.H. Furst Company. Washington, D.C. 1910

Mathematicians assume the right to choose, within the limits of logical contradiction, what path they please in reaching their results.

*A Letter to American Teachers of History*

Preface (p. v)

Press of J.H. Furst Company. Washington, D.C. 1910

He supposed that, except musicians, every one thought Beethoven a bore, as every one except mathematicians thought mathematics a bore.

In Ernest Samuels (ed.)

*The Education of Henry Adams*

Chapter V (p. 80)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Adler, Alfred** 1870–1937

Austrian psychiatrist

The mathematical life of a mathematician is short. Work rarely improves after the age of twenty-five or thirty. If little has been accomplished by then, little will ever be accomplished.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 5)

Wadsworth, Inc. Belmont, California, USA. 1984

Perhaps mathematicians, lacking the imagination to appreciate the scope and sophistication of the outside world, confuse minor success with real achievement and are satisfied with it. Then, too, they seldom recognize failure when they are confronted with it; rather, they tend to think of it as simply one more betrayal by a society that usually patronizes them while elevating armies of patently inferior claimants. In the academic world, on the other hand, mathematicians often enjoy rewards that they do no merit. They are engulfed by admirers from the department of philosophy and the social sciences...

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 6)

Wadsworth, Inc. Belmont, California, USA. 1984

Each generation has its few great mathematicians, and mathematics would not even notice the absence of the others. They are useful as teachers, and their research harms no one, but it is of no importance at all. A mathematician is great or he is nothing.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 3)

Wadsworth, Inc. Belmont, California, USA. 1984

In the company of friends, writers can discuss their books, economists the state of the economy, lawyers their latest cases, and businessmen their latest acquisitions, but

mathematicians cannot discuss their mathematics at all. And the more profound their work, the less understandable it is.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 7)

Wadsworth, Inc. Belmont, California, USA. 1984

...the mathematician learns early to accept no fact, to believe no statement, however apparently reasonable or obvious or trivial, until it has been proved, rigorously and totally by a series of steps proceeding from universally accepted first principles.

In Douglas M. Campbell and John C. Higgins (eds.)

*Mathematics: People, Problems, Results* (Volume 2)

Mathematics and Creativity (p. 5)

Wadsworth, Inc. Belmont, California, USA. 1984

**Ascham, Roger** 1516–68

English humanist and scholar

Mark all Mathematical heads [he continued] which be wholly and only bent on these sciences, how solitary they be themselves, how unfit to live with others, how unapt to serve the world.

In E.G.R. Taylor

*The Mathematical Practitioners of Tudor & Stuart England* (p. 5)

**Auden, W. H.** 1907–72

English-born poet

How happy the lot of the mathematician! He is judged solely by his peers, and the standard is so high that no colleague or rival can ever win a reputation he does not deserve.

*The Dyer's Hand and Other Essays*

Writing (p. 15)

Random House. New York, New York, USA. 1962

**Barrow, Isaac** 1630–77

English clergyman and mathematician

[Mathematicians] only take those things into consideration, of which they have clear and distinct ideas, designating them by proper, adequate, and invariable names, and premising only a few axioms which are most noted and certain to investigate their affections and draw conclusions from them, and agreeably laying down a very few hypotheses, such as are in the highest degree consonant with reason and not to be denied by anyone in his right mind. In like manner they assign generations or causes easy to be understood and readily admitted by all, they preserve a most accurate order, every proposition immediately following from what is supposed and proved before, and reject all things howsoever specious and probable which can not be inferred and deduced after the same manner.

*Mathematical Lectures*

Lecture IV (p. 65)

Printed for Stephen Austen. London, England. 1734

It may be observed of mathematicians that they only meddle with such things as are certain, passing by those that are doubtful and unknown. They profess not to know all things, neither do they affect to speak of all things. What they know to be true, and can make good by invincible arguments, that they publish and insert among their theorems. Of other things they are silent and pass no judgment at all, choosing rather to acknowledge their ignorance, than affirm anything rashly.

*Mathematical Lecture*

Lecture IV (p. 64)

Printed for Stephen Austen. London, England. 1734

An accomplished mathematician, *i.e.* a most wretched orator.

*Mathematical Lectures* (p. 32)

The Prefatory Oration (p. xxxii)

Printed for Stephen Austen. London, England. 1734

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

That wretched monosyllable “all” has caused mathematicians more trouble than all the rest of the dictionary.

*The Queen of the Sciences*

Chapter X (p. 134)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

The mathematician is a much rarer character in fiction than his cousin the scientist, and when he does appear in the pages of a novel or on the screen he is only too apt to be a slovenly dreamer totally devoid of common sense — comic relief.

*Men of Mathematics* (p. 8)

Simon & Schuster. New York, New York, USA. 1937

Fools have always been governed by fools and doubtless always will be, but not all scientists and mathematicians are yet fools.

*Mathematics: Queen and Servant of Science*

Points of View (p. 13)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Experience has taught most mathematicians that much that looks solid and satisfactory to one mathematical generation stands a fair chance of dissolving into cobwebs under the steadier scrutiny of the next...

In Morris Kline

*Mathematics: The Loss of Certainty*

Chapter XI (p. 257)

Oxford University Press, Inc. New York, New York, USA. 1980

When a complicated mathematical argument ends in a spectacular prediction, subsequently verified by observation or experiment, a physicist may be excused for feeling that he has participated in a miracle. And then a skilled mathematician astounds himself with a discovery he had no conscious intention of striving after, he may well believe for a few moments as Pythagoras believed all his life, and may even repeat — after the eminent English

mathematician, G.H. Hardy — the following confession of faith. [I believe that mathematical reality lies outside us, that our function is to discover or observe it, and that the theorems which we prove, and which we describe grandiloquently as our ‘creations’ are simply our notes of our observations.]

*The Magic of Numbers*

Chapter 1 (p. 8)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

Mathematicians are not, as a rule, credulous; their clients almost invariably are.

*Mathematics: Queen and Servant of Science*

Choice and Chance (p. 381)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

Mathematicians may safely be left to follow their own bent as their contributions to this age of science. What they did in the past century is enough for a vast region of science and technology as they exist today; what mathematicians as professionals are interested in today will, if there is any continuity at all in scientific and industrial history, be the indispensable framework of the science and technology of tomorrow.

*The Queen of the Sciences*

Chapter VI (p. 83)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

If mathematics is indeed the science of self-evident things, mathematicians are a phenomenally stupid lot to waste the tons of good paper they do in proving the fact.

*Mathematics: Queen and Servant of Science*

Mathematical Truth (p. 20)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Bernoulli, Daniel** 1700–82

Swiss mathematician

...there is no philosophy which is not founded upon knowledge of the phenomena, but to get any profit from this knowledge it is absolutely necessary to be a mathematician.

In C. Truesdell

*Essays in the History of Mechanics*

Chapter VII (p. 318)

Springer-Verlag, Inc. New York, New York, USA. 1968

**Black, Max** 1909–88

Anglo-American philosopher

...a result once generally accepted by mathematicians is seldom retracted, and then only with great pangs.

*The Nature of Mathematics: A Critical Survey*

Section III (p. 169)

Routledge & Kegan Paul. London, England. 1933

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

A mathematician will recognize Cauchy, Gauss, Jacobi, of Helmholtz after reading a few pages, just as musicians

recognize, from the first few bars, Mozart, Beethoven, or Schubert.

In Arthur Koestler

*The Act of Creation*

Book One, Part Two, Chapter XI (p. 265)

The Macmillan Company. New York, New York, USA. 1964

**Bonaparte, Napoleon** 1769–1821

French soldier and emperor of France

Lagrange is the lofty pyramid of the mathematical sciences.

In E.T. Bell

*Men of Mathematics* (p. 153)

Simon & Schuster. New York, New York, USA. 1937

**Bourbaki, Nicholas**

Mathematical discussion group leader

For twenty-five centuries mathematicians have been in the habit of correcting their errors — and seeing their science enriched rather than impoverished thereby. This gives them the right to contemplate the future with serenity.

In Lucienne Felix

*The Modern Aspect of Mathematics* (p. 33)

Basic Books. New York, New York, USA. 1960

Many mathematicians take up quarters in a corner of the domain of mathematics, which they do not intend to leave; not only do they ignore almost completely what does not concern their special field, but they are unable to understand the language and the terminology used by colleagues who are working in a corner remote from their own. Even among those who have the widest training, there are none who do not feel lost in certain regions of the immense world of mathematics; those who, like Poincaré or Hilbert, put the seal of their genius on almost every domain, constitute a very great exception even among the men of greatest accomplishment.

In Morris Kline

*Mathematics: The Loss of Certainty*

Chapter XIII (p. 284)

Oxford University Press, Inc. New York, New York, USA. 1980

**Boyd, William Andrew Murray** 1952–

Writer

The natural world is full of irregularity and random alteration, but in the antiseptic, dust-free, shadowless, brightly lit, abstract realm of the mathematicians they like their cabbages spherical, please.

*Brazzaville Beach: A Novel*

Cabbages Are Not Spheres (p. 86)

William Morrow. New York, New York, USA. 1990

**Buchanan, Scott** 1895–1968

American educator and philosopher

The mathematician has again been lured to an adventure with a symbolic hobbyhorse and has discovered new routes to the absolute or infinite.

*Poetry and Mathematics*

Chapter VIII

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Poets do not go mad; but chess-players do. Mathematicians go mad, and cashiers; but creative artists very seldom.

*Orthodoxy*

Chapter II (p. 27)

John Lane Company. New York, New York, USA. 1918

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

Mathematics is written for mathematicians...

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Preface and Dedication to Pope Paul III (p. 509)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Courant, Richard** 1888–1972

German-born American mathematician

It becomes the urgent duty of mathematicians, therefore, to mediate about the essence of mathematics, its motivations and goals and the ideas that must bind divergent interests together.

Mathematics in the Modern World

*Scientific American*, Volume 211, Number 3, September 1964 (p. 42)

**Crick, Francis Harry Compton** 1916–2004

English biochemist

...in my experience most mathematicians are intellectually lazy and especially dislike reading experimental papers.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 12 (p. 136)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Let no one read me who is not a mathematician in my beginnings.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Philosophy (p. 95)

George Braziller. New York, New York, USA. 1958

In order to make trial of anyone and see whether he has a true judgment as to the nature of weights, ask him at what point one ought to cut one of the two equal arms of the balance so as to cause the part cut off, attached to the extremity to its remainder, to form with precision a counterpoise to the opposite arm. The thing is never possible, and if he gives you the position, it is clear that he is a poor mathematician.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 2)



Experiments (p. 788)  
George Braziller. New York, New York, USA. 1958

**Dantzig, Tobias** 1884–1956  
Russian mathematician

The mathematician may be compared to a designer of garments, who is utterly oblivious of the creatures who his garments may fit. To be sure, his art originated in the necessity for clothing such creatures, but this was long ago; to this day a shape will occasionally appear which will fit into the garment as if the garment had been made for it. Then there is no end of surprise and of delight.

*Number: The Language of Science* (4<sup>th</sup> edition)  
Chapter Twelve, 2 (pp. 231–232)  
The Macmillan Company. New York, New York, USA. 1954

**Darwin, Charles Galton** 1887–1962  
English physicist and administrator

A mathematician is a blind man in a dark room looking for a black hat which isn't there.

In Fort Tomlinson  
Mathematics and the Sciences  
*The American Mathematical Monthly*, Volume 47, Number 9, November 1940 (p. 606)

**Davis, Philip J.** 1923–  
American mathematician

**Hersh, Reuben** 1927–  
American mathematician

The ideal mathematician's work is intelligible only to a small group of specialists, numbering a few dozen or at most a few hundred. This group has existed for only a few decades, and there is every possibility that it may become extinct in another few decades. However, the mathematician regards his work as part of the very structure of the world, containing truths that are valid forever, from the beginning of time, even in the most remote corner of the universe.

*The Mathematical Experience*  
The Ideal Mathematician (p. 38)  
Birkhäuser. Boston, Massachusetts, USA. 1981

**Day-Lewis, Cecil** 1904–72  
Irish poet

They say that a mathematician  
Once fell to such a passion  
For x and y, he locked  
His door to keep outside  
Whatever might distract  
Him from his heavenly bride:  
And presently died  
In the keenest of blisses  
With a dozen untasted dishes  
Outside his door.

*Collected Poems 1929–1933*  
Transitional Poem, Part II, 16, 1.  
Virginia Woolf at the Hogarth Press. London, England. 1935

**de Fontenelle, Bernard le Bovier** 1657–1757  
French author

...it was the business of the Sorbonne to discuss; of the Pope to decide; and of the mathematician to go to heaven in a perpendicular line.

In Dugald Stewart  
*The Collected Works of Dugald Stewart* (Volume 4)  
Part Third, Chapter I, Section 3 (p. 203)  
T & T Clark. Edinburgh, Scotland. 1877

...grant a mathematician but one minute principle, he immediately draws a consequence from it, to which you must necessarily assent; and from this consequence another, till he leads you so far (whether you will or no) that you have much ado to believe all he has proved, and what you have already assented to.

*Conversations on the Plurality of Worlds*  
The Fifth Evening (p. 156)  
Printed for Peter Wilson. Dublin, Ireland. 1761

**de Morgan, Augustus** 1806–71  
English mathematician and logician

We know that mathematicians care no more for logic than logicians for mathematics. The two eyes of exact science are mathematics and logic: the mathematical sect puts out the logical eye, the logical sect puts out the mathematical eye, each believing that it can see better with one eye than with two.

In Florian Cajori  
*A History of Mathematics* (p. 316)  
Macmillan & Company Limited. London, England. 1905

**Dieudonné, Jean** 1906–92  
French mathematician and educator

...there is no criterion for appreciation which does not vary from one epoch to another and from one mathematician to another.... These divergences in taste recall the quarrels aroused by works of art, and it is a fact that mathematicians often discuss among themselves whether a theorem is more or less "beautiful." This never fails to surprise practitioners of other sciences: for them the sole criterion is the "truth" of a theory or formula.... Other criteria are therefore necessary to evaluate mathematical work, and these are unavoidably subjective, a fact which makes some people say that mathematics is much more an art than a science.

*Mathematics — The Music of Reason*  
Chapter II, Section 2 (p. 28)  
Springer-Verlag. Berlin, Germany. 1992

**Doxiadis, Apostolos** 1913–75  
Greek filmmaker and former mathematician

As for mathematicians themselves: don't expect too much help. Most of them are too far removed in their ivory towers to take up such challenges. And anyway, they are not competent. After all, they are just mathematicians — what we need is paramathematicians, like you....

It is you who can be the welding force, between mathematicians and stories, in order to achieve the synthesis.

Opening address to the Third Mediterranean Conference on Mathematics Education  
January 3, 2003

**Dyson, Freeman J.** 1923–

American physicist and educator

On being asked what he meant by the beauty of a mathematical theory of physics, Dirac replied that if the questioner was a mathematician then he did not need to be told, but were he not a mathematician then nothing would be able to convince him of it.

In John D. Barrow

*Theories of Everything: The Quest for Ultimate Explanation*

Chapter Two (p. 16, fn)

The Clarendon Press. Oxford, London. 1991

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...it is obvious that the moon and the mathematician use different methods of finding the lunar orbit.

*The Nature of the Physical World*

Chapter XII (p. 258)

The Macmillan Company. New York, New York, USA. 1930

**Egrafov, M.**

No biographical data available

If you ask mathematicians what they do, you always get the same answer. They think. They think about difficult and unusual problems. They do not think about ordinary problems: they just write down the answers.

*Mathematics Magazine*, Volume 65, Number 5, December 1992 (p. 301)

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Every man who is not a monster, a mathematician, or a mad philosopher, is the slave of some woman or other.

*Scenes of Clerical Life*

The Sad Fortunes of the Rev. Amos Barton

Part I, Chapter iv (p. 19)

Harper & Brothers. New York, New York, USA. 1858

**Escher, M. C.** 1898–1972

Dutch graphic artist

Although I am absolutely innocent of training or knowledge in the exact sciences, I often seem to have more in common with mathematicians than with my fellow artists.

In Stanley Gudder

*A Mathematical Journey* (p. 94)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Faraday, Michael** 1791–1867

English physicist and chemist

There is one thing I would be glad to ask you. When a mathematician engaged in investigating physical actions

and results has arrived at his conclusions may they not be expressed in common language as fully, clearly, and definitely as in mathematical formulae? If so, would it not be a great boon to such as I to express them so? — translating them out of their hieroglyphics, that we also might work upon them by experiment. I think it must be so, because I have always found that you could convey to me a perfectly clear idea of your conclusions, which though they may give me no full understanding of the steps of your process, give me the results neither above nor below the truth, and so clear in character that I can think and work from them. If this be possible, would it not be a good thing if mathematicians, working on these subjects, were to give us the results in this popular, useful, working state, as well as in that which is their own and proper to them?

In D.K.C. MacDonald

*Faraday, Maxwell and Kelvin* (p. 79)

Anchor Press. Garden City, New York, USA. 1964

**Flammarion, Camille** 1842–1925

French astronomer and author

Mathematicians, whose tempers are generally intolerable, are perhaps psychologically excusable, for the constant tension of their mind is, perhaps, the cause of their bad digestion and their state of hypochondria.

*Popular Astronomy: A General Description of the Heavens*

Book IV, Chapter II (fn, pp. 346–347)

Chatto & Windus. London, England. 1894

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

It may be true that men who are mere mathematicians, have certain specific shortcomings, but that is not the fault of mathematics, for it is equally true of every other exclusive occupation. So there are mere philologists, mere jurists, mere soldiers, mere merchants, etc. To such idle talk it might further be added: that whenever a certain exclusive occupation is coupled with specific shortcomings, it is likewise almost certainly divorced from certain other shortcomings.

*Gauss-Schumacher Briefwechsel*

Bd. 4, Altoma, 1862 (p. 387)

Publisher undetermined

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

The mathematician requires tact and good taste at every step of his work, and he has to learn to trust to his own instinct to distinguish between what is really worthy of his efforts and what is not.

Presidential Address, British Association for the Advancement of Science

*Nature*, Section A, Volume 42, Number 1089, September 11, 1890 (p. 467)

**Gowers, Timothy** 1963–

English mathematician

...a mathematician is more anonymous than an artist. While we may greatly admire a mathematician who discovers a beautiful proof, the human story behind the discovery eventually fades away and it is, in the end, the mathematics itself that delights us.

*Mathematics: A Very Short Introduction*

Chapter 8 (p. 138)

Oxford University Press, Inc. Oxford, England. 2002

### Graham, L. A.

No biographical data available

A mathematician named Ray

Says extraction of cubes is child's play.

You don't need equations

Or long calculations

Just hot water to run on the tray.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 14

Dover Publications, Inc. New York, New York, USA. 1959

### Guillen, Michael

Theoretical physicist

[Mathematicians] might actually be looking at life with a most trenchant sense — one that perceives things the other five senses cannot.

*Bridges to Infinity: The Human Side of Mathematics*

Introduction (p. 7)

Jeremy P. Tarcher, Inc. Los Angeles, California. USA. 1983

### Hammersley, J.

No biographical data available

People do acquire a little brief authority by equipping themselves with jargon: they can pontificate and air a superficial expertise. But what we should ask of educated mathematicians is not what they can speechify about, nor even what they know about the existing corpus of mathematical knowledge, but rather what can they now do with their learning and whether they can actually solve mathematical problems arising in practice. In short, we look for deeds not words.

In *Institute of Mathematics and Its Applications*

On the Enfeeblement of Mathematical Skills by "Modern Mathematics" and by Similar Soft Intellectual Trash in Schools and Universities

*Bulletin of the Institute of Mathematics and its Applications*, Volume 4, Number 4, October 1968

### Hardenberg, Friedrich von 1772–1801

German poet and novelist

The mathematicians are the only happy ones. He who does not reach for a mathematical book with devotion and read it as the word of God does not understand it.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Introduction (p. 18)

The Macmillan Company. New York, New York, USA. 1967

### Hardy, G. H. (Godfrey Harold) 1877–1947

English pure mathematician

The case for my life, then, or for that of any one else who has been a mathematician in the same sense in which I have been one, is this: that I have added something to knowledge, and helped others to add more; and that these somethings have a value which differs in degree only, and not in kind, from that of the creations of the great mathematicians, or of any of the other artists, great or small, who have left some kind of memorial behind them.

*A Mathematician's Apology*

Chapter 29 (p. 151)

Cambridge University Press. Cambridge, England. 1967

No mathematician should ever allow himself to forget that that mathematics, more than any other art or science, is a young man's game.

*A Mathematician's Apology*

Chapter 4 (p. 70)

Cambridge University Press. Cambridge, England. 1967

But is not the position of an ordinary applied mathematician in some ways a little pathetic? If he wants to be useful, he must work in a humdrum way, and he cannot give full play to his fancy even when he wishes to rise to the heights. "Imaginary" universes are so much more beautiful than this stupidly constructed "real" one; and the finest products of an applied mathematician's fancy must be rejected, as soon as they have been created, for the brutal but sufficient reason that they do not fit the facts.

*A Mathematician's Apology*

Chapter 26 (p. 135)

Cambridge University Press. Cambridge, England. 1967

Archimedes will be remembered when Aeschylus is forgotten, because languages die and mathematical ideas do not. "Immortality" may be a silly word, but probably a mathematician has the best chance of whatever it may mean.

*A Mathematician's Apology*

Chapter 8 (p. 81)

Cambridge University Press. Cambridge, England. 1967

If a man is in any sense a real mathematician, then it is a hundred to one that his mathematics will be better than anything else he can do, and that he would be silly if he surrendered any decent opportunity of exercising his one talent in order to do undistinguished work in other fields.

*A Mathematician's Apology*

Chapter 3 (p. 70)

Cambridge University Press. Cambridge, England. 1967

It is a melancholic experience for a professional mathematician to find himself writing about mathematics. The function of a mathematician is to do something, to prove new theorems, to add to mathematics, and not to talk about what he or other mathematicians have done...there is no scorn more profound, or on the whole more justifiable, than that of the men who make for the men who explain. Exposition, criticism, appreciation, is work for second-rate minds.

*A Mathematician's Apology*

Chapter 1 (p. 61)

Cambridge University Press. Cambridge, England. 1967

...*reductio ad absurdum*... is one of a mathematician's finest weapons. It is a far finer gambit than any chess gambit: a chess player may offer the sacrifice of a pawn or even a piece, but the mathematician offers the game.

*A Mathematician's Apology*

Chapter 12 (p. 94)

Cambridge University Press. Cambridge, England. 1967

A MATHEMATICIAN, like a painter or a poet, is a maker of patterns. If his patterns are more permanent than theirs it is because [his] are made with ideas. A Painter makes patterns with shapes and colours, a poet with words... A mathematician, on the other hand, has no material to work with but ideas, and so his patterns are likely to last longer...

*A Mathematician's Apology*

Chapter 10 (p. 84)

Cambridge University Press. Cambridge, England. 1967

**Hayes, Brian**

American scientist, columnist, and author

Dead diatoms are becoming rare elsewhere in the academic world, but mathematicians are still expected to be masters of blackboard technique.

Aftermath

*The Emissary*, Fall 1999 (p. 12)**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Even Cambridge mathematicians deserve justice.

In Harold Jeffreys and Bertha Swirles

*Methods of Mathematical Physics*

Chapter 7 (p. 228)

At The University Press. Cambridge, England. 1962

But it is perhaps too much to expect a man to be both the prince of experimentalists and a competent mathematician.

*Electromagnetic Theory*

Chapter I, Volume I (p. 14)

"The Electrician" Publishing &amp; Printing Company. London, England.

1894–1912

**Hughes, Richard** 1900–76

British author

Science, being human enquiry, can hear no answer except an answer couched somehow in human tones. Primitive man stood in the mountains and shouted against a cliff; the echo brought back his own voice and he believed it a disembodied spirit. The scientists of today stands counting out loud in the face of the unknown. Numbers come back to him — and he believes in the Great Mathematician.

In Jefferson Hane Weaver

*The World of Physics* (Volume 3)

X.3 (p. 597)

Simon &amp; Schuster. New York, New York, USA. 1987

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

A mathematician is a savant only on condition that he be also a sage.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 416)

The Heritage Press. New York, New York, USA. 1961

**Huxley, Thomas Henry** 1825–95

English biologist

The Mathematician deals with two properties of objects only, number and extension, and all the inductions he wants have been formed and finished ages ago. He is now occupied with nothing but deductions and verification.

*Lay Sermons, Addresses and Reviews* (p. 87)

D. Appleton &amp; Company. New York, New York, USA. 1872

**Inge, William Ralph** 1860–1954

English religious leader and author

A mathematician, it has been suggested, might pray to  $x^n$ .

*A Rustic Moralist*

Preface (p. 7)

G.P. Putnam's Sons. New York, New York, USA. 1937

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

The mathematician is still regarded as the hermit who knows little of the ways of life outside his cell, who spends his time compounding incredible and incomprehensible theorems in a strange, clipped, unintelligible jargon.

*Mathematics and the Imagination*

Introduction (p. xiii)

Simon &amp; Schuster. New York, New York, USA. 1940

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Let us then hear no more nonsense about the interference of mathematicians in matters with which they have no concern; rather let them be lauded for condescending from their proud preeminence to help out of a rut the too ponderous wagon of some scientific brother.

In Joe D. Burchfield

*Lord Kelvin and the Age of the Earth*

Chapter IV (p. 93)

The University of Chicago Press. Chicago, Illinois, USA. 1990

**Keyser, Cassius Jackson** 1862–1947

American mathematician

To think the thinkable — that is the mathematician's aim.

*The Universe and Beyond**Hibbert Journal*, Volume 3, 1904–1905 (p. 312)

**King, Jerry P.**

American mathematician

A mathematician, like everyone else, lives in the real world. But the objects with which he works do not. They live in that other place — the mathematical world. Something else lives here also. It is called truth.

*The Art of Mathematics*

Chapter 2 (p. 29)

Plenum Press. New York, New York, USA. 1992

A mathematician, however, almost always works alone... When a mathematician works at mathematics he sits alone in his study staring at equations scribbled on his blackboard or at a dog-eared reprint of the research paper whose results he is trying to extend. It is quiet work, like writing poetry, and includes lots of “dead time” when the mathematician, like the poet, does nothing but sit and stare at the blank page. When you walk in on a research mathematician and find him reclining with his feet up, gazing wistfully out the window, what you say is: “Sorry, I didn’t know you were working.” Because he probably is.

*The Art of Mathematics*

Chapter 2 (pp. 36–37)

Plenum Press. New York, New York, USA. 1992

**Kline, Morris** 1908–92

American mathematics professor and writer

Mathematicians create by acts of insight and intuition. Logic then sanctions the conquests of intuition. It is the hygiene that mathematics practice to keep its ideas healthy and strong. Moreover, the whole structure rests fundamentally on uncertain ground, the intuitions of man. Here and there an intuition is scooped out and replaced by a firmly built pillar of thought; however, this pillar is based on some deeper, perhaps less clearly defined intuition. Though the process of replacing intuitions by precise thoughts does not change the nature of the ground on which the mathematics ultimately rests, it does add strength and height to the structure.

*Mathematics in Western Culture*

Chapter XXV (p. 408)

Oxford University Press, Inc. New York, New York, USA. 1953

Mathematicians have always constituted a clannish, elitist, snobbish, highly individualistic community in which status is determined, above all, by the presumed importance or original contributions to mathematics; and in which the greatest rewards are bestowed upon those who, at least in the opinion of their peers, will leave a permanent mark on its evolution.

*Why the Professor Can't Teach: Mathematics and the Dilemma of University Education*

Chapter 11 (p. 240)

St. Martin's Press. New York, New York, USA. 1977

Mathematicians respond to intellectual challenge much as businessmen do to the excitement of making money. They

enjoy the fascination of the quest, the sense of adventure, the thrill of discovery, the satisfaction of mastering difficulties, the pride and glory of achievement — or, if one wishes, the exaltation of the ego and the intoxication of success.

*Why the Professor Can't Teach: Mathematics and the Dilemma of University Education*

Chapter 6 (p. 129)

St. Martin's Press. New York, New York, USA. 1977

**Krantz, Steven** 1951–

Mathematician

A mathematician experiments, amasses information, makes a conjecture, finds out that it does not work, gets confused and then tries to recover. A good mathematician eventually does so — and proves a theorem.

*Conformal Mappings**American Scientist*, Sept.–Oct. 1999 (p. 445)**Lakatos, Imre** 1922–74

Hungarian-born philosopher

On the face of it there should be no disagreement about mathematical proof. Everybody looks enviously at the alleged unanimity of mathematicians; but in fact there is a considerable amount of controversy in mathematics. Pure mathematicians disown the proofs of applied mathematicians, while logicians in turn disavow those of pure mathematicians. Logicians disdain the proofs of formalists and some intuitionists dismiss with contempt the proofs of logicians and formalists.

*Mathematics, Science and Epistemology* (Volume 2)

Chapter 4 (p. 61)

Cambridge University Press. Cambridge, England. 1978

**Langer, Susanne Knauth** 1895–1985

American philosopher

Mathematicians are rarely practical people, or good observers of events. They are apt to be cloistered souls, like philosophers and theologians.

*Philosophy in a New Key*

Chapter 1 (p. 19)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Lavoisier, Antoine Laurent** 1743–94

French chemist

...mathematicians obtain the solution of a problem by the mere arrangement of data, and by reducing their reasoning to such simple steps, to conclusions so very obvious, as never to lose sight of the evidence which guides them.

*Elements of Chemistry In a New Systematic Order*

Preface of the Author (p. xviii)

Printed for William Creech. Edinburgh, Scotland. 1790

**Lebesgue, Henri** 1875–1941

French mathematician

Mathematicians have never been in full agreement on their science, though it is said to be the science of self-evident

verities — absolute, indisputable and definitive. They have always been in controversy over the developing aspects of mathematics, and they have always considered their own age to be a period of crisis.

In Lucienne Felix

*The Modern Aspect of Mathematics* (p. 3)

Basic Books. New York, New York, USA. 1960

In my opinion a mathematician, in so far as he is a mathematician, need not preoccupy himself with philosophy — an opinion, moreover, which has been expressed by many philosophers.

In E.T. Bell

*Men of Mathematics* (p. xvii)

Simon & Schuster. New York, New York, USA. 1937

**Lehmer, Derrick Henry** 1905–1991

American mathematician

**Lebesgue, Henri** 1875–1941

French mathematician

The real difficulty lies in the fact that only a finite number of angels can dance on the head of a pin, whereas the mathematician is more apt to be interested in the infinite angel problem only.

Mechanized Mathematics

*Bulletin of the American Mathematical Society*, Volume 72, Number 5,

September 1966 (p. 744)

**Lewis, Sinclair** 1885–1951

American novelist

“The regularity of the rate at which the streptolysin disappears suggests that an equation may be found.”

“Then why did you not make the equation?”

“Well — I don’t know. I wasn’t enough of a mathematician.”

“Then you should not have published till you knew your math!”

*Arrowsmith*

Chapter XXVI, Section I (p. 288)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Locke, William John** 1863–1930

Novelist and short story writer

Now all the world understands the irresistible force that compels the poet, at last, to give form to long haunting dreams; the need, also, of the astronomer to crystallize the results of his discoveries and formulate his epoch-making theories; but the passion of the mathematician to do the same is not so easily comprehensible. For years Baltazar had dreamed of an exhaustive and monumental treatise on the Theory of Groups which would revolutionize the study of the higher mathematics, a gorgeous vision, the mere statement of which must leave the ordinary being cold and the first attempt at explanation petrify him with its icy unintelligibility.

*The House of Baltazar*

Chapter IV (p. 47)

John Lane. London, England. 1920

**Lodge, Sir Oliver** 1851–1940

English physicist

It is undeniable that mathematicians, with a self-denying ordinance about coefficients, can thus attain remarkable criteria, and are able to anticipate definite results; but we need not seek to engraft their modes of expression on the real world of physics.

Geometrization of Physics, and Its Supposed Bias on the

Michelson–Morley Experiment

*Nature*, Volume 106, Number 2677, February 17, 1921 (p. 798)

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Mathematicians are reputed to be rare and special people, exulting in the exercise of a gift far beyond the performance, and perhaps even the conception, of ordinary people.

*The Limits of Science*

An Essay on Scians [Science] (p. 9)

Harper & Row, Publishers. New York, New York, USA. 1984

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Even if we admit that mathematicians are of great value to the world, the fact remains that there are many charlatans (*circulatores*) among them. They talk too much of their discoveries, and nothing grieves them more than to see some other mathematician get ahead of them. How vast is their joy when they solve a problem within the time limits set by him who posited it! They use up every ounce of their energy in that struggle for fame.

In Johann B. Mencke

*The Charlatanry of the Learned*

Lecture II, fn 74 (p. 152)

Alfred A. Knopf. New York, New York, USA. 1937

**Mordell, Louis Joel** 1888–1972

English mathematician

No one will get very far or become a real mathematician without certain indispensable qualities. He must have hope, faith, and curiosity, and prime necessity is curiosity.

*Reflections of a Mathematician*

Chapter II (p. 7)

Canadian Mathematical Congress. 1959

**Morley, Christopher** 1890–1957

American writer

Sweep the pale hair, like wings, above the ears;

Whittle the nose, and carve and bone the jaw;

Blank the studying eyes, till human fears

Eliminate in universal law.

Slack the mortal shirt, stiffen the hands,

Holding the dear old pipe, half-smoked, unlit —  
So, lovingly, we loose Orion's Bands

And write equation with the Infinite.

*The Ballad of New York, New York, and Other Poems 1930–1956*

Portrait of a Mathematician

Doubleday & Company, Inc. Garden City, New York, USA. 1950

**Morton, Henry Vollam** 1892–1979

English travel writer

In the dusk of a lane I met a shepherd with his sheep.  
A small dog with the expression of a professor of mathematics does all the work.

*In Search of Scotland*

Chapter 1, Section 3 (p. 8)

Methuen & Company Ltd. London, England. 1949

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

Mathematicians that find out, settle & do all the business must content themselves with being nothing but dry calculators and drudges & another that does nothing but pretend and grasp at all things must carry away all the invention...

*Lives of Eminent Persons*

Letter to Edmund Halley, 20 June, 1686 (p. 21)

Society for the Diffusion of Useful Knowledge. Great Britain. 1833

...if instead of sending the Observations of seamen to able Mathematicians at Land, the Land would send able Mathematicians to Sea, it would signify much more to the improvement of Navigation and safety of Men's lives and estates on the alimant.

In E.G.R. Taylor

*The Mathematical Practitioners of Tudor & Stuart England* (p. 119)

At the University Press. Cambridge, England. 1954

**Pascal, Blaise** 1623–62

French mathematician and physicist

Mathematicians who are only mathematicians have exact minds, provided all things are explained to them by means of definitions and axioms; otherwise they are inaccurate and insufferable, for they are only right when the principles are quite clear.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 1

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pearson, Karl** 1857–1936

English mathematician

The mathematician, carried along on his flood of symbols, dealing apparently with purely formal truths, may still reach results of endless importance for our description of the physical universe.

In John N. Shive and Robert L. Weber

*Similarities in Physics*

Chapter 6 (p. 58)

John Wiley & Sons, Inc. New York, New York, USA. 1982

**Perfect, D. C.**

No biographical data available

Said a mathematician (age 7)

“Shall I ever get into Heaven

If I cannot tell why

hc/p

$2e^2$  must be 137?”

*The Observatory*, Volume 73, Number 216, 1953

**Plato** 428 BCE–347 BCE

Greek philosopher

I have hardly ever known a mathematician who was capable of reasoning.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 531 (p. 397)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The mathematician does not study pure mathematics because it is useful; he studies it because he delights in it and he delights in it because it is beautiful.

In H.E. Huntley

*The Divine Proportion: A Study in Mathematical Beauty*

Introduction (p. 1)

Dover Publications. New York, New York, USA. 1970

Mathematicians do not deal in objects, but in relations between objects; thus, they are free to replace some objects by others so long as the relations remain unchanged. Content to them is irrelevant: they are interested in form only.

In Tobias Dantzig

*Number: The Language of Science* (4<sup>th</sup> edition)

Chapter D (p. 317)

The Macmillan Company. New York, New York, USA. 1954

A scientist worthy of the name, above all a mathematician, experiences in his work the same impressions as an artist; his pleasure is as great and of the same nature.

In Stanley Gudder

*A Mathematical Journey* (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Pólya, George** 1887–1985

Hungarian mathematician

The mathematician as the naturalist, in testing some consequence of a conjectural general law by a new observation, addresses a question to Nature: “I suspect that this law is true. Is it true?” If the consequence is clearly refuted, the law cannot be true. If the consequence is clearly verified, there is some indication that the law may be true. Nature may answer Yes or No, but it whispers one answer and thunders the other, its Yes is provisional, its No is definitive.

*Induction and Analogy in Mathematics* (Volume 1)

Chapter I (p. 10)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Pringsheim, Alfred** 1850–1941  
German mathematician

The true mathematician is always a great deal of an artist, an architect, yes, of a poet. Beyond the real world, though perceptibly connected with it, mathematicians have created an ideal world which they attempt to develop into the most perfect of all worlds, and which is being explored in every direction. None has the faintest conception of this world except him who knows it; only presumptuous ignorance can assert that the mathematician moves in a narrow circle. The truth which he seeks is, to be sure, broadly considered, neither more nor less than consistency; but does not his mastership show, indeed, in this very limitation? To solve questions of this kind he passes unenviably over others. *Jahresberichte der Deutschen Mathematiker Vereinigung*, Volume 13, 1904 (p. 381)

A mathematician's work is mostly a tangle of guesswork, analogy, wishful thinking and frustration, and proof, far from being the core of discovery, is more often than not a way of making sure that our minds are not playing tricks. In Philip J. Davis and Reuben Hersh  
*The Mathematical Experience*  
Introduction (p. xviii)  
Birkhäuser. Boston, Massachusetts, USA. 1981

**Reid, Constance**  
Mathematical biographer

The answer to the question Can there be a general method for solving all mathematical problems? is no!

Perhaps, in a world of unsolved and apparently unsolvable problems, we would have thought that the desirable answer to this question from any point of view, would have been yes. But from the point of view of mathematicians a yes would have been far less satisfying than a no is. Not only are the problems of mathematics infinite and hence inexhaustible, ...mathematics itself is inexhaustible. *Introduction to Higher Mathematics for the General Reader* (p. 180)  
Thomas Y. Crowell. New York, New York, USA. 1959

Mathematics is a world created by the mind of man, and the mathematicians are people who devote their lives to what seems to me a wonderful kind of play!  
In G.L. Anderson  
An Interview with Constance Reid  
*Two Year College Mathematical Journal*, Volume 11, 1980 (p. 238)

**Reid, Thomas** 1710–96  
Scottish philosopher

The mathematician pays not the least regard either to testimony or conjecture, but deduces everything by demonstrative reasoning, from his definitions and axioms. Indeed, whatever is built upon conjecture, is improperly called science; for conjecture may beget opinion, but cannot produce knowledge.

*Essays on the Intellectual Powers of Man*  
Essay I, Chapter III (p. 46)  
Printed for John Bell. London, England. 1785

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

Philosophers and psychiatrists should explain why it is that we mathematicians are in the habit of systematically erasing our footsteps. Scientists have always looked askance at this strange habit of mathematicians, which has changed little from Pythagoras to our day. Two Turning Points in Invariant Theory  
*The Mathematical Intelligencer*, 21(1) Winter 1999 (p. 26)

Mathematicians have to attend (secretly) physics meetings in order to find out what is going on in their fields. Physicists have the P.R., the savoir-faire, and the chutzpah to write readable, or at least legible accounts of subjects that are not yet obsolete, something few mathematicians would dare to do, fearing expulsion from the A.M.S. *Indiscrete Thoughts*  
Chapter XX (p. 215)  
Birkhäuser. Boston, Massachusetts, USA. 1997

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

The main source of mathematical invention seems to be within man rather than outside of him: his own inveterate and insatiable curiosity, his constant itching for intellectual adventure; and likewise the main obstacles to mathematical progress seem to be also within himself; his scandalous inertia and laziness, his fear of adventure, his need of conformity to old standards, and his obsession by mathematical ghosts. *The Study of the History of Mathematics*  
The Study of the History of Mathematics (p. 16)  
Dover Publications, Inc. New York, New York, USA. 1936

The concatenations of mathematical ideas are not divorced from life, far from it, but they are less influenced than other scientific ideas by accidents, and it is perhaps more possible, and more permissible, for a mathematician than for any other man to secrete himself in a tower of ivory. *The Study of The History of Mathematics*  
The Study of the History of Mathematics (pp. 19–20)  
Dover Publications, Inc. New York, New York, USA. 1936

Mathematicians and other scientists, however great they may be, do not know the future. Their genius may enable them to project their purpose ahead of them; it is as if they had a special lamp, unavailable to lesser men, illuminating their path; but even in the most favorable cases the lamp sends only a very small cone of light into the infinite darkness. *The Study of the History of Mathematics*  
The Study of the History of Mathematics (pp. 17–18)  
Dover Publications, Inc. New York, New York, USA. 1936



The main duty of the historian of mathematics, as well as his fondest privilege, is to explain the humanity of mathematics, to illustrate its greatness, beauty and dignity, and to describe how the incessant efforts and accumulated genius of many generations have built up that magnificent monument, the object of our most legitimate pride as men, and of our wonder, humility, and thankfulness, as individuals. The study of the history of mathematics will not make better mathematicians but gentler ones, it will enrich their minds, mellow their hearts, and bring out their finer qualities.

*The American Mathematical Monthly*, Volume 102, Number 4, April 1995 (p. 369)

### Serge, Corrado

No biographical data available

[A] mathematician can not be really content with a result which he has obtained by non-rigorous methods; he will not feel sure of it until he has rigorously proved it. But he will not reject summarily these imperfect methods in the case of difficult problems when he is unable to substitute better ones, since the history of the science precisely shows what service such methods have always rendered.

On Some Tendencies in Geometric Investigations

*Bulletin of the American Mathematical Society*, 2<sup>nd</sup> Series, Volume 10, June 1904 (pp. 453–454)

### Shchatunovskii, Samuil

No biographical data available

It is not the job of mathematicians...to do correct arithmetical operations. It is the job of bank accountants.

In George Gamow

*My World Line: An Informal Autobiography*

Chapter 1 (p. 24)

The Viking Press. New York, New York, USA. 1979

### Shulman, Milton 1925–

Canadian writer and journalist

I knew a mathematician who said, “I do not know as much as God. But I know as much as God knew at my age.”

*Stop the Week*

BBC Radio 4, year unknown

### Solzhenitsyn, Aleksandr Isayevich 1918–

Russian novelist and historian

All my life I have thought of mathematicians as Rosicrucians of some kind, and I always regretted that I never had the opportunity of being initiated into their secrets.

*The First Circle*

Chapter 9 (p. 39)

Harper & Row. New York, New York, USA. 1968

### Stewart, Dugald 1753–1828

Scottish philosopher

...I have never met with a mere mathematician who was not credulous to a fault...

*The Collected Works of Dugald Stewart* (Volume 4)

Part Third, Chapter I, Section 3 (p. 209)

T & T Clark. Edinburgh, Scotland. 1877

### Stewart, Ian 1945–

English mathematician and science writer

The true mathematician is not a juggler of numbers, but a juggler of concepts.

*Concepts of Modern Mathematics*

Preface to the First Edition (p. vii)

Dover Publications, Inc. New York, New York, USA. 1995

### Swann, William Francis Gray 1884–1962

Anglo-American physicist

It has been said that the pure mathematician is never as happy as when he does not know what he is talking about...

*The Architecture of the Universe*

Chapter IV (p. 117)

The Macmillan Company. New York, New York, USA. 1934

### Swift, Jonathan 1667–1745

Irish-born English writer

...what I chiefly admired, and thought altogether unaccountable, was the strong disposition I observed in them [the mathematicians of Laputal] towards news and politics; perpetually enquiring into publick affairs; giving their judgments in matters of state; and passionately disputing every inch of party opinions. I have indeed observed the same disposition among most of the mathematicians I have known in Europe; although I could never discover the least analogy between the two sciences...

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter II (pp. 97–98)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Sylvester, James Joseph 1814–97

English mathematician

The mathematician lives long and lives young; the wings of his soul do not early drop off, nor do its pores become clogged with the earthy particles blown from the dusty highways of vulgar life.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)

Presidential Address to the British Association (p. 658)

University Press. Cambridge, England. 1904–1912

It is the constant aim of the mathematician to reduce all his expressions to their lowest terms, to retrench every superfluous word and phrase, and to condense the Maximum of meaning into the Minimum of Language.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

On Recent Discoveries in Mechanical Conversion of Motion

(pp. 72–73)

University Press. Cambridge, England. 1904–1912

### Synge, John L. 1897–1995

Irish mathematician and physicist

The modern mathematician weaves an intricate pattern of microscopic precision. To him, a false statement — an exception to a general statement — is an unforgiving sin. The heroic mathematician, on the other hand, paints with broad splashes of color, with a grand contempt for singular cases until they could no longer be avoided.

*The Scripta Mathematica Studies Number 2*

The Life and Early Works of Sir William Rowan Hamilton (p. 16)  
Scripta Mathematica. New York, New York, USA.

Mathematicians are human beings.

*The Scripta Mathematica Studies Number 2*

The Life and Early Works of Sir William Rowan Hamilton (p. 13)  
Scripta Mathematica. New York, New York, USA.

**Thom, René** 1923–2002

French mathematician

Everything considered, mathematicians should have the courage of their most profound convictions and thus affirm that mathematical forms indeed have an existence that is independent of the mind considering them.... Yet, at any given moment, mathematicians have only an incomplete and fragmentary view of this world of ideas.

Modern Mathematics: An Educational and Philosophical Error?

*American Scientist*, Volume 59, 1971 (p. 695)

**Thompson, Silvanus P.** 1851–1916

English physics professor and author

Once when lecturing to a class he [Lord Kelvin] used the word “mathematician,” and then interrupting himself asked his class, “Do you know what a mathematician is?” Stepping to the blackboard he wrote upon it: — Then putting his finger on what he had written, he turned to his class and said: “A mathematician is one to who that is as obvious as that twice two makes four is to you.

In S.P. Thompson

*The Life of William Thomson Baron Kelvin of Largs* (Volume 2)

Views and Opinions (p. 1139)

Macmillan & Company Limited. London, England. 1910

**Tomlinson, Henry Major** 1873–1958

English novelist

We may doubt the warranty of the priest, but never that of the mathematician.

*All Our Yesterdays*

Part I, Chapter Two (p. 10)

Harper & Brothers Publishers. New York, New York, USA. 1930

**Veblen, Oswald** 1880–1960

American mathematician

The conclusion seems inescapable: that formal logic has to be taken over by the mathematicians. The fact is that there does not exist an adequate logic at the present time, and unless the mathematicians create one, no one else is likely to do so.

*A Century of Mathematics In America* (Volume 2)

Retiring address of the AMS 1924 (p. 219)

American Mathematical Society. Providence, Rhode Island, USA. 1989

...let me remind any non-mathematicians...that when a mathematician lays down the elaborate tools by which he achieves precision in his own domain, he is unprepared and awkward in handling the ordinary tools of language. This is why mathematicians always disappoint the expectation that they will be precise and reasonable and clear-cut in their statements about everyday affairs, and why they are, in fact, more fallible than ordinary mortals.

Geometry and Physics

*Science*, Volume 57, Number 1466, February 2, 1923 (p. 130)

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

...the mathematician is only complete in so far as he feels within himself the beauty of the true.

In Oswald Spengler

*The Decline of the West* (Volume 1)

Chapter II, Section iv (p. 61)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

**Walther, Hans**

No biographical data available

Take the mathematician away: He is a stupid augur, blind prophet, a crazy soothsayer. Man may know the present; only God can foresee the future.

In Jan Gullberg

*Mathematics: From the Birth of Numbers* (p. 17)

W.W. Norton & Company, Inc. New York, New York, USA. 1997

**Weierstrass, Karl** 1815–97

German mathematician

A mathematician who is not also something of a poet will never be a complete mathematician.

In Oswald Spengler

*The Decline of the West* (Volume 1)

Chapter II, Section iv (p. 62)

Alfred A. Knopf, Inc. New York, New York, USA. 1926

**Weil, André** 1906–98

French mathematician

Rigor is to the mathematician what morality is to man. It does not consist in proving everything, but in maintaining a sharp distinction between what is assumed and what is proved, and in endeavoring to assume as little as possible at every stage.

Mathematical Teaching in Universities

*The American Mathematical Monthly*, Volume 61, Number 1, January 1954 (p. 35)

But, if logic is the hygiene of the mathematician, it is not his source of food; the great problems furnish the daily bread on which he thrives.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May 1950 (p. 297)

...the mathematician...believe[s] that he will be able to slake his thirst at the very sources of knowledge, convinced as he is that they will always continue to pour forth, pure and abundant, while others have to have recourse to the muddy streams of a sordid reality.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May 1950 (p. 306)

...it [the mathematician] be asked why he persists on the high glaciers whither no one but his own kind can follow him, he will answer.... For the honor of the human spirit.

The Future of Mathematics

*The American Mathematical Monthly*, Volume 57, Number 5, May 1950 (p. 306)

### Weinberg, Steven 1933–

American nuclear physicist

It is positively spooky how the physicist finds the mathematician has been there before him or her.

Lectures on the Applicability of Mathematics

*Notices of the American Mathematical Society*, October 1986

### Weyl, Hermann 1885–1955

German mathematician

It cannot be denied, however, that in advancing to higher and more general theories the inapplicability of the simple laws of classical logic eventually results in an almost unbearable awkwardness. And the mathematician watches with pain the larger part of his towering edifice which he believed to be built of concrete dissolve into mist before his eyes.

*Philosophy of Mathematics and Natural Science*

Part I, Chapter II (p. 54)

Princeton University Press. Princeton, New Jersey, USA. 1949

### White, William Frank

No biographical data available

Behind the artisan is the chemist, behind the chemist a physicist, behind the physicist a mathematician.

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays* (p. 217)

Open Court Publishing Company. La Salle, Illinois, USA. 1942

### Wiener, Norbert 1894–1964

American mathematician

One of the chief duties of the mathematician in acting as an advisor to scientists...is to discourage them from expecting too much from mathematics.

In Douglas M. Campbell and John C. Higgins

*Mathematics: People, Problems, Results* (Volume 3)

In Richard A. De Millo, Richard J. Lipton and Alan J. Perlos

*Social Processes and Proofs of Theorems and Programs* (p. 29)

Wadsworth, Inc. Belmont, California, USA. 1984

### Wittgenstein, Ludwig Josef Johann 1889–1951

Austrian-born English philosopher

The mathematician is an inventor, not a discoverer.

*Remarks on the Foundations of Mathematics*

Appendix I, 167 (p. 47e)

The MIT Press. Cambridge, Massachusetts, USA. 1967

## MATTER

### Bicknell, Alexander ?–1796

English writer

So when we view a castle-wall  
Rent by a ponderous cannon ball,  
We must conclude from your new rules

(Our reas'ning fathers being fools),

That 'tis not solid brick or stone

Which solid iron has o'erthrown;

But that a Nothing did attract,

And had not strength to counteract,

By its repulsive force the thing,

(The Thing your pardon Sir, the Nothing).

*The Putrid Soul. A Poetical Epistle to Joseph Priestley on His*

*Disquisitions Relating to Matter and Spirit* (p. 8–10)

Printed for J. Bowen. London, England. 1780

### Bohm, David 1917–92

American physicist

Matter is like a small ripple on this tremendous ocean of energy, having some relative stability and being manifest.

Quoted by Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 51)

Routledge & Kegan Paul. London, England. 1986

### Born, Max 1882–1970

German-born English physicist

Living matter and clarity are opposites — they run away from each other.

*The Born–Einstein Letters: Correspondence Between Albert Einstein*

*and Max and Hedwig Born from 1916 to 1955*

Letter to Albert Einstein 1927 (p. 95)

Walker & Company. New York, New York, USA. 1971

### Boswell, James 1740–95

Scottish biographer and diarist

I shall always remember the alacrity with which Johnson answered, striking his foot with mighty force against a large stone, till he rebounded from it — “I refute it thus.”

*Boswell's "Life of Samuel Johnson"*

6 August, 1763 (p. 333)

Oxford University Press, Inc. Oxford, England. 1965

### Brady, Nicholas 1659–1726

Anglican divine and poet

Soul of the World, inspir'd by Thee,

The jarring Seeds of Matter did agree.

Thou didst the scattr'd Atoms bind,  
Which, by thy Laws of True Proportion join'd,  
Made up of various Parts  
One Perfect Harmony.

In John Bell

*Bell's Classical Arrangement of Fugitive Poetry* (Volume 3)

Ode for St. Cecelia's Day

Printed by John Bell. London, England. 1793

**Bryson, Bill** 1951–

Author

In three minutes, 98 percent of all the matter there is or will ever be has been produced. We have a universe. It is a place of the most wondrous and gratifying possibility, and beautiful, too. And it was all done in about the time it takes to make a sandwich.

*A Short History of Nearly Everything*

Chapter 1 (p. 10)

Broadway Books. New York, New York, USA. 2003

**Capek, Milic** 1909–97

Czechoslovakian philosopher and physicist

This concept [matter] has hardly changed from the times of Leucippus to the beginning of the twentieth century: an impenetrable something, which fills completely certain regions of space and which persists through time even when it changes its location.

*The Philosophical Impact of Contemporary Physics*

Chapter IV (p. 54)

D. Van Nostrand Company, Inc. Toronto, Ontario, Canada. 1961

**Chaudhuri, Haridas** 1913–75

Scholar of Indian religions

We know too much about matter today to be materialists any longer.

*The Philosophy of Integralism: The Metaphysical Synthesis of Sri*

*Aurobindo's Teaching* (p. 146)

Sri Aurobindo Ashram. Pondicherry, India. 1967

**Cornforth, John W.** 1917–2004

English organic chemist

...the business of chemists is matter...

Scientists as Citizens

*Australian Journal of Chemistry*, Volume 46, 1993 (p. 268)

**Darling, David** 1953–

Freelance science writer

You are roughly eighteen billion years old and made of matter that has been cycled through the multimillion-degree heat of innumerable giant stars. You are composed of particles that once were scattered across thousands of light-years of interstellar space, particles that were blasted out of exploding suns and that for eons drifted through the cold, starlit vacuum of the Galaxy. You are very much a child of the cosmos.

*Equations of Eternity: Speculations on Consciousness, Meaning, and the Mathematical Rules that Orchestrate the Cosmos*

Introduction (p. xiii)

Hyperion. New York, New York, USA. 1993

**Dastre, A.**

No biographical data available

Between the organic and the inorganic worlds is an apparent abyss.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

The Life of Matter (p. 393)

Government Printing Office. Washington, D.C. 1903

**Dewey, John** 1859–1952

American philosopher and educator

It would be difficult to find a greater distance between any two terms than that which separates “matter” in the Greek-medieval tradition and the technical signification, suitably expressed in mathematical symbols, that the word bears in science today.

In Yervant H. Krikorian (ed.)

*Naturalism and the Human Spirit*

Antinaturalism in extremis (p. 3)

Columbia University Press. New York, New York, USA. 1944

**Dirac, Paul Adrian Maurice** 1902–84

English theoretical physicist

To get an interpretation of some modern experimental results one must suppose that particles can be created and annihilated. Thus if a particle is observed to come out from another particle, one can no longer be sure that the latter is composite. The former may have been created. The distinction between elementary particles and composite particles now becomes a matter of convenience. This reason alone is sufficient to compel one to give up the attractive philosophical idea that all matter is made up of one kind, or perhaps two kinds of bricks.

*Nobel Lectures, Physics 1922–1941*

Nobel lecture for award received in 1933

Theory of Electrons and Positrons (p. 321)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Dyson, Freeman J.** 1923–

American physicist and educator

We have learned that matter is weird stuff. It is weird enough, so that it does not limit God's freedom to make it do what he pleases.

*Infinite in All Directions*

Part One, Chapter One (p. 8)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

**Frost, Robert** 1874–1963

American poet

It was in a state  
Of Atomic One

Matter was begun —  
 And in fact complete  
 One and yet discrete  
 To conflict and pair.  
 Everything was there  
 Every single thing  
 Waiting was to bring  
 Clear from hydrogen  
 All the way to men.

*Complete Poems of Robert Frost*

A Never Naught Song

Henry Holt & Company. New York, New York, USA. 1949

### **Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Darwin applied a consistent philosophy of materialism to his interpretation of nature. Matter is the ground of all existence; mind, spirit, and God as well, are just words that express the wondrous results of neuronal complexity.

*Ever Since Darwin: Reflections in Natural History*

Prologue (p. 13)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

[Darwin's notebooks] include many statements showing that he espoused but feared to expose something he perceived as far more heretical than evolution itself: philosophical materialism — the postulate that matter is the stuff of all existence and that all mental and spiritual phenomena are its by-products.

*Ever Since Darwin: Reflections in Natural History*

Chapter 1. Darwin's Delay (p. 24)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

### **Hawking, Stephen William** 1942–

English theoretical physicist

The point is that the new raw material doesn't really have to come from anywhere.... The universe can start off with zero energy and still create matter.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 51)

Routledge & Kegan Paul. London, England. 1986

### **Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Even if we resolve all matter into one kind, that kind will need explaining, and so on for ever and ever deeper and deeper into the pit at whose bottom truth lies, without ever reaching it, for the pit is bottomless.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 10 (p. 133)

Longmans, Green & Company. London, England. 1967

### **Herbert, Nick**

American physicist

The world is one substance. As satisfying as this discovery may be to philosophers, it is profoundly distressing to physicists as long as they do not understand the nature of that substance. For if quantum stuff is all there is and you don't understand quantum stuff, your ignorance is complete.

*Quantum Reality: Beyond the New Physics*

Chapter 3 (p. 40)

Anchor Press. Garden City, New York, USA. 1985

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If there is anything more wonderful than matter in the sheer versatility of its behavior, I have yet to hear tell of it.

*Frontiers of Astronomy*

Chapter Twelve (p. 224)

Harper & Row, Publishers. New York, New York, USA. 1955

### **Huxley, Julian** 1887–1975

English biologist, philosopher, and author

I am Matter. I am the condensation,  
 The Kink in empty space that provides resistance,  
 Precious inertia — mine the sole foundation  
 On which swift Energy's flow of fluid emanation  
 Fraternally builds reality into existence.

*The Captive Shrew and Other Poems of a Biologist*

Matter, Energy, Time and Space

Harper & Brothers. New York, New York, USA. 1933

### **Huxley, Thomas Henry** 1825–95

English biologist

...there are three great problems of our time.... One of these is that doctrine concerning the constitution of matter which, for want of a better name, I'll call "molecular"; the second is the doctrine of the conservation of energy; the third is the doctrine of evolution.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 66)

Macmillan & Company Ltd. London, England. 1904

### **Kant, Immanuel** 1724–1804

German philosopher

Give me matter and I will construct a world out of it!

In W. Hastie (ed.)

*Kant's Cosmogony*

Preface (p. 17)

Greenwood Publishing Corporation. New York, New York, USA. 1968

### **Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

If the motion of every particle of matter in the universe were precisely reversed at any instant, the course of nature would be simply reversed for ever after. The bursting bubble of foam at the foot of a waterfall would

reunite and descend into the water; the thermal motions would reconcentrate their energy, and throw the mass up the fall in drops reforming in a close column of ascending water...living creatures would grow backwards, with conscious knowledge of the future, but no memory of the past, and would become again unborn.

In John D. Barrow

*The World Within The World* (p. 126)

Clarendon Press, Oxford, England. 1988

**Kline, Morris** 1908–92

American mathematics professor and writer

...where is the good, old-fashioned, solid matter that obeys precise, compelling mathematical laws? The stone that Dr. Johnson once kicked to demonstrate the reality of matter has become dissipated in a diffuse distribution of mathematical probabilities.

*Mathematics in Western Culture*

Chapter XXIV (p. 382)

Oxford University Press, Inc. New York, New York, USA. 1953

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

Matter is the miracle of miracles, the most mystical of all things mystical.

*Science, Matter and Immortality*

Chapter XVI (p. 196)

William & Norgate. London, England. 1909

**Mendeleev, Dmitry** 1834–1907

Russian chemist

By gradually studying matter, people finally take command of it. Their predictions concerning it, proved by the facts, become ever more accurate. They use it more widely and more frequently to satisfy their needs. There are no grounds to think that knowledge and our mastery over matter have bounds.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Progress Publishers. Moscow, Russia. 1979

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

The quantity of matter is the measure of the same, arising from its density and bulk conjointly.

In *Great Books of the Western World* (Volume 34)

*Mathematical Principles of Natural Philosophy*

Definitions, Definition 1 (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It seems to me, that if the matter of our Sun and Planets and all ye matter in the Universe was evenly scattered throughout all the heavens, and every particle had an innate gravity towards all the rest and the whole space throughout which this matter was scattered was but finite: the matter on ye outside of this space would by its

gravity tend towards all ye matter on the inside and by consequence fall down to ye middle of the whole space and there compose one great spherical mass. But if the matter was evenly diffused through an infinite space, it would never convene into one mass.

*Four Letters from Sir Isaac Newton to Doctor Bentley*

Letter to Richard Bentley, 10 December 1692

Printed for R. & J. Dodsley. London, England. 1756

And much harder it is to suppose that all ye particles in an infinite space should be so accurately poised one among another as to stand still in a perfect equilibrium. For I reckon this as hard as to make not one needle only but an infinite number of them (so many as there are particles in an infinite space) stand accurately poised upon their points.

*Four Letters from Sir Isaac Newton to Doctor Bentley*

Letter to Richard Bentley, 10 December 1692

Printed for R. & J. Dodsley. London, England. 1756

As to your first query, it seems to me that if the matter of our sun and planets and all the matter of the universe were evenly scattered throughout all the heavens, and every particle had an innate gravity toward all the rest, and the whole space throughout which this matter was scattered was but finite, the matter on the outside of this space would, by its gravity, tend toward all the matter on the inside and, by consequence, fall down into the middle of the whole space and there compose one great spherical mass.

*Four Letters from Sir Isaac Newton to Doctor Bentley*

Letter to Richard Bentley, 10 December 1692 (p. 211)

Printed for R. & J. Dodsley. London, England. 1756

...it seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable, moveable particles, of such sizes and figures, and with such other properties, and in such proportion to space, as most conduced to the end for which he formed them; and that these primitive particles being solids, are incomparably harder than any porous bodies compounded of them; even so very hard as never to wear or break in pieces; no ordinary power being able to divide what God himself made one in the first creation.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book II, Part I (very near the end)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

When matter is becoming disturbed by non-equilibrium conditions it organizes itself, it wakes up. It happens that our world is a non-equilibrium system.

In Renée Weber

*Dialogues with Scientists and Sages: The Search For Unity* (p. 51)

Routledge & Kegan Paul. London, England. 1986

**Reeves, Hubert** 1932–

Canadian astrophysicist

The organization of the universe demands that matter abandon itself to the games of chance.

*Atoms of Silence*

Chapter 16 (p. 177)

The MIT Press. Cambridge, Massachusetts, USA. 1984

**Rorty, Richard** 1931–

American philosopher

[When] we tell our Whiggish stories about how our ancestors gradually crawled up the mountain on whose (possibly false) summit we stand, we need to keep some things constant throughout the story. The forces of nature and the small bits of matter, as conceived by current physical theory, are good choices for this role.

*Philosophy and the Mirror of Nature*

Chapter VII (p. 344)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

“Matter” is a convenient formula for describing what happens where it isn’t.

*An Outline of Philosophy*

Chapter XV (p. 165)

The World Publishing Company. Cleveland, Ohio, USA. 1960

**Santayana, George (Jorge Agustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

...and the animate world must needs concern the physicist, since it is the crown of nature, the focus where matter concentrates its fires and best shows what it is capable of doing.

*The Realm of Matter*

Chapter VIII (p. 141)

Charles Scribner’s Sons. New York, New York, USA. 1930

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

What stuff ‘tis made of, whereof it is born, I am to learn...

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume One)

The Merchant of Venice

Act I, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shelley, Percy Bysshe** 1792–1822

English poet

I change but I cannot die.

*The Complete Poetical Works of Percy Bysshe Shelley*

The Cloud, l. 76

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Silver, Brian L.**

Israeli professor of physical chemistry

Matter is the flesh of the universe; chemical and nuclear change is its soul.

*The Ascent of Science*

Preface (p. xvii)

Solomon Press Book. New York, New York, USA. 1998

**Spencer, Theodore**

No biographical data available

Matter whose movement moves us all

Moves to its random funeral,

And Gresham’s law that fits the purse

Seems to fit the universe.

In Helen Plotz

*Imagination’s Other Place*

Entropy (p. 90)

Thomas Y. Crowell Company. New York, New York, USA. 1955

**Tait, Peter Guthrie** 1831–1901

Scottish physicist and mathematician

Only sheer ignorance could assert that there is any limit to the amount of information which human beings may in time acquire of the constitution of matter. However far we may manage to go, there will still appear before us something further to be assailed. The small separate particles of a gas are each, no doubt less complex in structure than the whole visible universe, but the comparison is a comparison of two infinities.

*Lectures on Some Recent Advances in Physical Science*

Lecture XII (pp. 288–289)

Macmillan & Company Ltd. London, England. 1876

Nothing is so preposterously unscientific than to assert... that with the utmost strides attempted by science we should necessarily be sensibly nearer to a conception of the ultimate nature of matter.

*Lectures on Some Recent Advances in Physical Science* (p. 284)

Macmillan & Company Ltd. London, England. 1876

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

We do not get what we call matter as a result of the simple aggregation and juxtaposition of atoms. For that, a mysterious identity must absorb and cement them, an influence at which our mind rebels in bewilderment at first, but which in the end must perform accept.

*The Phenomenon of Man*

Book One, Chapter I, Section 2 (p. 42)

Harper & Brothers Publishers. New York, New York, USA. 1959

...the more we split and pulverise matter artificially, the more insistently it proclaims its fundamental unity.

*The Phenomenon of Man*

Book One, Chapter I, Section 1 (p. 41)

Harper & Brothers Publishers. New York, New York, USA. 1959

**Tesla, Nikola** 1865–1943

Electrical engineer and inventor

...but now a mechanism of a finite number of parts and few at that, cannot perform an infinite number of definite

motions, hence the impulses which govern its movements must come from the environment. So the atom, the ulterior element of the Universe's structure is tossed about in space eternally, a play of external influences, like a boat in a troubled sea. Were it to stop its motion it would die. Matter at rest, if such a thing could exist, would be matter dead. Death of matter! Never has a sentence of deeper philosophical meaning been uttered.... There is no death of matter, for throughout the infinite universe, all has to move to vibrate, that is, to live.

*Lectures, Patents, Articles*

On light and other high frequency phenomena, delivered before the Franklin Institute, Philadelphia, February 1893.

N. Tesla Museum, Beograd, Yugoslavia, 1956

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

Cell and tissue, shell and bone, leaf and flower, are so many portions of matter, and it is in obedience to the laws of physics that their particles have been moved, molded and conformed. They are no exceptions to the rule that God always geometrizes. Their problems of form are in the first instance mathematical problems, their problems of growth are essentially physical problems, and the morphologist is, ipso facto, a student of physical science.

*On Growth and Form* (Volume 1)

Chapter I (p. 10)

At The University Press. Cambridge, England. 1951

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

...when we pass from ordinary sight to scientific vision, how subtle and ethereal matter becomes! What pictures modern physics gives us of a restless activity suggestive of life!

*The System of Animate Nature* (Volume 1)

Lecture II (p. 67)

William & Norgate. London, England. 1920

**Thomson, Sir Joseph John** 1856–1940  
English physicist

From the point of view of the physicist, a theory of matter is a policy rather than a creed; its object is to connect or co-ordinate apparently diverse phenomena, and above all to suggest, stimulate and direct experiment. It ought to furnish a compass which, if followed, will lead to observer further and further into previously unexplored regions.

*The Corpuscular Theory of Matter*

Chapter I (p. 1)

Charles Scribner's Sons. New York, New York, USA. 1907

**Updike, John** 1932–  
American novelist, short story writer, and poet

There is infinitely more nothing in the universe than anything else.

*The Poorhouse Fair*

Chapter II (p. 93)

Random House, Inc. New York, New York, USA. 2004

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

...we cannot triumph over the machinery of matter by ignoring it; we can triumph over it only by subordinating it to the aims of our moral intelligence. We must familiarise ourselves with its levers and pulleys, fatal though it be to poetic contemplation, in order to be able to govern them after our own will, and therein lies the complete justification of physical investigation, and its vast importance for the advance of human civilisation.

In David Cahan (ed.)

*Science and Culture: Popular and Philosophical Essays*

On Goethe's Scientific Researches

Lecture, 1853 (p. 17)

The University of Chicago Press. Chicago, Illinois, USA. 1995

**Ward, Henshaw**

No biographical data available

Every particle of matter large enough to be seen is composed of quadrillions of regions of electrical energy.... And each one of the regions is a complication of secrets that are quite unfathomable.

In Frederick Houk Law

*Science in Literature*

A Drop of Water (p. 276, 277)

Harper & Brothers Publishers. New York, New York, USA. 1929

**Weyl, Hermann** 1885–1955  
German mathematician

Not the state of rest, but the states of uniform translation form an objectively distinguished class of motions, and this puts an end to the substantial ether. Finally, and fourthly, the general relativity theory re-endows this metric world structure with the capacity of reacting to the forces of matter. Thus, in a sense, the circle is closed.

*Philosophy of Mathematics and Natural Science*

Part II, Chapter III (p. 176)

Princeton University Press. Princeton, New Jersey, USA. 1949

And now, in our time, there has been unloosed a cataclysm which has swept away space, time and matter, hitherto regarded as the firmest pillars of natural science, but only to make place for a view of things of wider scope, and entailing a deeper vision.

Translated by Henry L. Brose

*Space — Time — Matter*

Introduction (p. 2)

Dover Publications, Inc. New York, New York, USA. 1922

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Thus, to a really learned man, matter exists in test tubes, animals in cages, art in museums, religion in churches, knowledge in libraries.



*Essays in Science and Philosophy*

Part III, Harvard: The Future, Section IV (p. 215)

Philosophical Library, New York, New York, USA. 1947

**Young, Edward** 1683–1765

English poet and dramatist

Has Matter innate Motion? Then each Atom,  
Asserting its indisputable Right

To dance, would form an Universe of Dust:

Has Matter none? Then whence these glorious Forms,  
And boundless Flights, from Shapeless, and Repos'd?

*Night Thoughts*, l. 1472–1476

Printed by R. Nobels for R. Edwards. London, England. 1797

## MAXWELL'S THEORY

**Hertz, Heinrich** 1857–94

German physicist

To this question, “What is Maxwell’s theory?” I cannot give any clearer or briefer answer than the following: Maxwell’s theory is the system of Maxwell’s equations.

*Electric Waves: Being Researches on the Propagation of Electric Action With Finite Velocity through Space* (p. 23)

Macmillan & Company Ltd. London, England. 1893

## MEANING

**Syngé, John L.** 1897–1995

Irish mathematician and physicist

A statement acquires meaning (and truth or falsehood) only when interpreted against a background.

*Kandelman's Krim*

Chapter Four (p. 83)

Jonathan Cape. London, England. 1957

## MEASLES

**Ward, Artemus (Charles Farrar Browne)** 1834–67

American humorist

Did you ever have the measles, and if so, how many?

*The Complete Works of Artemus Ward*

The Census (p. 69)

G. W. Dillingham. New York, New York, USA. 1898

## MEASUREMENT

**Adams, George** 1750–95

English instrument maker

Most of our philosophical instruments are measures of effects. The progress made in natural philosophy increases every day by the number of these measures; by these it still continues to be improved.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture VI (p. 265)

Printed by R. Hindmarsh. London, England. 1794

**Asimov, Isaac** 1920–92

American author and biochemist

...we must remember that measures were made for man and not man for measures.

*Time and Space and Other Things*  
Of Part II, of Other Things (p. 143)

Doubleday & Company, Inc. Garden City, New York, USA. 1965

**Balfour, Arthur James** 1848–1930

British prime minister

Science depends upon measurement, and things not measurable are therefore excluded, or tend to be excluded, from its attention.

In William H. George

Address

The Scientist in Action: A Scientific Study of His Methods

Some Problems in Theorizing (pp. 263–264)

William & Norgate. London, England. 1936

**Bell, J. A.**

No biographical data available

The concept of “measurement” becomes so fuzzy on reflection that it is quite surprising to have it appearing in physical theory at the most fundamental level.

*Speakable and Unsayable in Quantum Mechanics*

Chapter 15 (p. 117)

Cambridge University Press. Cambridge, England. 1987

**Bondi, Sir Hermann** 1919–2005

English mathematician and cosmologist

A quantity like time, or any other physical measurement, does not exist in a completely abstract way. We find no sense in talking about something unless we specify how we measure it. It is the definition by the method of measuring a quantity that is the one sure way of avoiding talking nonsense...

*Relativity and Common Sense: A New Approach to Einstein*

Chapter VII (p. 65)

Doubleday & Company, Inc. Garden City, New York. 1964

**Brouwer, L. E. J.**

No biographical data available

It is well to notice in this connection [the mutual relations between the results of counting and measuring] that a natural law, in the statement of which measurable magnitudes occur, can only be understood to hold in nature with a certain degree of approximation; indeed natural laws as a rule are not proof against sufficient refinement of the measuring tools.

Intuitionism and Formalism

*Bulletin of the American Mathematical Society*, Volume 20, November 1913 (p. 82)

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

It is important to realize that it is not the one measurement, alone, but its relation to the rest of the sequence that is of interest.

*Statistical Adjustment of Data* (p. 3)

John Wiley & Sons, Inc. New York, New York, USA. 1938

**Dewey, John** 1859–1952  
American philosopher and educator

Insistence upon numerical measurement when it is not inherently required by the consequence to be effected, is a mark of respect for the ritual of scientific practice at the expense of its substance.

*Logic: The Theory of Inquiry*

Chapter XI (p. 205)

Henry Holt & Company. New York, New York, USA. 1938

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

I really cannot tell you anything about it, if you will not let me make measurements of any kind. Measurement is my only means of finding out about nature. I am not a metaphysicist.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Prologue (p. 2)

At The University Press. Cambridge, England. 1921

**Ellis, Brian**  
No biographical data available

Measurement is the link between mathematics and science.

*Basic Concepts of Measurement*

Introduction (p. 1)

At The University Press. Cambridge. 1966

**Ferguson, Kitty**  
Science writer

Measuring is one of the more practical uses of mathematics, but the ability and desire to measure aren't always wrapped up with the need to know useful answers.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*

Prologue (p. 3)

Walker & Company. New York, New York, USA. 1999

**Fox, Russell**  
No biographical data available

**Gorbunov, Max**  
No biographical data available

Measurement has meaning only if we can transmit the information without ambiguity to others.

*The Science of Science*

Part II, 4 (p. 31)

Walker & Company. New York, New York, USA. 1997

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

If it were not for our conception of weights and measures we would stand in awe of the firefly as we do before the sun.

*Sand and Foam: A Book of Aphorisms* (p. 52)

Alfred A. Knopf. New York, New York, USA. 1959

**Hales, Stephen** 1677–1761  
English physiologist and clergyman

Since we are assured that the all-wise Creator has observed the most exact proportions of number, weight and measure in the make of all things, the most likely way therefore to get any insight into the nature of those parts of the Creation which come within our observation must in all reason be to number, weigh and measure.

*Vegetable Statics*

The Introduction (p. xxxi)

The Scientific Book Guild. London, England. 1961

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

Astronomical distances have the air of a conjuring trick. The vastness of cosmic dimensions fills us with astonishment. Yet like a conjuring trick it all looks very obvious when we see how it is done. The methods of measurement are indeed of a very mundane character.

*Frontiers of Astronomy*

Chapter Ten (p. 163)

Harper & Row, Publishers. New York, New York, USA. 1955

**Kaplan, Abraham** 1918–93  
American philosopher of science, author, and educator

Proleptically [anticipatively], I would say that whether we can measure something depends, not on that thing, but on how we have conceptualized it, on our knowledge of it, above all on the skill and ingenuity which we can bring to bear on the process of measurement which our inquiry can put to use.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter V, Section 20 (p. 176)

Chandler Publishing Company. San Francisco, California, USA. 1964

One of the subjects of Kinsey's study of sexual behavior in the human male afterwards complained bitterly of the injury to his masculine ego. "No matter what I told him," he explained, "he just looked me straight in the eye and asked, "How many times?"...The principle, "Let's get it down to something we can count!" does not always formulate the best research strategy.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter V, Section 20 (p. 171)

Chandler Publishing Company. San Francisco, California, USA. 1964

Measurement, we have seen, always has an element of error in it. The most exact description or prediction that a scientist can make is still only approximate. If, as sometimes happens, a perfect correspondence with observation does appear, it must be regarded as accidental, and, as

Jevons ...remarks, it “should give rise to suspicion rather than to satisfaction.”

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter VI, Section 25 (p. 215)

Chandler Publishing Company, San Francisco, California, USA. 1964

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Measurement is a means, not an end.

Address to the British Association

*Life*, Volume 2, 1871 (p. 200)

Accurate and minute measurement seems to the nonscientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long contained labor in the minute sifting of numerical results.

*Report of the British Association For the Advancement of Science*,

Volume 41, xci, 1871

**Lewis, Gilbert Newton** 1875–1946

American chemist

I have no patience with attempts to identify science with measurement, which is but one of its tools, or with any definition of the scientist which would exclude a Darwin, a Pasteur, or a Kekulé.

*The Anatomy of Science*

Chapter I (p. 6)

Yale University Press, New Haven, Connecticut, USA. 1926

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

We are ourselves the measure of the miraculous; if we should find a universal measure, the miraculous elements would disappear, and all things would be of equal size.

*Lichtenberg: Aphorisms & Letters*

Aphorisms (p. 27)

Jonathan Cape, London, England. 1969

**Onnes, Heike Kamerlingh** 1853–1926

Dutch physicist

Through measure to knowing is the motto I would like to write above every physics laboratory.

In Arno Laesecke

Through Measurement to Knowledge: The Inaugural Lecture of Heike Kamerlingh Onnes (1882)

*Journal of Research of the National Institute of Standards and Technology*, Volume 107, Number 3, May–June 2002 (p. 264)

**Peter, Lawrence J.**

No biographical data available

Coomb’s Law. If you can’t measure it, I’m not interested.

Peter’s People

*Human Behavior*, August, 1976 (p. 9)

**Plato** 428 BCE–347 BCE

Greek philosopher

The points that I mean are length and shortness, excess and defect, with all of which the art of measurement is conversant.

In *Great Books of the Western World* (Volume 7)

*Statesman*

Section 283 (p. 594)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Rankine, William John Macquorn** 1820–72

Scottish engineer and physicist

A party of astronomers went measuring of the earth,

And forty million meters they took to be its girth;

Five hundred million inches, though, go through from pole to pole;

So lets stick to inches, feet, and yards, and the good old three-foot rule.

*Songs and Fables*

The Three-Foot Rule, Stanza III

J. Maclehose, Glasgow, Scotland. 1874

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...measurement demands some one-one relations between the numbers and magnitudes in question — a relation which may be direct or indirect, important or trivial, according to circumstances.

*The Principles of Mathematics*

Chapter XXI (p. 176)

W.W. Norton & Company, New York, New York, USA. 1938

**Read, Herbert** 1893–1968

English poet

Beauty had been born, not, as we so often conceive it nowadays, as an ideal of humanity, but as measure, as the reduction of the chaos of appearances to the precision of linear symbols. Symmetry, balance, harmonic division, mated and mensurated intervals — such were its abstract characteristics.

*Icon and Idea: The Function of Art in the Development of Human Consciousness*

Chapter IV (p. 75)

Harvard University Press, Cambridge, Massachusetts, USA. 1955

**Reynolds, H. T.**

No biographical data available

Crude measurement usually yields misleading, even erroneous conclusions no matter how sophisticated a technique is used.

*Analysis of Nominal Data*

Chapter 3 (p. 56)

Sage Publications, Beverly Hills, California, USA. 1977

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

The rejection of realism has logical consequences. In general, a variable has no definite value before I measure it; then measuring it does not mean ascertaining the value that it has. But then what does it mean? There must still be some criterion as to whether a measurement is true or false, a method is good or bad, accurate, or inaccurate — whether it deserves the name of measurement process at all.

The Present Situation in Quantum Mechanics  
*Proceedings of the American Philosophical Society*, Volume 124, 1980

### **Singer, Charles** 1876–1960

Historian of science and medicine

Galileo showed men of science that weighing and measuring are worthwhile. Newton convinced a large proportion of them that weighing and measuring are the only investigations that are worthwhile.

*A Short History of Medicine*

Chapter V, Section 1 (p. 138)

At The Clarendon Press, Oxford, England. 1928

### **Sophocles** 496 BCE–406 BCE

Greek playwright

Nay, if these measures give any ground of confidence, we think that thy design is not amiss.

In *Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

Trachiniae, l. 587

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Spearman, Charles** 1863–1945

English psychologist

...great as may be the potency of this [the experimental method], or of the preceding methods, there is yet another one so vital that, if lacking it, any study is thought by many authorities not to be scientific in the full sense of the word. This further and crucial method is that of measurement...

*Psychology Down the Ages* (Volume 1) (p. 89)

Macmillan & Company Ltd. London, England. 1937

### **Standen, Anthony**

Anglo-American science writer

If the idols of scientists were piled on top of one another in the manner of a totem pole the topmost would be a grinning fetish called Measurement.

*Science Is a Sacred Cow*

Chapter III (p. 82)

E.P. Dutton & Company, Inc. New York, New York, USA. 1950

### **Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Search for measurable elements among your phenomena, and then search for relations between these measures of physical quantities.

*Science and the Modern World*

Chapter III (p. 66)

The Macmillan Company. New York, New York, USA. 1929

### **Wordsworth, William** 1770–1850

English poet

I've measured it from side to side:

'Tis three feet long, and two feet wide.

*The Complete Poetical Works of William Wordsworth*

The Thorn, iii (Early Reading)

Crowell. New York, New York, USA. 1888

## MECHANICS

### **Adams, George** 1750–95

English instrument maker

The knowledge of mechanics is one of those things that contribute to distinguish civilized nations from barbarians. From it the works of art derive much of their beauty and value; without it we can make very little progress in the knowledge of the works of nature. By this science we are enabled to improve every power and force in nature, and render the motions of the elements water, air, and fire, subservient to the purposes of life.

*Lectures on Natural and Experimental Philosophy* (Volume 3)

Chapter XXXI (p. 257)

Printed by R. Hindmarsh. London, England. 1794

### **Cross, Hardy** 1885–1959

American professor of civil and structural engineering

Mechanics, for instance, is a diamond of many facets and scintillates with different colors for the mathematician, the student of pure physics, the student of cosmic physics or the engineer.

*Engineers and Ivory Towers*

The Education of an Engineer (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

### **da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Mechanics is the paradise of the mathematical sciences because by means of it one comes to the fruit of mathematics.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Mathematics (p. 613)

George Braziller. New York, New York, USA. 1958

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I am standing on the threshold about to enter a room. It is a complicated business. In the first place I must shove against an atmosphere pressing with a force of fourteen pounds on every square inch of my body. I must make sure of landing on a plank traveling at twenty miles a second round the sun — a fraction of a second too early or too late, the plank would be miles away. I must do

this whilst hanging from a round planet, head outward in space, and with a wind of aether blowing at no one knows how many miles a second through every instance of my body.

*The Nature of the Physical World*

Chapter XV (p. 342)

The Macmillan Company. New York, New York, USA. 1930

### **Einstein, Albert** 1879–1955

German-born physicist

Just now I am teaching the foundations of poor deceased mechanics, which is so beautiful. What will her successor look like? With that question I torment myself incessantly.

In Keith Hannabuss

*An Introduction to Quantum Theory*

Letter to Heinrich Zangger, November 14, 1911 (p. 246)

Oxford University Press, Inc. Oxford, England. 1997

### **Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

Proper is it that in the gradual development of a science, and in the instruction of individuals, the easy should precede the difficult, the simple the complex, the special the general, yet the mind, when once it has reached a higher point of view, demands the contrary course, in which all statistics shall appear simply as a special case of mechanics.

In Ernst Mach

*History and Root of the Principle of the Conservation of Energy*

Chapter II (p. 34)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

### **Gregory, Olinthus** 1774–1841

English mathematician

The science of mechanics, whether considered in its theory as a subject of curious and refined speculations, calculated for the learned, ingenious, and contemplative, or in practice as contribution to the conveniences and elegancies of life, and the wealth of nations, may be ranked the first and most important of all human acquirements.

A Treatise of Mechanics

*American Journal of Science*, Volume 7, 1824 (p. 72)

### **Hertz, Heinrich** 1857–94

German physicist

All physicists agree that the problem of physics consists in tracing the phenomena of nature back to the simple laws of mechanics.

In D.E. Jones and J.T. Walley

*The Principles of Mechanics Presented in a New Form*

Preface (p. xxi)

Dover Publications, Inc. New York, New York, USA. No date

### **Jamin, E. V.**

No biographical data available

Physics will one day form a chapter of general mechanics.

In L. Poincaré

*The New Physics and Its Evolution*

Chapter I (pp. 9–10)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

### **Kirchoff, Gustav Robert** 1824–87

German physicist

The highest object to which the natural sciences are constrained to aim, but which they will never reach, is the determination of the forces, which are present in nature, and of the state of matter at any given moment — that is, the reduction of all the phenomena of nature to mechanics.

Über das Ziel der Naturwissenschaften (p. 24)

*Prorektoratsrede*, s. 9, 1865 (p. 24)

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

That branch of physics which is at once the oldest and the simplest and which is therefore treated as introductory to other departments of this science, is concerned with the motions and equilibrium of masses. It bears the name of mechanics.

*The Science of Mechanics* (5<sup>th</sup> edition)

Introduction (p. 1)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Purely mechanical phenomena do not exist...are abstractions, made, either intentionally or from necessity, for facilitating our comprehension of things. The science of mechanics does not comprise the foundations, no, nor even a part of the world, but only an aspect of it.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter V, Part I, Section 1 (p. 597)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

### **Oliver, David**

No biographical data available

Mechanics is the wellspring from which physics flows...

*The Shaggy Steed of Physics: Mathematical Beauty in the Physical World*

Preface (p. xi)

Springer-Verlag. New York, New York, USA. 2004

Mechanics is the vehicle of all physical theory. Mechanics is the vehicle of war. The two have been inseparable.

*The Shaggy Steed of Physics: Mathematical Beauty in the Physical World*

Preface (p. xii)

Springer-Verlag. New York, New York, USA. 2004

The sword of mechanics proclaims the profane. But the plowshare of mechanics parts the earth revealing the sacred in matter.

*The Shaggy Steed of Physics: Mathematical Beauty in the Physical World*

Preface (p. xiv)

Springer-Verlag. New York, New York, USA. 2004

### **von Helmholtz, Hermann** 1821–94

German scientist and philosopher

...the ultimate aim of physical science must be to demonstrate the movements which are the real causes of all other phenomena and discover the motive powers on which they all depend; in other words, to merge itself into mechanics.

*Popular Lectures on Scientific Subjects*

Lecture VIII (p. 375)

D. Appleton & Company, New York, New York, USA. 1885

## MEDIAN

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The median isn't the message.

The Median Isn't the Message

*Discover*, June 1985 (p. 40)

## MEDICAL SCIENCE

**Ace, Goodman** 1899–1982

American radio writer and performer

A rule of thumb in the matter of medical advice is to take everything any doctor says with a grain of aspirin.

*The Fine Art of Hypochondria*

Only Sick People Go to the Doctors (p. 44)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Adams, Samuel Hopkins** 1871–1958

American author

Medicine would be the ideal profession if it did not involve giving pain.

*The Health Master*

Chapter I

Houghton Mifflin Company, Boston, Massachusetts, USA. 1913

With the exception of lawyers, there is no profession which considers itself above the law so widely as the medical profession.

*The Health Master*

Chapter I

Houghton Mifflin Company, Boston, Massachusetts, USA. 1913

**Albright, Fuller** 1900–69

American physician and endocrinologist

One cannot possibly practice good medicine and not understand the fundamentals underlying therapy. Few if any rules for therapy are more than 90 per cent correct. If one does not understand the fundamentals, one does more harm in the 10 per cent of instances to which the rules do not apply than one does good in the 90 per cent to which they do apply.

In Russell L. Cecil and Robert F. Loeb

*Textbook of Medicine*

Diseases of the Ductless Glands

Introduction

W.B. Saunders Company, Philadelphia, Pennsylvania, USA. 1979

**Armstrong, John** 1709–79

American civil engineer and soldier

For want of timely care

Millions have died of medicable wounds.

*The Art of Preserving Health*

Book III, l. 515 (p. 92)

Printed by Hosea Sprague, Boston, Massachusetts, USA. 1802

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Surely every medicine is an innovation, and he that will not apply new remedies must expect new evils...

*Bacon's Essays*

Of Innovations (p. 114)

Donohue, Henneberry & Company, Chicago, Illinois, USA. 1883

The poets did well to conjoin music and medicine in Apollo, because the office of medicine is but to tune this curious harp of man's body and to reduce it to harmony.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter X, Section 2 (p. 51)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Medicine is a science which hath been, as we have said, more professed than laboured, and yet more laboured than advanced: the labour having been in my judgment, rather in circle than in progression.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter X, Section 3 (pp. 51–52)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Berkenhout, John** 1730–91

Physician

I do not deny that many lives might be saved by the skillful administration of proper medicine; but a thousand indisputable facts convince me that the present established practice of physic in England is infinitely destructive of the lives of his Majesty's subjects. I prefer the practice of old women, because they do not sport with edged tools; being unacquainted with the powerful articles of the *Materia Medica*.

In Roy Porter

*The Greatest Benefit to Mankind: A Medical History of Humanity*

(p. 262)

W.W. Norton & Company, Inc. New York, New York, USA. 1998

**Bernard, Claude** 1813–78

French physiologist

To conserve health and to cure disease: Medicine is still pursuing a scientific solution of this problem, which has confronted it from the first.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Introduction (p. 1)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bigelow, Jacob** 1786–1879  
Physician

Most men form an exaggerated estimate of the powers of medicine, founded on the common acceptance of the name, that medicine is the art of curing diseases. That this is a false definition is evident from the fact that many diseases are incurable, and that one such disease must at last happen to every living man. A far more just definition would be that medicine is the art of understanding diseases, and of curing or relieving them when possible.

*Nature in Disease*

Chapter 2 (p. 69)

Phillips, Sampson & Company. Boston, Massachusetts, USA. 1859

### **Bloom, Samuel W.**

No biographical data available

Art and science march hand in hand through the history of medicine, each taking turns at the lead. A century or more ago science became the dominant partner and has remained so ever since. The art of medicine meanwhile, like an honored but neglected wife, walked behind, passive and obedient to call at those odd moments when the master needed a change of pace.

*The Doctor and His Patient: A Sociological Interpretation*

Chapter 1 (p. 33)

Russell Sage Foundation. New York, New York, USA. 1963

### **Bonaparte, Napoleon** 1769–1821

French soldier and emperor of France

Medicine is not an exact and positive science but a science based on conjectures and observations. I would have more confidence in a physician who has not studied the natural sciences than in one who has.

In J. Christopher Herold (ed.)

*The Mind of Napoleon*

Science and the Arts (p. 139)

Columbia University Press. New York, New York, USA. 1955

### **Bryce, John**

No biographical data available

Medicine [is] the only profession that labours incessantly to destroy the reason for its own existence.

Address

At dinner for General W.C. Gorgas

March 23, 1914

### **Butler, Samuel** 1612–80

English novelist, essayist, and critic

Learn'd he was in medic'nal lore,  
For by his side a pouch he wore,  
Replete with strange hermetic powder  
That wounds nine miles point-blank would solder.

*The Poetical Works of Samuel Butler* (Volume 1)

Part I, Canto II, l. 223–6

Bell & Daldy. London, England. 1835

### **Charles, Prince of Wales** 1948–

Heir apparent to British throne

The whole imposing edifice of modern medicine is like the celebrated tower of Pisa — slightly off balance.

*Observer*, 2 January 1983

### **Charlie Chan**

Fictional character

To describe bitter medicine will not improve its flavor.

*Charlie Chan in the City of Darkness*

Film (1939)

### **Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

Medicine is my lawful wife and literature is my mistress. When I get tired of one I spend the night with the other.

*Letters on the Short Story, the Drama, and Other Literary Topics*

Letter to A.S. Souvorin, September 11, 1888 (p. 42)

Minton, Balch & Company. New York, New York, USA. 1924

### **Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

I have been inclined to feel from time to time that there ought to be a hagiology of medical science and that we ought to have saints' days to commemorate the great discoveries which have been made for all mankind, and perhaps for all time — or for whatever time may be left to us. Nature, like many of our modern statesmen, is prodigal of pain. I should like to find a day when we can take a holiday, a day of jubilation, when we can fête good Saint Anaesthesia and chaste and pure Saint Antiseptic.

In F.B. Czarnomski

*The Wisdom of Winston Churchill*

Speech, Guildhall, London, September 10, 1947 (p. 59)

George Allen & Unwin Ltd. London, England. 1956

I do not profess to be very deeply acquainted with the science of medicine. I am not a surgeon myself. My experiences in medicine have been vivid and violent, and completely absorbing while they were going on. Nevertheless, I cannot claim that they have given me that broad, detached, general experience which, I believe, is the foundation for all correct scientific action.

Speech

March 2, 1944, Royal College of Physicians

### **Colman, George (The Younger)** 1762–1836

English playwright

When taken,

To be well shaken.

*Broad Grins*

The Newcastle Apothecary, Stanza 12

Printed for M'Creery. London, England. 1819

### **Croll, Oswald** 1560–1609

German chemist and physician

The choice also of the Medicines must always be considered, and their preparations and compositions made by the Physitian himself, and not carelessly left to others. He is truly a genuine Physitian who can tell how (not only by Reason, as mear Rationall Physitians doe, but) by their own hand to prepare the medicaments...

*Philosophy Reformed and Improved in Four Profound Tractates*  
(pp. 151–152)

Printed by M.S. for Lodowick Lloyd. London, England. 1657

**Crookshank, Francis Graham** 1873–1933

English chemist and physicist

Medicine is today an Art or Calling, to whose exercise certain Sciences are no doubt ancillary; but she has forfeited pretension to be deemed a Science, because her Professors and Doctors decline to define fundamentals or to state first principles, and to refuse to consider, in express terms, the relations between Things, Thoughts and Words involved in their communications to others.

In C.K. Ogden and I.A. Richards

*The Meaning of Meaning*

Supplement II, The Importance of a Theory of Signs and a Critique of Language in the Study of Medicine (p. 338)

Harcourt, Brace & Company. New York, New York, USA. 1949

**da Costa, J. Chalmers** 1863–1933

American physician

A medical man in the plumage of pretense resembles the humming bird, which, when stripped of its plumage, is not larger than the bumble bee.

*The Trials and Triumphs of the Surgeon*

Stepping Stones and Stumbling Blocks, Part III (p. 230)

Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

**de Cervantes, Miguel** 1547–1616

Spanish novelist, playwright, and poet

...God who sends the wound sends the salve.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part II, Chapter 19 (p. 262)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**De Guevara, Antonio** 1481–1545

Spanish chronicler and moralist

Medicine is to be praised when it is in the hands of a Physitian that is learned, grave, wise, stayed and of experience...

*The Familiar Epistles of Sir Anthonie of Guevara of Seven Notable Benefits of Proceeding From the Good Physitian* (p. 285)

Printed by Ralph Newberie. London, England. 1584

**de Madariaga, Salvador** 1886–1978

Spanish writer and statesman

There is no medicine; there are only medicine-men.

*Essays with a Purpose*

On Medicine (p. 172)

Hollis & Carter. London, England. 1954

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

The mind is so intimately dependent upon the condition and relation of the organs of the body, that if any means can ever be found to render men wiser and more ingenious than hitherto, I believe that it is in medicine they must be sought for.

*A Discourse on Method*

Part IV

J.M. Dent & Sons Ltd. London, England. 1912

**Dickens, Charles** 1812–70

English novelist

Some medical beast had revived tar-water in those days as a fine medicine, and Mrs. Joe always kept a supply of it in the cupboard; having a belief in its virtues correspondent to its nastiness. At the best of times, so much of this elixir was administered to me as a choice restorative, that I was conscious of going about, smelling like a new fence.

*Great Expectations*

Chapter II (p. 10)

Rinehart & Company, Inc. New York, New York, USA. 1948

**Dickinson, Emily** 1830–86

American lyric poet

It knew no Medicine —

It was not Sickness — then —

Nor any need of Surgery —

And therefore — 'twas not Pain —

*The Complete Poems of Emily Dickinson*

No. 559 (p. 271)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

Is Heaven a physician?

They say that He can heal;

But medicine posthumous

Is unavailable.

*The Complete Poems of Emily Dickinson*

No. 1270 (p. 555)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

There are one or two elementary rules to be observed in the way of handling patients, he remarked, seating himself on the table and swinging his legs. The most obvious is that you must never let them see that you want them. It should be pure condescension on your part seeing them at all; and the more difficulties you throw in the way of it, the more they think of it. Break your patients in early, and keep them well to heel.

*The Stark Munro Letters*

Letter VII (p. 152)

D. Appleton & Company. New York, New York, USA. 1895

And now, Doctor, perhaps you would kindly attend to my thumb, or rather to the place where my thumb used to be.



In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
 The Adventure of the Engineer's Thumb (p. 210)  
 Wings Books. New York, New York, USA. 1967

Dr. Munro, sir, said he, I am a walking museum. You could fit what isn't the matter with me on to the back of a visiting card. If there's any complaint you want to make a special study of, just you come to me, sir, and see what I can do for you. It's not every one that can say that he has had cholera three times, and cured himself by living on red pepper and brandy.

*The Stark Munro Letters*  
 Letter XII (p. 278)  
 D. Appleton & Company. New York, New York, USA. 1895

**Drake, Daniel** 1785–1852  
 American physician

Medicine is not a science of meditations, but of observation.  
*An Introductory Lecture, on the Means of Promoting the Intellectual Improvement of the Students* (p. 13)  
 Prentice & Wessinger. Louisville, Kentucky, USA. 1844

**Dryden, John** 1631–1700  
 English poet, dramatist, and literary critic

Better to hunt in Fields, for Health unbought, Than fee the Doctor for a nauseous Draught. The Wise, for Cure, on Exercise depend; God never made his Work for Man to mend.

*The Poems of John Dryden* (Volume 4)  
 To John Dryden, of Chesterton, l. 92–95 (p. 1532)  
 Longman. London, England. 1995

**Dubos, René Jules** 1901–82  
 French-born American microbiologist and environmentalist

Throughout history, and whatever the level of civilization, the structure of medicine has been determined not only by the state of science but also by religious and philosophical beliefs. This is just as true of the most evolved urban and industrialized societies as it is of the most primitive populations. Like his Stone Age ancestors, modern man lives by myths.

*Man, Medicine, and Environment* (p. 53)  
 Frederick A. Praeger. New York, New York, USA. 1968

**Flexner, Abraham** 1866–1959  
 American educator

The student...does not have to be a passive learner, just because it is too early for him to be an original explorer. He can actively master and securely fix scientific technique and method in the process of acquiring the already known.... The undergraduate student of medicine will for the most part acquire the methods, standards, and habits of science by working over territory which has been traversed before, in an atmosphere freshened by the search for truth.

*Medical Education in the United States and Canada: A Report to the Carnegie Foundation for the Advancement of Teaching*  
 Bulletin 4 (p. 57)  
 The Carnegie Foundation. New York, New York, USA. 1910

**Galsworthy, John** 1867–1933  
 English novelist and dramatist

I'm bad, he said, pouting — been bad all the week; don't sleep at night. The doctor can't tell why. He's a clever fellow, or I shouldn't have him, but I get nothing out of him but bills.

*The Forsyte Saga*  
 Book I, Part I, Chapter I (p. 11)  
 Charles Scribner's Sons. New York, New York, USA. 1948

**Garth, Sir Samuel** 1661–1719  
 English physician and poet

The Patient's Ears remorseless he assails,  
 Murthers with Jargon where his Med'cine fails.  
*The Dispensary*  
 Canto II, l. 96  
 Printed by J. Lister, at St. John's Gate. London, England. 1768

**Gregory, John** 1724–73  
 Scottish physician and philosopher

People may dispute, whether physick, on the whole, does more good or harm to mankind; just as they may dispute, whether the faculty of reason, considering how it is often perverted, really contributes to make human life more or less happy...

*Lectures on the Duties and Qualifications of a Physician* (p. 3)  
 W. Strahan. London, England. 1772

**Gull, Sir William Withey** 1816–90  
 English physician

The study of Medicine is an object lesson; the object, man's body in health and disease.

*A Collection of the Published Writings* (Volume 2) (p. lix)  
 New Sydenham Society. London, England. 1896

**Haggard, Howard W.**  
 Physician

Mystery, magic, and medicine: in the beginning they were one and the same.

*Mystery, Magic and Medicine: The Rise of Medicine from Superstition to Science* (p. 9)  
 Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Herophilus** 325 BCE–255 BCE  
 Greek physician

Medicines are nothing in themselves, if not properly used, but the very hands of the gods, if employed with reason and prudence.

In Samuel Evans Massengill  
*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 28)  
 The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

**Heschel, Abraham J.** 1907–72

Jewish theologian

Medicine is more than a profession. Medicine has a soul, and its calling involves not only the application of knowledge and the exercise of skill but also facing a human situation. It is not an occupation for those to whom career is more precious than humanity or for those who value comfort and serenity above service to others. The doctor's mission is prophetic.

*The Insecurity of Freedom*

The Patient as a Person (p. 28)

Farrar, Straus &amp; Giroux. New York, New York, USA. 1966

**Hess, Elmer**

No biographical data available

There is no great reward in our profession than the knowledge that God has entrusted us with the physical care of His people. The Almighty has reserved for Himself the power to create life but He has assigned to a few of us the responsibility of keeping in good repair the bodies in which this life is sustained.

Do Doctors Charge Too Much?

*American Weekly*, April 24, 1955**Hewitt, Barnard**

No biographical data available

Still I wish I knew a half a dozen good long medical terms to give an authentic air of learning to my conversation.

*The Doctor in Spite of Himself*

Act III (p. 67)

Row, Peterson &amp; Company. Evanston, Illinois, USA. 1941

**Hoffmann, Friedrich** 1660–1742

German physician

To live in a medical fashion, that is, according to the strict and academic rules of the physicians, is to live miserably and uncomfortably.

*Fundamenta Medicinæ*

Medical Hygiene, Chapter I, 10 (p. 103)

American Elsevier. New York, New York, USA. 1971

In physics experience can best be sought from mathematics and mechanics, chemistry, and anatomy; in medical practice experience derives most abundantly from the observations of diseases, and from more accurate histories and cures.

*Fundamenta Medicinæ*

Physiology, Chapter I, 8 (p. 5)

American Elsevier. New York, New York, USA. 1971

**Hippocrates** 460 BCE–377 BCE

Greek physician

Instruction in medicine is like the culture of the productions of the earth. For our natural disposition is, as it were, the soil; the tenets of our teacher are, as it were, the seed in the ground at the proper season; the place where

the instruction is communicated is like the food imparted to vegetables by the atmosphere; diligent study is like the cultivation of the fields; and it is time which imparts strength to all things and brings them to maturity.

*In Great Books of the Western World* (Volume 10)*Hippocratic Writings*

The Law, 3 (p. 144)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The physician must be able to tell the antecedents, know the present, and foretell the future — must mediate these things, and have two special objects in view with regard to diseases, namely, to do good or to do no harm. The art consists in three things — the disease, the patient, and the physician. The physician is the servant of the art, and the patient must combat the disease along with the physician.

*In Great Books of the Western World* (Volume 10)*Hippocratic Writings*

Of the Epidemics, 5 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

For the art of Medicine would not have been invented at first, nor would it have been made a subject of investigation (for there would have been no need of it) if when men [were] indisposed, the same food and other articles of regimen which they eat and drink when in good health were proper for them, and if no others were preferable to these. But now necessity itself made medicine to be sought out and discovered by men.

*In Great Books of the Western World* (Volume 10)*Hippocratic Writings*

On Ancient Medicine, 3 (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Medicine is of all the Arts the most noble, but, owing to the ignorance of those who practice it, and of those who, inconsiderately, form a judgment of them, it is at present far behind all the other arts. Their mistakes appear to me to arise principally from this, that in the cities there is no punishment connected with the practice of medicine (and with it alone)...

*In Great Books of the Western World* (Volume 10)*Hippocratic Writings*

The Law, 1 (p. 144)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Let us inquire then regarding what is admitted to be Medicine; namely, that which was invented for the sake of the sick, which possesses a name and practitioners.

*In Great Books of the Western World* (Volume 10)*Hippocratic Writings*

On Ancient Medicine, 2 (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hoffmann, Friedrich** 1660–1742

German physician

Frequent changes of medicines proclaims the ignorance of the physician and is calamitous for the patients.

*Fundamenta Medicinæ*

Therapeutics, Chapter I, 37 (p. 137)  
American Elsevier. New York, New York, USA. 1971

As far as medicine uses the principles of physics, it can be properly called a science; as far as it relies on practice, it can be called an art.

*Fundamenta Medicinæ*

Physiology, Chapter I, 9 (p. 6)  
American Elsevier. New York, New York, USA. 1971

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

I firmly believe that if the whole *materia medica* could be sunk to the bottom of the sea, it would be all the better for mankind and all the worse for the fishes.

Address to the Harvard Medical School  
May 30, 1860

**Hulme, Keri** 1947–

New Zealand writer

What is your objection to hospitalisation and treatment? The doctor is curious but dispassionate. Primarily, that I forgo control over myself and my destiny. Secondly, medicine is in a queer state of ignorance. It knows a lot, enough to be aware that it is ignorant, but practitioners are loath to admit that ignorance to patients. And there is no holistic treatment. Doctor does not confer with religious who does not confer with dietician who does not confer with psychologist.... What you are saying basically is that you have no trust in doctors or current medicine? Right on.

*The Bone People*

IV, 12 (pp. 415–416)  
Spiral in association with Hodder & Stoughton, Auckland, New Zealand. 1985

**Hurston, Zora Neale** 1891–1960

American writer and anthropologist

...if science ever gets to the bottom of Voodoo in Haiti and Africa, it will be found that some important medical secrets, still unknown to medical science, give it its power, rather than the gestures of ceremony.

*Dust Tracks on a Road*

Chapter X (p. 205)  
University of Illinois Press. Urbana, Illinois, USA. 1984

**Hutchison, Sir Robert Grieve** 1871–1960

English radiologist

It is unnecessary — perhaps dangerous — in medicine to be too clever.

*Lancet*, Volume 2, 1938 (p. 61)

**Huth, Edward Janavel** 1923–

American physician

Two functions are central to medicine: caring and knowing.... To survive we need to be able to read the world

around us, to deduce what may harm us, to deduce what may help us. This is knowing. When we ask physicians to care for us, we expect them to know what they need to know to help us survive. They need a special knowledge of the world...

Science, Information Systems, and the Future of Medical Practice  
*The Pharos*, Volume 49, Summer, 1986

**Huxley, Thomas Henry** 1825–95

English biologist

...“medicine” not merely denotes a kind of knowledge, but it comprehends the various applications of that knowledge to the alleviation of the sufferings, the repair of the injuries, and the conservation of health, of living beings.

*Science and Culture and Other Essays*

Chapter XIII (p. 325)  
Macmillan & Company Ltd. London, England. 1881

**Jerome, Jerome K.** 1859–1927

English author

It is a most extraordinary thing, but I never read a patent medicine advertisement without being impelled to the conclusion that I am suffering from the particular disease therein dealt with in its most virulent form.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter 1 (p. 2)  
Time Incorporated. New York, New York, USA. 1964

**Kipling, Rudyard** 1865–1936

British writer and poet

To discuss medicine before the ignorant is of one piece with teaching the peacock to sing...

*Kim*

Chapter Twelve (p. 261)  
The Modern Library. New York, New York, USA. No date

Cure them if they have fever, but by no means work charms.

*Kim*

Chapter Twelve (p. 254)  
The Modern Library. New York, New York, USA. No date

**Kraus, Karl** 1874–1936

Austrian essayist and poet

Medicine — “Your money and your life!”

In Harry Zohn (ed.)

*Half-Truths & One-and-a-Half Truths*

Lord, Forgive Them (p. 111)  
The University of Chicago Press. Chicago, Illinois, USA. 1990

**Kubler-Ross, Elisabeth** 1926–2004

Swiss-born psychiatrist

What happens in a changing field of medicine, where we have to ask ourselves whether medicine is to remain a humanitarian and respected profession or a new but depersonalized science in the service of prolonging life rather than diminishing human suffering?

*On Death and Dying*

Chapter 2 (p. 11)

The Macmillan Company. New York, New York, USA. 1969

**Lewis, Denslow** 1856–1913

Physician

It is a happy sign of the times when medical men understand that they must study sociology, that they must appreciate economic conditions, that they must face the facts and know life as it is, and not as their wishes would have it to be.

The Social Evil

*Buffalo Medical Journal*, Volume 62, 1906

**Lyly, John** 1554?–1606

English dramatist

Oh ye Gods, have ye ordeyned for every malady a medicine, for every sore a salve, for every paine a plaster...

*Euphues* (p. 61)

At the University Press. Cambridge, England. 1957

**Maugham, W. Somerset** 1874–1965

English novelist and playwright

The medical profession is the only one which a man may enter at any age with some chance of making a living.

*Of Human Bondage*

Chapter LV (p. 243)

Doubleday & Company, Inc. Garden City, New York, USA. 1936

**Manning, P. E.**

No biographical data available

**DeBakey, L.**

No biographical data available

An inquiring, analytical mind; an unquenchable thirst for new knowledge; and a heartfelt compassion for the ailing — these are prominent traits among the committed clinicians who have preserved the passion for medicine.

*Medicine: Preserving the Passion*

Precedes First Chapter

Springer-Verlag. New York, New York, USA. 1987

**Martin, Walter**

No biographical data available

The very success of medicine in a material way may now threaten the soul of medicine. Medicine is something more than the cold mechanical application of science to human disease. Medicine is a healing art. It must deal with individuals, their fears, their hopes and their sorrows. It must reach back further than a disease that the patient may have to those physical and emotional environmental factors which condition the individual for the reception of disease.

Inaugural Address

American Medical Association, news report of June 23, 1954

**Mather, Cotton** 1663–1728

American minister and religious writer

...[there is an] angelical conjunction of medicine with divinity.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter III (p. 69)

Clarendon Press. Oxford, England. 1925

**Mayo, Charles Horace** 1865–1939

American physician

While medicine is a science, in many particulars it cannot be exact, so baffling are the varying results of varying conditions human life.

*Collected Papers of the Mayo Clinic & Mayo Foundation* (1905–1909)

President's Address

W.B. Saunders Company. Philadelphia, Pennsylvania, USA. 1909

It would seem that the study of medicine does not always contribute to broadmindedness, as men who choose medicine as a profession are apt to lose rather than gain breadth of perception. It could be said rather that medicine develops individualism.

The Value of Broadmindedness

*Medical Life*, Volume 34, April 1927

Medicine can be used only as people are educated to its accomplishments.

International Medical Progress

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 23, 1931

**Mayo, William J.** 1861–1939

American physician

The aim of medicine is to prevent disease and prolong life; the ideal of medicine is to eliminate the need of a physician.

The Aims and Ideals of the American Medical Association

*Proceedings of the National Education Association*, Volume 66, 1928

The church and the law deal with the yesterdays of life; medicine deals with the tomorrows.

The Preliminary Education of the Clinical Specialist

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 23, 1931

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

The aim of medicine is surely not to make men virtuous: it is to safeguard and rescue them from the consequences of their vices. The true physician does not preach repentance; he offers absolution.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#3942 (p. 219)

Harper & Row, Publishers. New York, New York, USA. 1969

One of the chief objects of medicine is to save us from the natural consequences of our vices and follies. The moment it becomes moral it becomes quackery. A scientific

physician should have no opinion about the ethical standards and deserts of his patient.

*Minority Report: H.L. Mencken's Notebooks*

Number 7 (p. 7)

Alfred A. Knopf. New York, New York, USA. 1956

**Merck, George** 1894–1957

American scientist

Medicine is for the patient. Medicine is for the people. It is not for the profits.

*Time*, November 3, 1952

**Minot, George R.** 1885–1950

American physician

Medicine disregards international boundaries. The physician studies for the benefit of mankind.

*Les Prix Nobel. The Nobel Prizes in 1934*

Nobel banquet speech for award received in 1934

Nobel Foundation. Stockholm, Sweden. 1935

**Morgan, John**

No biographical data available

As the most precious metals in a state of ore are mixed with dross, so the choice truths of Medicine are frequently blended with a heap of rubbish.

*A Discourse upon the Institution of Medical Schools in America* (p. 48)

William Bradford. Philadelphia, Pennsylvania, USA. 1765

**Mumford, E.**

No biographical data available

Medicine is the science of uncertainty and an art of probability.

*From Students to Physicians* (p. 158)

Harvard University Press. Cambridge, Massachusetts, USA. 1970

**Morris, Joseph F.**

No biographical data available

Medical reporter — Staph writer.

*Quote, the Weekly Digest*, July 21, 1968 (p. 57)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Every medical student should remember that his end is not to be a chemist, or a physiologist or an anatomist, but to learn how to recognize and treat disease, to become a practical physician.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter X (p. 100)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

The [medical] student often resembles the poet — he is born, not made.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Student Life (p. 397)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The critical sense and skeptical attitude of the Hippocratic school laid the foundation of modern medicine on broad lines, and we owe to it: first, the emancipation of medicine from the shackles of priestcraft and of caste; secondly, the conception of medicine as an art based on accurate observation, and as a science, an integral part of the science of man and of nature; thirdly, the high moral ideals, expressed in that “most memorable of human documents” (Gomperz), the Hippocratic oath; and fourthly, the conception and realization of medicine as the profession of a cultivated gentleman.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 266)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The desire to take medicine is perhaps the greatest feature which distinguishes man from animal.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XIV (p. 342)

Clarendon Press. Oxford, England. 1925

...medicine, unlike law and theology, is a progressive science...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter VI (p. 129)

Clarendon Press. Oxford, England. 1925

**Ovid** 43 BCE–17 AD

Roman poet

The healing art knows not how to remove crippling gout, it helps not the fearful dropsy.

In Arthur Lislie Wheeler

*Ovid with an English Translation*

Ex Ponto, Book I, iii (pp. 281, 283)

Harvard University Press. Cambridge, Massachusetts, USA. 1924

For the sharp medic'cine is the patient's cure.

*The Art of Love*

Amores, Book III, Elegy XI, l. 21

Medicine sometimes removes, sometimes bestows safety, showing what plant is healthful, what harmful.

*Ovid with an English Translation*

Tristia, Book II, l. 269

Harvard University Press. Cambridge, Massachusetts, USA. 1924

...the same object will both wound and cure me.

*Ovid with an English Translation*

Tristia, Book II, l. 20

Harvard University Press. Cambridge, Massachusetts, USA. 1924

**Paracelsus (Theophrastus Phillipus Aureolus**

**Bombastus von Hohenheim)** 1493–1541

Alchemist and mystic

The art of medicine cannot be inherited nor can it be copied from books.

*Das Zweite Buch der Grossen Wundarznei*

Foreword  
 Publisher undetermined

**Pavlov, Ivan Petrovich** 1849–1936  
 Russian physiologist

Only by passing through the fire of experiment will medicine as a whole become what it should be, namely a conscious and, hence, always purposefully acting science.

*Experimental Psychology and Other Essays*  
 Fusion of Principal, Branches of Medicine in Modern Experimentation as Demonstrated by the Example of Digestion (p. 493)  
 Philosophical Library. New York, New York, USA. 1957

**Peabody, Francis Weld** 1881–1927  
 Physician

There is no more contradiction between the science of medicine and the art of medicine than between the science of aeronautics and the art of flying.

*The Care of the Patient*  
 The Care of the Patient (p. 10)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1928

Medicine is not a trade to be learned but a profession to be entered.

*The Care of the Patient*  
 The Care of the Patient (p. 9)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Petrarch (Francesco Petrarca)** 1304–74  
 Italian poet and humanist

When we see how doctors themselves live, how their slight illnesses turn to tragic ends, we may well suspect that this thing called medicine, whatever it may be in itself, is yet among men a certain art of deception, invented to men's peril, to enrich a few and endanger many. Or we may think it a true art, contrived for useful ends, but little understood by men of our time. Or perhaps better, it may be understood, but hardly applicable to men's natures, in their infinite and incredible variety.

*Letters from Petrarch*  
 Letters; Book XII, 2  
 To Giovanni Dondi of Padua (p. 283)  
 Indiana University Press. Bloomington, Indiana, USA. 1966

**Porter, Roy** 1946–2002  
 English historian

Medicine is a notoriously messy mix of laboratory research and clinical crisis, the itch for knowledge and the need to act. Different experts contribute diverse skills, and the whole has been likened to a jigsaw [puzzle] being pieced together by total strangers, each of whom is only guessing at the picture.

Offering Resistance: The Checkered History and Contemporary Travails of Cancer Immunotherapy  
*The New York Times*, 29 June, 1997 (p. 9)

**Proust, Marcel** 1871–1922  
 French novelist

For, medicine being a compendium of the successive and contradictory mistakes of medical practitioners, when we summon the wisest of them to our aid, the chances are that we may be relying on a scientific truth the error of which will be recognized in a few years' time.

Translated by Mark Trehame  
*The Guermantes Way*  
 Part I, My Grandmother's Illness (p. 292)  
 The Penguin Group. New York, New York, USA. 1888

**Renard, Jules**  
 No biographical data available

There is nothing so sickening as to leaf through a medical dictionary.

In Evan Esar  
*20,000 Quips and Quotes* (p. 511)  
 Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Robinson, Victor** 1886–1947  
 Physician

Medicine is a natural art, conceived in sympathy and born of necessity...

*The Story of Medicine*  
 Chapter I (p. 1)  
 The New York Home Library. New York, New York, USA. 1943

**Romains, Jules** 1885–1972  
 French author

Medicine is a rich soil but it doesn't yield its harvest unaided.

*Knock*  
 Act 1 (p. 11)  
 Barron's Educational Series, Inc. Great Neck, New York, USA. 1962

**Romanoff, Alexis Lawrence** 1892–1980  
 Russian soldier and scientist

The desire to live is the best medicine of all.

*Encyclopedia of Thoughts*  
 Aphorisms 2048  
 Ithaca Heritage Books. Ithaca, New York, USA. 1975

Good medicine is man's salvation;  
 Excessive use gives aggravation.  
*Encyclopedia of Thoughts*  
 Couplets  
 Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Sacks, Oliver W.** 1933–  
 American neurologist and author

We rationalize, we dissimilate, we pretend: we pretend that modern medicine is a rational science, all facts, no nonsense, and just what it seems. But we have only to tap its glossy veneer for it to split wide open, and reveal to us its roots and foundations, its old dark heart of metaphysics, mysticism, magic and myth.

*Awakenings*  
 Prologue (p. 28)  
 Vintage Books. New York, New York, USA. 1990

**Sammonicus, Serenus** ? 2<sup>nd</sup> century  
Roman savant

Thou shalt on paper write the spell divine,  
Abracadabra called, in many a line;  
Each under each in even order place,  
But the last letter in each line efface.  
As by degrees the elements grow few  
Still take away, but fix the residue,  
Till at the last one letter stands alone  
And the while dwindles to a tapering cone.  
Tie this about the neck with flaxen string;  
Mighty the good 'twill to the patient bring.  
Its wondrous potency shall guard his head —  
And drive disease and death far from his bed.

In Victor Robinson  
*The Story of Medicine*  
Chapter VII (p. 194)  
The New York Home Library. New York, New York, USA. 1943

**Scarlett, Earle P.**  
Physician

Their lot has always been much the same. Hard work,  
long hours, poor accommodation for the majority, a sharp  
meeting with reality at a relatively young age, a long grind  
of years — these have prevailed in every generation.

In C.G. Roland (ed.)  
*In Sickness and in Health: Reflections on the Medical Profession* (p. 3)  
McClelland & Stewart. Toronto, Ontario, Canada. 1972

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

It is not the fault of our doctors that the medical service  
of the community, as at present provided for, is a mur-  
derous absurdity. That any sane nation, having observed  
that you could provide for the supply of bread by giving  
bakers a pecuniary interest in baking for you, should  
go on and give a surgeon a pecuniary interest in cutting  
off your leg, is enough to make one despair of political  
humanity.

*The Doctor's Dilemma*  
Preface on Doctors (p. v)  
Brentano's. New York, New York, USA. 1920

Doctoring is not even the art of keeping people in health  
(no doctor seems able to advise you what to eat any better  
than his grandmother or the nearest quack): it is the art  
of curing illnesses.

*The Doctor's Dilemma*  
Preface on Doctors  
Are Doctors Men of Science? (p. xxx)  
Brentano's. New York, New York, USA. 1920

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

What physician can heal his patient on a flying visit?  
*Ad Lucilium Epistulae Morales* (Volume 1)  
Epistle xl, Section 4

It is medicine, not scenery, for which a sick man must go  
a-searching.

Translated by Richard M. Gummere  
*Ad Lucilium Epistulae Morales* (Volume 3)  
Epistle civ, Section 18 (p. 201)  
Harvard University Press. Cambridge, Massachusetts,  
USA. 1925

...not even medicine can master incurable diseases.

Translated by Richard M. Gummere  
*Ad Lucilium Epistulae Morales* (Volume 3)  
Epistle xciv, Section 24 (p. 27)  
Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Not poppy, nor mandragora, Nor all the drowsy syrups  
of the world, Shall ever medicine thee to that sweet sleep  
Which thou ow'dst yesterday.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Othello, The Moor of Venice  
Act III, Scene iii, l. 331–334  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Out, loathed medicine! hated potion, hence!

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
A Midsummer-Night's Dream  
Act III, Scene ii, l. 264  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Great griefs, I see medicine the less.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Cymbeline  
Act IV, Scene ii, l. 244  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smollett, Tobias George** 1721–71  
Scottish novelist

...Sir, the practice of medicine is one of the most hon-  
ourable professions exercised among the sons of men;  
a profession which hath been revered at all periods and  
in all nations, and even held sacred in the most polished  
ages of antiquity.

*The Life and Adventures of Sir Launcelot Greaves*  
Chapter XXIV (p. 192)  
Oxford University Press, Inc. London, England. 1973

**Starr, Paul** 1949–  
Professor of sociology

The organizational culture of medicine used to be  
dominated by the ideals of professionalism and vol-  
unteerism which softened the underlying acquisitive  
activity. The restraint exercised by these ideals now  
grows weaker, the health center of one era is the profit  
center of the next.

*The Social Transformation of American Medicine* (p. 448)  
Basic Books, Inc., Publishers. New York, New York, USA. 1982

Modern medicine is one of those extraordinary works of reason: an elaborate system of specialised knowledge, technical procedures, and rules of behavior.

*The Social Transformation of American Medicine*

Introduction (p. 3)

Basic Books, Inc., Publishers. New York, New York, USA. 1982

The medical profession has had an especially persuasive claim to authority. Unlike the law and the clergy, it enjoys close bonds with modern science, and at least for most of the last century, scientific knowledge has held a privileged status in the hierarchy of belief.

*The Social Transformation of American Medicine*

Introduction (p. 4)

Basic Books, Inc., Publishers. New York, New York, USA. 1982

### **Steinbeck, John** 1902–68

American novelist

The medical profession is unconsciously irritated by lay knowledge.

*East of Eden*

Chapter 54, Section 1 (p. 589)

The Viking Press. New York, New York, USA. 1952

### **Sydenham, Thomas** 1624–89

English physician

Inasmuch as the structure of the human frame has been so set together by Nature, that it is unable, from the continuous flux of particles, to remain unchanged; whilst, from the action of external causes, it is subjected to influences beyond its own: and since, for these reasons, a numerous train of diseases has pressed upon the earth since the beginning of time; so without doubt the necessity of investigations into the Art of Healing has exercised the wit of mankind for many ages.

*The Works of Thomas Sydenham, MD*

3<sup>rd</sup> ed., Volume 1

Classics of Medicine Library, Birmingham. 1979

### **Szasz, Thomas** 1920–

Hungarian-born American psychiatrist

Formerly, when religion was strong and science weak, men mistook magic for medicine; now, when science is strong and religion weak, men mistake medicine for magic.

*The Second Sin*

Science and Scientism (p. 128)

Anchor Press/Doubleday. Garden City, New Jersey, USA. 1974

### **Thomas, Lewis** 1913–93

American physician and biologist

There is within medicine, somewhere beneath the pessimism and discouragement resulting from the disarray of the health-care system and its stupendous cost, an undercurrent of almost outrageous optimism about what may lie ahead for the treatment of human disease if we can only keep learning.

*The Medusa and the Snail: More Notes of a Biology Watcher*

Medical Lessons from History (p. 166)

The Viking Press. New York, New York, USA. 1979

### **Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Any mummerly will cure if the patient's faith is strong in it.

*A Connecticut Yankee in King Arthur's Court*

Chapter XXVI (p. 234)

Harper & Brothers Publishers. New York, New York, USA. 1899

### **Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

...practical medicine is never the same thing as scientific medicine but rather, even in the hands of the greatest master, an application of it.

Translated by Lelland J. Rather

*Disease, Life, and Man*

Standpoints in Scientific Medicine (p. 27)

Stanford University Press. Stanford, California, USA. 1958

No physiologist or practitioner ought ever to forget that medicine unites in itself all knowledge of the laws which apply to the body and the mind.

Translated by Lelland J. Rather

*Disease, Life, and Man*

Scientific Method and Therapeutic Standpoints (p. 66)

Stanford University Press. Stanford, California, USA. 1958

### **von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Medicine's spirit one can grasp with ease.

The great and little world you study though

To let things finally their course pursue

As God may please.

In *Great Books of the Western World* (Volume 47)

*Faust*

The First Part

Auerbach's Cellar, I. 2011–2014

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Williams, William Carlos** 1883–1963

American physician and poet

My "medicine" was the thing that gained me entrance to these secret gardens of the self. It lay there, another world, in the self. I was permitted by my medical badge to follow the poor, defeated body into these gulfs and grottos.

In M.L. Rosenthal

*The William Carlos Williams Reader* (p. 307)

New Directions. New York, New York, USA. 1966

### **Young, Edward** 1683–1765

English poet and dramatist

Will toys amuse, when med'cines cannot cure?

*Night Thoughts*

Night II, l. 67 (p. 21)

Printed by R. Nobels for R. Edwards. London, England. 1797



# Index

## Symbols

19th Century Naval Song 1457  
6th Baron Byron 762

## A

Abbe, Cleveland 1246  
Abbey, Edward 26, 67, 156, 172, 256, 334, 337, 432, 451, 653, 710, 740, 759, 928, 942, 959, 968, 970, 1064, 1143, 1161, 1197, 1208, 1230, 1260, 1262, 1269, 1417, 1579, 1640, 1649, 1715, 1720  
Abbey, Henry 1056  
Abbot, Charles 186  
Abbot, Charles Greeley 116, 509, 774  
Abbott, Donald Putnam 696, 1025, 1091, 1574  
Abbott, Edwin A. 345, 517  
Abbott, Roy L. 41  
Abel, Niels Henrik 803, 1459  
Abel, Reuben 436  
Abelard, Peter 1722  
Abelson, Philip H. 509  
Abernethy, John 1073, 1365  
Accreditation Board for Engineering and Technology 447  
Ace, Goodman 641, 894  
Achard, Franz Karl 1117  
Ackerman, Diane 26, 54, 59, 66, 75, 79, 144, 188, 322, 759, 970, 1010, 1143, 1153, 1155, 1188, 1374, 1696  
Ackerman, Edward A. 1417  
Ackoff, Russell Lincoln 270, 970  
Acton, F. S. 1575  
Acton, John Emerich 653  
Acton, Loren 1502  
Adam, John A. 1624  
Adams, Abby 970  
Adams, Charles C. 383  
Adams, Douglas 37, 336, 375, 510, 679, 711, 759, 1007, 1025, 1076, 1108, 1174, 1215, 1244, 1430, 1477, 1551, 1595, 1673, 1696  
Adams, Franklin Pierce 437  
Adams, George 12, 281, 437, 515, 516, 547, 609, 664, 711, 889, 892, 920, 963, 970, 1046, 1244, 1246, 1382, 1502, 1624, 1649  
Adams, Henry Brooks 80, 224, 486, 517, 581, 606, 803, 869, 1109, 1269, 1382, 1526  
Adams, John 1174  
Adams, Robert 1091  
Adams, Roger 74  
Adams, Samuel Hopkins 894, 1072  
Addis, Thomas 261, 1704  
Addison, Joseph 377, 633, 712, 942, 971  
Addison, Thomas 8  
Adelman, Leonard 1164  
Adler, Alfred 305, 804, 870, 1579  
Advertisement 310, 620, 1526  
Aeschylus 284, 1013, 1040, 1167  
Aesop 230, 1206  
Agassiz, Jean Louis Rodolphe 26, 48, 213, 257, 278, 292, 301, 451, 517, 591, 959, 962, 968, 971, 1039, 1081, 1143, 1409, 1426, 1494, 1549, 1727, 1737  
Ager, Derek 378  
Agnew, Neil McK. 1246, 1421  
Agnew, Ralph Palmer 559, 567, 653, 1188, 1430  
Agre, Peter 1411  
Agricola, Georgius 929  
Aiken, Conrad 1502  
Airy, George Biddell 116, 1144  
Ajello, Libero 568  
Akenside, Mark 201, 670, 1270  
Albright, Fuller 894  
Albritton, William Foxwell 91  
Albritton, Jr., Claude 304  
Albutt, Thomas Clifford 11

- Alcott, Louisa May 517  
 Aldersey-Williams, Hugh 236, 937  
 Alderson, M. H. 147  
 Aldrich Thomas Bailey 971  
 Aleksandrov, Aleksandre Danilovic 804  
 Alexander, Burton F. 1575  
 Alexander, Christopher 222  
 Alexander, Franz 310  
 Alexander, R. McNeill 347  
 Alexander, William 911  
 Alexander the Great 1093  
 Alfven, Hannes 299, 1477, 1673  
 Alger, John R. M. 408, 1188, 1498  
 Alger, William R. 942  
 Alighieri, Dante 633, 712, 774, 918, 1270, 1502  
 Alison, Richard 1585  
 Allaby, (John) Michael 383  
 Allee, Warder C. 26, 54, 169  
 Allen, Charles M. 1579  
 Allen, Dave 609  
 Allen, Durward L. 169, 322  
 Allen, Elizabeth Akers 1636  
 Allen, Ethan 609  
 Allen, Grant 49, 452, 968  
 Allen, Robert Porter 46, 222  
 Allen, Roy George Douglas 21, 1526  
 Allen, Woody 294, 804, 1063, 1551, 1617  
 Allison, G. Burgess 389  
 Allman, David 322, 1093  
 Allport, Gordon 1382  
 Allport, Susan 188, 1270  
 Alon, Noga 505  
 Alpher, Ralph Asher 1382  
 Alphonsus X 162  
 Altmann, Jeanne 1025  
 Alvarez, Luis Walter 183, 1117, 1215, 1262, 1501  
 Alves, Reuben 1270  
 Amaldi, Ginestra Giovane 312, 1010, 1673  
 Amati, Danielle 1549  
 Ambler, Eric 213  
 Amend, Bill 510  
 American Geophysical Union 259  
 American Institute of Biological Science 1963 1084  
 American Museum of Natural History 517  
 American Society for Engineering Education 422  
 Ames, Bruce 1161  
 Ames, Nathaniel 1206  
 Amiel, Henri-Frédéric 11, 310, 437, 578, 628, 1270  
 Amis, Martin 1718  
 Ammons, Archie Randolph 64  
 Ampere, Andre-Marie 517  
 Amundson, Ronald 642  
 Anaxagoras 446, 684, 1048  
 Anderson, Peggy 1022  
 Anderson, Poul 209, 1188  
 Anderson, Tempest 1710  
 Andreas, Brian 1502  
 Andreski, Stanislav 145  
 Andric, Ivo 191  
 Angell, Roger 1526  
 Angelou, Maya 347  
 Anglin, William S. 804  
 Anscombe, Francis John 328, 437, 1025, 1521  
 Anyidoho, Kofi 1711  
 Apfel, Necia H. 1673  
 Apollo 11 107  
 Apostle, Hippocrates George 804  
 Appleton, Sir Edward 1354, 1430  
 Appleyard, Bryan 1270, 1382, 1430  
 Aquinas, St. Thomas 201, 213, 452, 1722  
 Arabic Proverb 1270  
 Arago, Francois 116, 387, 804  
 Aratus 284, 289, 1502  
 Arber, Agnes Robertson 167, 1421  
 Arbuthnot, John 14, 712, 804, 1175  
 Archilochus 381  
 Archimedes of Syracuse 450, 759, 1013, 1265  
 Archytas of Tarentum 689  
 Ardrey, Robert 82, 694, 760, 792, 1365  
 Arendt, Hannah 1144  
 Argelander, Friedrich Wilhelm August 1025  
 Arieti, Silvano 305  
 Aristo, Chian 805  
 Aristophanes 548  
 Aristotle 105, 156, 188, 202, 209, 222, 257, 517, 547,  
 609, 640, 654, 679, 712, 782, 805, 971, 1013,  
 1144, 1472, 1567, 1625, 1649, 1723  
 Armitage, Simon 737  
 Armour, Richard 8, 25, 1073  
 Armstrong, David Malet 1163, 1459  
 Armstrong, Henry Edward 231, 236  
 Armstrong, John 181, 188, 894  
 Armstrong, Martin D. 573  
 Armstrong, Neil A. 946, 1165, 1482  
 Arnaldus de Villa Nova 1093  
 Arnauld, Antoine 270, 1230  
 Arnheim, Rudolf 231, 1266  
 Arnold, James R. 1482  
 Arnold, John E. 80  
 Arnold, Matthew 517, 972  
 Arnold, Sir Edwin 1564, 1640  
 Arnold, Thurman 328  
 Arnoldus 341  
 Arnott, Neil 621, 1665  
 Aron, Raymond 213, 295, 557  
 Aronin, Ben 408  
 Aronowitz, Stanley 1649  
 Arp, Halton Christian 1025

- Arthur, Timothy Shay 202  
 Artstein, Zvi 805  
 Artuad, Antonin 1430  
 Arwaker, Edmund 408  
 Ascham, Roger 870  
 Ashby, Sir Eric 1579  
 Ashlock, P. D. 737  
 Asimov, Isaac 86, 179, 236, 323, 422, 490, 609, 712,  
 788, 792, 805, 889, 954, 1013, 1084, 1165, 1240,  
 1246, 1270, 1354, 1369, 1396, 1406, 1482, 1495,  
 1595, 1620, 1702  
 Askey, Vincent 641  
 Asphaug, Erik 106  
 Asquith, Herbert 642  
 Association of American Colleges 1580  
 Astaire, Fred 213, 1081  
 Astbury, William Thomas 1270  
 Aston, Francis W. 402  
 Astronomy Survey Committee 1470  
 Atchity, Kenneth 670  
 Aterman, Kurt 781  
 Athenaeus 1547  
 Atherton, Gertrude 147, 202, 972  
 Atiyah, Sir Michael 1665  
 Atkins, Peter William 81, 128, 231, 236, 270, 276, 504,  
 805, 1077, 1617, 1673  
 Atkins, Russell 1175  
 Atkinson, Brooks 32  
 Atkinson, Richard John Copeland 91  
 A Traveler 517  
 Atwood, Margaret 1010  
 Auden, W. H. 870, 1430  
 Audubon, John James 35, 39, 40, 45, 46, 378, 712, 972,  
 1056  
 Auenbrugger, Leopold 1077  
 Aurelius Antoninus, Marcus 202, 445, 452, 689, 1025,  
 1093, 1502, 1625, 1673  
 Austen, Jane 195, 950, 1175  
 Auster, Paul 1013, 1169, 1200  
 Austin, Alfred 236  
 Austin, Mary Hunter 68, 74, 335, 792, 950, 1269  
 Author undetermined 14, 30, 46, 51, 58, 64, 66, 68, 72,  
 78, 83, 101, 144, 184, 231, 264, 331, 352, 374,  
 376, 378, 389, 400, 401, 408, 436, 517, 561, 574,  
 593, 743, 805, 927, 928, 929, 936, 954, 1008,  
 1056, 1070, 1090, 1093, 1109, 1117, 1139, 1214,  
 1246, 1262, 1270, 1369, 1421, 1557, 1576, 1640,  
 1665, 1711, 1719, 1732  
 Auvaiyaar 1702  
 Avedon, Richard 1649  
 Avicenna 950  
 Avogadro, Amedeo 1714  
 Awiakta, Marilou 156  
 Ayala, Francisco J. 642, 1084, 1586  
 Ayer, Alfred Jules 1070, 1596  
 Aylett, Robert 1557  
 Ayres, Clarence Edwin 1025, 1164  
 Aytoun, William Edmondstoune 144
- B**
- Babbage, Charles 744  
 Babylonian Inscription 264  
 Babylonian Sun-God Marduk 285  
 Bach, Richard 712  
 Bachelard, Gaston 402  
 Bachrach, Arthur J. 1246  
 Bacon, Leonard 1673  
 Bacon, Roger 805, 1705, 1732  
 Bacon, Sir Francis 2, 23, 85, 97, 152, 156, 202, 211,  
 213, 341, 344, 353, 367, 452, 491, 517, 574, 670,  
 681, 696, 704, 712, 805, 894, 972, 1013, 1048,  
 1094, 1117, 1225, 1265, 1271, 1350, 1377, 1431,  
 1549, 1625, 1649, 1665, 1674  
 Baden-Powell, Robert Stephenson Smyth 128  
 Baeyer, Adolf von 275  
 Baez, Joan 642  
 Bagehot, Walter 2, 654, 1175, 1674  
 Baggott, Jim 211  
 Bagnold, Enid 545  
 Bagnold, Ralph A. 1469  
 Bahn, Paul 88, 91, 1188  
 Bailar, Jr., John C. 236  
 Bailey, Edward Battersby 1160  
 Bailey, Geoff 91  
 Bailey, Janet 1464  
 Bailey, Liberty Hyde 1640  
 Bailey, Percival 1094  
 Bailey, Philip James 408, 684, 972, 1477, 1503, 1551  
 Bailey, Thomas D. 147  
 Bailey, W. B. 1522, 1527  
 Bailey, William Whitman 1157, 1640, 1719  
 Baillie, Joanna 408  
 Baily, Francis 381  
 Bain, Alexander 257, 806  
 Baines, J. A. 1527  
 Bajer, Francis J. 916  
 Bak, Per 452  
 Baker, Adolph 1109  
 Baker, Henry 437, 916, 972, 1026, 1457  
 Baker, Russell 905, 1431  
 Baker, W. R. 345  
 Bakker, Robert T. 347, 1061  
 Balard, Antoine-Jérôme 1271  
 Balchin, Nigel 295, 518, 1523, 1527  
 Baldwin, J. Mark 1621  
 Baldwin, Joseph G. 1094  
 Balfour, Arthur James 87, 486, 889, 1649, 1699  
 Balifour, Arthur J. 793

- Ball, John 931  
 Ball, Philip 162, 231, 389, 760, 937, 1144, 1204  
 Ball, Sir Robert S. 1156, 1246  
 Ball, Walter William Rouse 1117  
 Ballard, Chris 91  
 Ballard, James Graham 1406, 1580  
 Ballard, Robert 760  
 Banach, Stefan 19  
 Bangs, Richard 1715  
 Banks, Iain M. 17  
 Banks, Sir Joseph 1139  
 Banting, Frederick G. 698  
 Barbauld, Anna Laetitia 61  
 Barbellion, Wilhelm Nero Pilate 372, 452, 1674  
 Barbour, Julian 1665  
 Barcroft, Joseph 344  
 Barfield, Owen 270, 642, 670, 713, 1649  
 Baring, Maurice 367  
 Barley, Nigel 83  
 Barnard, Christiaan N. 630  
 Barnard, Edward Emerson 1153  
 Barnes, Barry 1064  
 Barnes, Bishop 1477  
 Barnes, Djuna 104, 630, 1022, 1462  
 Barnes, Michael R. 1076  
 Barnett, I. A. 1021  
 Barnett, Lincoln 1109, 1271, 1491, 1617, 1625  
 Barnett, P. A. 806, 1230  
 Baron Munchausen 702  
 Baron von Frankenstein 972  
 Barr, Amelia Edith Huddleston 1431  
 Barr, H. F. 559  
 Barrell, Joseph 1144  
 Barrett-Browning, Elizabeth 37, 39, 43, 549, 581, 638, 1013, 1527, 1641  
 Barrie, Sir James M. 14, 44, 518, 713, 1246, 1360  
 Barrow, Gordon M. 937  
 Barrow, Isaac 806, 870, 1625  
 Barrow, John D. 402, 1045, 1070, 1084, 1175, 1208, 1244, 1468, 1696  
 Barry, Dave 387, 1396  
 Barry, Frederick 518, 642, 713, 806, 1175  
 Barth, John 353, 1674  
 Barthelme, Donald 1081  
 Barthes, Roland 740  
 Bartlett, Albert A. 806  
 Bartlett, Elisha 172, 236, 642  
 Bartlett, Elizabeth 684  
 Bartlett, Maurice Stevenson 155, 1527  
 Bartol, C. A. 579  
 Bartow, Edward 236  
 Bartram, William 432  
 Bartusiak, Marcia 744  
 Baruch, Bernard M. 129, 310, 447, 518, 1271  
 Barwise, Jon 1460  
 Barzun, Jacques 756, 1271, 1576, 1580  
 Bashford, Sir Henry Howarth 576  
 Baskerville, Charles 1271  
 Bass, Murray H. 1094  
 Bass, William M. 1272  
 Bassler, Thomas J. 323  
 Bastin, Ted 209  
 Batchelor, G. K. 1421  
 Bates, Henry Walter 59, 452  
 Bates, Marston 282, 323, 518, 760, 793, 1246, 1272  
 Bates, R. L. 593  
 Bates, Rhonda 1161  
 Bateson, William 209, 452, 485, 635, 963, 1245  
 Batten, Henry L. 1288  
 Battles, William Snowden 642  
 Baudelaire, Charles 1503  
 Baudrillard, Jean 697, 1272, 1527  
 Baudrimont, A. E. 1225  
 Bauer, Georg (Agricola or Georgius Agricola) 1026  
 Bauer, Henry H. 81, 312, 1084, 1272, 1396, 1411, 1417  
 Baum, Harold 375, 1091  
 Baum, L. Frank 1247  
 Baumel, Judith 631, 1021  
 Baxter, Richard 1637  
 Bayliss, William Maddock 1409  
 Baynes, Ernest Harold 36  
 Beacock, Cal 553  
 Beadle, George Wells 575  
 Beale, Thomas 75  
 Beam, Alex 263  
 Beard, Charles A. 1272, 1363  
 Beard, George M. 437  
 Beattie, James 222, 1272  
 Beaumarchais, Pierre-Augustin Caron de 1230  
 Beaumont, Francis 310, 972  
 Beaumont, William 518, 1650  
 Beaver, Wilfred 64  
 Becher, Johann Joachim 232  
 Beck, Lewis White 1230  
 Becker, Carl L. 713, 793, 1411, 1665, 1726  
 Becker, Ernest 1650  
 Beckett, Chris 946  
 Beckett, Samuel 638, 1022, 1647  
 Beckmann, Petr 567, 1138  
 Bednyi, Demian 129  
 Beebe, William 31, 62, 518, 806, 973, 1040, 1272, 1452, 1719  
 Beecher, Henry Ward 453, 549, 1215, 1637  
 Beer, Stafford 1580  
 Beerbohm, Max 689  
 Begley, Sharon 806, 1013  
 Beguinus, Jean 237  
 Behe, Michael 453

- Belinfante, Frederik Jozef 1208  
 Belinsky, Vissarion Grigorievich 654, 1197  
 Belinsky, Vissarion Grigoryevich 518  
 Belitz, K. 934  
 Belkora, Leila 316  
 Bell, David F. 1299  
 Bell, E. T. (Eric Temple) 1, 21, 105, 213, 270, 402, 598, 625, 779, 785, 806, 871, 1013, 1118, 1200, 1215, 1495, 1527, 1592, 1723  
 Bell, J. A. 889  
 Bell, R. P. 1081  
 Bell, Sir Charles 1059  
 Bellamy, David 1144  
 Belleville, Nicholas 1096  
 Bellman, Richard 402, 807  
 Belloc, Hilaire 45, 47, 71, 72, 73, 74, 76, 195, 211, 271, 367, 953, 1247, 1523, 1527  
 Bellow, Saul 1523  
 Benchley, Peter 53  
 Benchley, Robert 129, 209, 262, 389  
 Benét, William Rose 1503  
 Benford, Gregory 1592  
 Benjamin, Arthur 331  
 Bennett, Arnold 117, 271, 1727  
 Bennett, Charles H. 195  
 Bennett, Jeffrey O. 108  
 Bennett, William Cox 1272  
 Bent, Henry Albert 237  
 Bentley, Arthur 807  
 Bentley, Richard 129, 609  
 Bentley, Wilson 1472  
 Benzer, Seymour 575  
 Bergaust, Erik 1477, 1666  
 Berger, J. O. 1527  
 Berger, John 1452  
 Berger, Peter L. 1382  
 Bergman, Charles 283  
 Bergman, Torbern Olaf 1666  
 Bergmann, P. 1109  
 Bergson, Henri 202, 453, 699, 807, 1118, 1477, 1625, 1637, 1674  
 Berkeley, Edmund C. 195, 318, 1189, 1596  
 Berkeley, George 334, 553, 598, 684, 1360, 1666  
 Berkenhout, John 894  
 Berlinski, David 198, 581, 778, 807, 1491  
 Bernal, John Desmond 237, 263, 504, 692, 760, 957, 1200, 1272, 1355, 1382, 1483  
 Bernard, Claude 147, 167, 202, 353, 437, 491, 502, 503, 518, 638, 642, 654, 713, 744, 760, 808, 894, 912, 1026, 1046, 1053, 1082, 1085, 1094, 1230, 1273, 1360, 1365, 1411, 1425, 1528, 1545, 1596, 1650  
 Bernoulli, Daniel 871  
 Bernstein, Al 1206  
 Bernstein, Jeremy 8, 19, 183, 664, 1396, 1596  
 Berrett, Wayne 377  
 Berrill, Norman John 760, 1576, 1723  
 Berry, Arthur 664  
 Berry, D. A. 1528  
 Berry, Daniel M. 1014  
 Berry, James H. 1585  
 Berry, M. V. 1118, 1258  
 Berry, Richard 1503  
 Berry, Richard James Arthur 383  
 Berry, Sir Michael 1244  
 Berry, Wendell 283, 1721  
 Berryman, John 67, 88  
 Bers, Lipman 808  
 Berselius, Jöns Jacob 737  
 Berthelot, Marcellin 4, 11, 129, 237, 1273, 1569  
 Berthollet, C. L. 230  
 Bertotti, Bruno 665  
 Berzelius, Jöns Jacob 227, 237, 1052, 1596  
 Bessey, Charles E. 1496  
 Besso, Michele 576  
 Bester, Alfred 337, 579, 1592, 1636  
 Beston, Henry 26, 32, 44, 256, 973, 1010, 1040, 1144, 1379, 1452  
 Bethe, Hans 331, 1596  
 Bevan, Aneurin 639  
 Beveridge, William Ian Beardmore 277, 353, 486, 643, 670, 920, 1189, 1230, 1247, 1417, 1431  
 Bialac, Richard N. 271  
 Bianchi, Leonardo 188  
 Bianco, Margery Williams 931, 1225  
 Bibby, Geoffrey 344  
 Bice, James 581  
 Bichat, Xavier 117  
 Bicknell, Alexander 883  
 Bierce, Ambrose 73, 331, 335, 581, 927, 1041, 1587, 1737  
 Bigelow, Jacob 895  
 Bigelow, S. Lawrence 1596  
 Biggs, Noah 237  
 Bilaniuk, Oleksa-Myron 1174  
 Bill, Max 808  
 Billings, John Shaw 1528  
 Billings, Josh (Henry Wheeler Shaw) 11, 147, 195, 519, 713  
 Billington, David 422  
 Billroth, Theodor 912  
 Binford, Lewis R. 19, 88, 318  
 Bing, Ilse 688  
 Birch, Arthur J. 305, 1247, 1273, 1502  
 Birchmore, Sue 409  
 Bird, J. M. 167  
 Bird, R. T. 554  
 Birkeland, Kristian 389

- Birkhoff, Garrett 1048  
 Birkhoff, George David 808, 1109, 1118  
 Birmingham Brown 636  
 Birrell, Augustine 1555  
 Bisch, Louis E. 668  
 Bishop, Elizabeth 973  
 Bishop, Errett 808  
 Bishop, Jim 92  
 Bishop, Morris 403  
 Bishop, Samuel 1206  
 Bishop Joseph Hall 1041  
 Bishop of Birmingham 1067  
 Black, Hugh 1273  
 Black, Joseph 232, 237, 1273  
 Black, Max 808, 871, 1426  
 Blackett, Lord Patrick Maynard Stuart 1118  
 Blackie, John Stuart 72, 224, 350, 581, 609  
 Blackmore, Sir Richard 1139, 1155, 1157  
 Blackwelder, R. E. 1574  
 Blackwell, Elizabeth 1094  
 Blagonravov, Anatoly A. 1483  
 Blaise, Clarke 920  
 Blake, William 31, 43, 129, 213, 403, 549, 622, 670, 685, 689, 793, 942, 1026, 1077, 1175, 1200, 1273, 1369, 1503, 1567, 1576, 1625, 1710  
 Blalock, Jr., Hubert M. 1528  
 Blane, Gilbert Sir 1546  
 Blanshard, Brand 61  
 Blavatsky, Elena Petrovna 1273  
 Bleckley, Logan E. 1175  
 Bloch, Arthur 491, 744, 1076, 1189, 1267, 1528, 1674  
 Bloch, Felix 195  
 Bloch, Marc 713  
 Blodgett, James H. 1523, 1528  
 Bloom, Allan 1273  
 Bloom, Orly Castel 577  
 Bloom, Samuel W. 895  
 Bloomfield, Leonard 740  
 Bloomfield, Robert 973  
 Bloor, David 713, 808, 1216  
 Blough, Roger M. 409  
 Blount, Sir Thomas Pope 378, 640, 1674  
 Blum, Harold 1617  
 Blumenbach, Johann Friedrich 561, 1496  
 Blumenberg, Hans 761  
 Blundeville, Thomas 1265  
 Bly, Robert 654  
 Boas, Franz 83  
 Boas, George 920, 1274  
 Boas, Jr., Ralph P. 1238  
 Boas, Ralph P. 198  
 Bobrow, Daniel Gureasko 1565  
 Bôcher, Maxime 598, 1735  
 Bochner, Salomon 808  
 Bock, W. J. 1737  
 Boeham, George A. W. 21  
 Boehm, G. A. W. 802  
 Boelter, L. M. K. 409  
 Boerhaave, Herman 237, 928, 1576  
 Boethius 115, 214, 688, 1014  
 Bogert, Marston Taylor 232  
 Bohm, David 2, 519, 609, 744, 774, 793, 883, 973, 1085, 1216, 1274, 1625  
 Bohn, H. G. 486  
 Bohr, Niels Henrik David 21, 129, 277, 486, 491, 680, 714, 740, 761, 809, 973, 1065, 1118, 1165, 1208, 1226, 1274, 1431, 1476, 1491, 1596, 1617, 1650  
 Bolles, Edmund Blair 1026  
 Bolton, Henrietta 1404  
 Bolton, Henry Carrington 195, 491, 1077, 1274  
 Boltzmann, Ludwig Edward 13, 156, 343, 574, 643, 871, 1109, 1216, 1594, 1618  
 Bolyai, János 353  
 Bolyai, Wolfgang 353  
 Bolz, Ray E. 306  
 Bombieri, Enrico 1169, 1216, 1258, 1736  
 Bonaparte, Napoleon 627, 872, 895, 1094, 1205, 1274  
 Bond, J. 668  
 Bond, S. 668  
 Bondi, Sir Hermann 297, 889, 1085, 1274, 1596, 1625  
 Bonnett, O. T. 668  
 Bonnor, William Bowen 609  
 Boole, George 2, 202, 1175  
 Boole, Mary Everest 14  
 Boone, John Allen 31, 79  
 Boorde, Andrew 1092  
 Boorse, Christopher 545  
 Boorstin, Daniel J. 787, 1198, 1528, 1546  
 Bordes, Francois 1663  
 Borel, Félix Edouard 680, 714  
 Borel, Félix Edouard Justin Emile 214, 279, 437, 598, 1014, 1175  
 Borges, Jorge Luis 26, 685, 739, 1014, 1567, 1625  
 Boring, Edwin Garrigues 1706  
 Borland, Hal 41, 59, 383, 453, 671, 690, 761, 793, 959, 973, 1144, 1157, 1503, 1626, 1641, 1721  
 Borlase, William 549, 962  
 Borman, Frank 942  
 Born, Max 129, 214, 312, 343, 389, 403, 409, 486, 609, 671, 883, 931, 1082, 1118, 1176, 1208, 1226, 1256, 1274, 1381, 1409, 1412, 1431, 1596, 1647, 1650, 1674  
 Bornstein, Kate 328  
 Borwein, J. 1736  
 Boscowitz, Arnold 378  
 Bosler, Jean 1275  
 Bostwick, Arthur Elmore 312, 1176  
 Boswell, James 883, 1176

- Bottomley, Gordon 787  
 Boulding, Kenneth E. 376, 569, 575, 714, 1085  
 Boulle, Pierre 744  
 Boulton, Matthew 1163  
 Boundy, Cather 608  
 Bounoure, Louis 454  
 Bourbaki, Nicholas 872, 1065  
 Bourdillon, Francis William 1551  
 Bourne, William 1046  
 Boutroux, Émile 328, 744, 809, 1383  
 Boutroux, Pierre 782  
 Bove, Ben 1674  
 Bowditch, Nanthaniel 809  
 Bowen, Elizabeth 486  
 Bowen, Norman L. 790, 1710  
 Bowley, Arthur L. 147, 1523, 1528, 1529  
 Bowman, Scotty 1529  
 Bowman, W. E. 1529  
 Bowyer, Stuart 1696  
 Box, George E. P. 690, 931, 1026  
 Boycott, A. E. 1409  
 Boyd, Lyle B. 1419  
 Boyd, William Andrew Murray 872  
 Boyer, Carl 809  
 Boyle, Robert 12, 14, 108, 232, 238, 394, 643, 737, 809, 973, 1118  
 Boynton, William 1153  
 Brackenridge, Hugh Henry 323, 1095  
 Bracker, Milton 1060  
 Bradbury, Ray 27, 519, 700, 930, 1153, 1275, 1477, 1483, 1597, 1626  
 Braddon, Mary Elizabeth 930  
 Bradford, Gamaliel 519  
 Bradley, A. C. 1247  
 Bradley, D. 1736  
 Bradley, Duane 409  
 Bradley, Jr., John Hodgdon 50, 154, 224, 378, 436, 454, 606, 761, 793, 974, 1060, 1144, 1204, 1263, 1275, 1453, 1478, 1551, 1597, 1674, 1711, 1715  
 Bradley, Mary Hastings 70  
 Bradley, Omar 129, 1360  
 Bradley, W. H. 593  
 Bradshaw, A. D. 383  
 Brady, Nicholas 883  
 Bragdon, Claude 97, 810  
 Bragg, Sir William Henry 389, 774, 1119  
 Bragg, Sir William Lawrence 9, 654, 1189  
 Brahe, Tycho 1265, 1471  
 Brahmagupta 14  
 Brain, Lord Walter Russell 1431  
 Brainard, John 285  
 Braithwaite, Richard B. 487  
 Braithwaite, William Stanley 373  
 Bramah, Ernest 275, 700  
 Bramley, William 1664  
 Brand, Stewart 692  
 Brandeis, Louis D. 101, 148, 409  
 Brandt, John C. 1471  
 Braudel, Fernand 680  
 Brautigan, Richard 301  
 Breathed, Guy Berkeley 45  
 Brecht, Bertolt 610, 665, 704, 714, 1109, 1275, 1369, 1503, 1587  
 Bredwell, Stephen 238  
 Bremer, J. 1275  
 Brennan, Richard P. 1119  
 Brenner, Sydney 454  
 Brett-Surman, Michael 1060  
 Bretz, J Harlen 581  
 Brew, John O. 1574  
 Brewster, David 117, 1503  
 Brewster, Edwin Tenney 581, 950, 1275, 1431  
 Brewster, G. W. 377  
 Bridges, Robert Seymour 157, 232, 238, 810  
 Bridgman, F. W. 1727  
 Bridgman, Helen Bartlett 974  
 Bridgman, Percy Williams 214, 277, 296, 385, 519, 697, 810, 974, 1014, 1208, 1275, 1412, 1468, 1597, 1618, 1626  
 Brillouin, Léon 503, 671, 1109, 1626  
 Brin, David 1397  
 British Admiralty 327  
 British Association for the Advancement of Science 1597  
 British Engineer to the Royal Aeronautical Society 422  
 Broad, William 1145, 1239, 1275, 1426  
 Broca, Paul 66  
 Broch, Hermann 1453  
 Brodie, Sir Benjamin Collins 671, 1565  
 Brody, Elaine M. 11  
 Brögger, A. W. 1663  
 Bromberger, Sylvain 579  
 Brome, Alexander 409  
 Bronk, Detlev W. 256  
 Bronk, William 1727  
 Bronowski, Jacob 117, 152, 257, 271, 397, 437, 487, 559, 625, 714, 789, 793, 810, 931, 974, 1085, 1119, 1226, 1276, 1365, 1375, 1431, 1580, 1650, 1706  
 Bronte, Charlotte 942, 974  
 Bronte, Emily 1641  
 Brood, William J. 1503  
 Brooks, Daniel R. 1067  
 Brooks, Edward 810  
 Brooks, Harvey 1226  
 Brooks, W. K. 546, 761  
 Brophy, Brigid 27, 1231  
 Brough, J. C. 1011

- Brougham, Henry 353, 671  
 Broun, Heywood 191  
 Brouwer, L. E. J. 889  
 Browder, Felix E. 810  
 Brower, David 36, 60, 168, 283, 1721  
 Brown, Fredric 598, 1504  
 Brown, Gerald 331  
 Brown, H. 594  
 Brown, Hugh Auchincloss 183, 1548  
 Brown, I. David 231  
 Brown, J. Howard 1247  
 Brown, John 1650  
 Brown, Jr., G. T. 705  
 Brown, Julian R. 1110, 1121  
 Brown, Lloyd 802  
 Brown, Michael S. 1095  
 Brown, Relis B. 454  
 Brown, Thomas 1048  
 Browne, B. P. 394  
 Browne, J. Stark 633, 1504, 1675  
 Browne, Sir Thomas 255, 310, 323, 367, 485, 608, 639, 974, 1046, 1048, 1205, 1231, 1626  
 Browning, Robert 232, 316, 491, 519, 633, 689, 974, 1041, 1247, 1471, 1504  
 Brownlee, Donald 1026, 1160, 1203  
 Bruchac, Joseph 27  
 Bruncken, Herbert Gerhardt 446  
 Bruner, Jerome Seymour 354, 643, 703, 810, 1576  
 Bruno, Giordano 665, 1478, 1675, 1728  
 Brusca, Gary 49  
 Bryan, J. Ingram 157, 974  
 Bryan, Kirk 802  
 Bryan, William Jennings 454, 1276  
 Bryant, Alice Franklin 1641  
 Bryant, William Cullen 549, 975, 1041, 1231, 1504, 1641  
 Bryce, John 895  
 Bryson, Bill 884, 1222, 1276  
 Bryson, Lyman 756  
 Bube, Richard H. 714  
 Buber, Martin 610  
 Buchan, William 1095  
 Buchanan, Robert Williams 97, 238  
 Buchanan, Scott 409, 654, 810, 872, 1015, 1200, 1240, 1432, 1565  
 Bucher, W. H. 562  
 Buchner, Edward 238  
 Büchner, Georg 582  
 Buchner, Ludwig 214, 519, 1276, 1529  
 Buck, Pearl S. 195, 761, 1383, 1432  
 Buck, R. C. 811  
 Buckham, John Wright 1276  
 Buckland, Francis T. 350  
 Buckland, Frank 1597  
 Buckle, Henry Thomas 1422  
 Buckley, Arabella B. 519, 671, 1404, 1715  
 Budworth, D. 1381  
 Buffalo Springfield 1664  
 Bulfinch, Thomas 714  
 Bulgakov, Mikhail 454  
 Bullard, Edward Crisp 790  
 Bullen, Frank T. 76  
 Bullock, J. Lloyd 232  
 Bullock, James 811  
 Bullock, Theodore Holmes 714  
 Bultmann, R. 1383  
 Bulwer, John 1567  
 Bunch, Sterling 1471  
 Bunge, Mario 1247, 1277, 1580  
 Bunsen, Robert Wilhelm Eberhard 1  
 Bunting, Basil 1277, 1504  
 Burbridge, Geoffrey 1119  
 Burdon-Sanderson, J. 706  
 Burgess, Anthony 1095  
 Burgess, Robert W. 1529  
 Burhoe, R. W. 1086  
 Burke, C. J. 374  
 Burke, Edmund 157, 811, 1015, 1504, 1715  
 Burnan, Tom 1529  
 Burnet, Frank Macfarlane 1495  
 Burnet, Thomas 202, 950, 975, 1082, 1145, 1504, 1711  
 Burney, Fanny 975, 1059, 1176  
 Burnham, Jr., Robert Jr. 633  
 Burnham, Robert, Jr. 117  
 Burns, Marilyn 1074  
 Burns, Olive Ann 1022  
 Burns, Robert 144, 222, 285, 520, 606, 1638, 1641  
 Burr, Lehigh 567  
 Burritt, Elijah H. 1504, 1675  
 Burroughs, Edgar Rice 280, 347, 783, 1490, 1597  
 Burroughs, John 58, 186, 454, 520, 591, 954, 975, 1027, 1078, 1140, 1157, 1260, 1263, 1277, 1377, 1383, 1473, 1474, 1647, 1710  
 Burroughs, William S. 1109, 1145, 1432, 1675  
 Burton, Leone 811  
 Burton, Robert 23, 310, 942, 947, 975, 1266, 1462  
 Burton, Sir Richard Francis 129, 942, 1231  
 Burt, B. L. 1574  
 Burt, E. A. 1226  
 Burt, W. A. 744  
 Bury, John Bagnell 85, 1277  
 Busch, Wilhelm 1638  
 Bush, George H. W. 188  
 Bush, Vannevar 11, 302, 714, 1176, 1248, 1277, 1383, 1420, 1651, 1666, 1675, 1723  
 Bushnell, Horace 1085, 1383  
 Butler, Brett 905  
 Butler, James Newton 1565  
 Butler, Joseph 610, 967, 1176



- Butler, Nicholas Murray 811, 1412  
 Butler, Samuel 14, 21, 69, 130, 185, 211, 214, 310,  
 373, 437, 450, 454, 487, 492, 510, 582, 627, 628,  
 654, 668, 715, 895, 908, 920, 942, 975, 1277,  
 1360, 1383, 1504, 1586, 1587, 1662, 1715  
 Butlerov, Aleksandr Mikhailovich 520, 715  
 Butterfield, Herbert 947, 1355  
 Butterworth, Brian 1015  
 Buttimer, Anne 1278  
 Buzzati-Traverso, Adriano 1278  
 Byford, W. H. 1547  
 Byrd, Deborah 118  
 Byrom, Gletcher L. 1580  
 Byron, George Gordon 762  
 Byron, George Gordon, 6th Baron Byron 71, 101, 107,  
 148, 238, 264, 367, 385, 715, 740, 781, 791, 793,  
 906, 951, 975, 1041, 1095, 1145, 1237, 1460,  
 1622, 1641, 1699
- C**
- Cabell, James Branch 1201  
 Cable, George W. 186, 429, 430, 976  
 Cabot, Richard Clarke 447  
 Cady, Varian 238  
 Cage, Jr., John Milton 438  
 Caglioti, Luciano 239  
 Cain, A. J. 1574  
 Caithness, James Balharrie 381, 908  
 Cajori, Florian 715, 811, 1011  
 Calder, Alexander 1432, 1675  
 Calder, Nigel 108  
 Calder, Peter Ritchie 354  
 Calder, Ritchie 1278  
 Caldwell, G. C. 708  
 Caldwell, George W. 1557  
 Callahan, Daniel 577  
 Callaway, Jack M. 562  
 Callen, Charles Lane 227  
 Calvin, Melvin 306, 1278, 1651  
 Calvin, William H. 906, 1208, 1397  
 Calvino, Italo 397, 398, 454  
 Cambridge Conference on School Mathematics 198  
 Camden, William 1095  
 Campbell, Donald T. 1723  
 Campbell, J. H. 454, 577  
 Campbell, Jeremy C. 976  
 Campbell, Norman R. 19, 385, 1086, 1278, 1370, 1412,  
 1597  
 Campbell, Thomas 976, 1278, 1505, 1641  
 Camras, Marvin 354  
 Camus, Albert 211, 487, 655, 685, 754, 912, 1079,  
 1278, 1675  
 Canetti, Elias 27  
 Canning, George 128, 640  
 Cannon, Annie Jump 1404  
 Cannon, Walter Bradford 354, 682, 715  
 Cantor, Georg 812, 1597  
 apek, Josef 54  
 apek, Karel 54  
 Capek, Milic 130, 162, 884  
 Caplan, Arthur 447  
 Capp, Al 422  
 Capra, Fritjof 172, 906, 957, 1248  
 Captain Janeway 1208  
 Captain Kirk 318, 1478  
 Card, Orson Scott 610, 680, 1675  
 Cardano, Girolamo 341  
 Cardenal, Ernesto 163, 179, 1618, 1696  
 Cardozo, Benjamin N. 487, 1176, 1239, 1594  
 Carlson, A. J. 1702  
 Carlton, J. T. 506  
 Carlyle, Thomas 64, 285, 367, 520, 547, 554, 579, 610,  
 685, 812, 976, 1027, 1095, 1278, 1474, 1491,  
 1505, 1529, 1573, 1622, 1626, 1637, 1675  
 Carmichael, Robert Daniel 812, 1651  
 Carnap, Rudolf 715, 1085, 1119  
 Carnochan, John Murray 1557  
 Carnot, Sadi Nicolas Leonhard 631  
 Carpenter, Kenneth 351  
 Carpenter, William B. 520, 554  
 Carr, Archie 30  
 Carr, William H. 951, 1721  
 Carr-Saunders, A. M. (Alexander Morris), Sir 97  
 Carr-Saunders, Sir A. M. (Alexander Morris), 95  
 Carrel, Alexis 148, 607, 1051, 1248, 1279  
 Carroll, J. E. 715  
 Carroll, Lewis (Charles Dodgson) 5, 7, 49, 53, 54, 75,  
 77, 79, 81, 101, 188, 295, 327, 375, 438, 492,  
 515, 520, 640, 643, 680, 709, 711, 783, 802, 912,  
 943, 947, 959, 962, 1529, 1567, 1587, 1627, 1638  
 Carruth, William Herbert 455  
 Carryl, Charles Edward 193, 1409  
 Carson, Hampton 562  
 Carson, Rachel 172, 283, 455, 520, 756, 779, 976,  
 1041, 1162, 1268, 1279, 1453, 1461, 1708  
 Cartwright, Nancy 1119  
 Carus, Paul 689, 812  
 Carver, George Washington 610  
 Casimir, Hendrik B. G. 740, 1351, 1422  
 Cassell, Eric J. 668  
 Cassidy, Harold Gomes 1370  
 Cassiodorus 812  
 Cassirer, Ernst 277, 1086, 1370  
 Cassius Dio 1711  
 Casson, Stanley 812  
 Casti, John L. 744  
 Cather, Willa 39  
 Caullery, Maurice 1248

- Cavendish, Margaret, Duchess of Newcastle 130  
 Cawein, Madison Julius 943, 976  
 Cayley, Arthur 157, 812  
 Cedering, Siv 598, 1587  
 Ceild, J. M. 579  
 Celsus, Aulus Cornelius 1557  
 Cerf, Bennett 1038, 1226  
 Cernan, Eugene 1505  
 Cernan, Gene 107  
 Chadwick, James 1009  
 Chadwick, John 264  
 Chadwick, Owen 1383  
 Chaisson, Eric J. 296, 297, 299, 571, 976  
 Chakrabarti, C. L. 239  
 Chalmers, Thomas 594  
 Chamberlain, Owen 1355  
 Chamberlain, Rollin T. 292, 709, 812, 1145  
 Chamberlin, T. C. 202, 582, 594, 1597  
 Chambers, Robert 1189  
 Chamfort, Nicolas 262, 323  
 Chamfort, Sebastien Roch 214  
 Chandler, Mary 1548  
 Chandler, Raymond Thornton 1651  
 Chandrasekhar, Subrahmanyan 157, 179, 790, 920,  
 1279, 1464  
 Chang, Kwang-Chih 19  
 Chantrenne, H. 165  
 Chapin, Charles V. 8  
 Chapman, C. H. 812  
 Chapman, Clark R. 106, 594, 1140  
 Chapman, Frank M. 32, 334  
 Chapman, Robert D. 1471  
 Chappell, Edwin 438  
 Chaptal, Jean-Antoine-Claude 239  
 Charcot, Jean-Martin 1598  
 Chargaff, Erwin 19, 118, 152, 155, 166, 168, 172, 209,  
 232, 277, 354, 492, 520, 715, 912, 932, 936, 954,  
 977, 1079, 1086, 1216, 1279, 1351, 1410, 1422,  
 1426, 1432, 1651, 1702  
 Charles, John 1702  
 Charles, Prince of Wales 895  
 Charlie Chan 75, 107, 279, 312, 450, 492, 520, 599,  
 715, 895, 1268, 1457, 1597, 1651  
 Chase, Stuart 377  
 Chasles, Michel 599  
 Chatfield, Christopher 271, 318, 1521, 1529  
 Chatton, Milton J. 294  
 Chaucer, Geoffrey 918, 977, 1140, 1266, 1627  
 Chaudhuri, Haridas 884  
 Chedd, Graham 679  
 Cheeseman, Peter 932  
 Chekhov, Anton Pavlovich 254, 323, 354, 367, 668,  
 895, 952, 1022, 1039, 1168, 1280, 1675  
 Chern, Shiing-Shen 599  
 Chernin, Kim 1280  
 Chernoff, H. 1523  
 Chernyshevsky, Nikolai Gavrilovich 354, 1198, 1280  
 Chesterton, G. K. (Gilbert Keith) 9, 182, 214, 255, 299,  
 345, 399, 455, 520, 633, 671, 697, 762, 783, 785,  
 787, 789, 794, 813, 872, 1086, 1189, 1248, 1280,  
 1351, 1361, 1375, 1377, 1432, 1567, 1598, 1648,  
 1724  
 Chestov, Leon 680  
 Chief Engineer Scott 76  
 Chief Seattle 1145  
 Child, Lydia M. 549, 977  
 Childe, V. Gordon 257, 318  
 Chinese ode 381  
 Chiras, Daniel D. 977  
 Chlandni, E. F. F. 911  
 Chomsky, Noam 354  
 Christiansen, Chris 1223  
 Christianson, Gale E. 1627  
 Christie, Agatha 1585  
 Chrysostom, John 1231, 1462  
 Chrystal, George 813  
 Chu, Steven 130, 1666  
 Chuang Tzu 203  
 Chudnovsky, David 1138  
 Church, Peggy Pond 143  
 Churchill, Charles 977  
 Churchill, Lord Randolph 327  
 Churchill, Sir Winston Spencer 101  
 Churchill, Winston Spencer 195, 367, 409, 521, 690,  
 813, 895, 1189, 1280, 1715  
 Ciardi, John 737  
 Cibber, Colley 97  
 Cicero (Marcus Tullius Cicero) 130, 203, 214, 340,  
 367, 438, 557, 633, 977, 1081, 1505  
 Clare, John 43, 46, 54, 78  
 Clark, C. A. 1521  
 Clark, David 92  
 Clark, Gordon H. 1086  
 Clark, Grahame 1167  
 Clark, R. B. 1549  
 Clark, W. C. 1383  
 Clarke, Arthur C. 105, 118, 505, 510, 521, 557, 637,  
 671, 680, 699, 794, 977, 1189, 1203, 1381, 1397,  
 1432, 1474, 1478, 1482, 1483, 1490, 1491, 1505,  
 1580, 1598, 1636, 1651, 1676  
 Clarke, F. W. 394  
 Clarke, J. M. 715  
 Clarke, John 1550  
 Clarke, M'Donald (The Mad Poet) 1505  
 Clarke, Samuel 1082  
 Clasius, Rudolph 431  
 Claude, Albert 209, 214, 762  
 Clawson, Calvin C. 1015

- Cleaver, Eldridge 1189  
Clegg, Johnny 1505  
Clemence, G. M. 1627  
Clemens, William 507  
Clendening, Logan 1560  
Clerke, Agnes Mary 118, 354, 715, 1156, 1198, 1499  
Cleugh, Mary F. 1627  
Cleveland, John 58  
Cleveland, Richard 1460  
Clifford, William Kingdon 15, 297, 554, 599, 937, 1361, 1379, 1425  
Clift, Wallace B. 957  
Cloos, Hans 183, 582, 927, 1145, 1551  
Close, Frank 130, 977  
Cloud, Preston Ercelle 18, 303, 655, 762  
Clough, Arthur Hugh 783  
Clowes, William 1095, 1206  
Clute, Willard N. 1158  
Coates, Florence Earle 1059  
Coates, Robert M. 745, 1570  
Coats, R. H. 1176, 1546  
Cobbe, Frances P. 1281  
Coblentz, Stanton 373  
Cochran, William G. 15, 1267, 1521  
Coggan, Donald 1281  
Cogswell, Theodore R. 1530  
Cohen, I. Bernard 655, 1189, 1281, 1355, 1370, 1729  
Cohen, Jack 1069, 1220  
Cohen, Jacob 1521, 1530  
Cohen, Jerome 521  
Cohen, Joel 172  
Cohen, Joel E. 1433  
Cohen, John 1176, 1224  
Cohen, Martin 1505  
Cohen, Morris Raphael 19, 148, 521, 643, 912, 1027, 1087, 1365  
Cohn, Ferdinand Julius 154  
Colbert, Edwin H. 1060, 1070, 1281  
Colby, Frank Moore 1216  
Colclaser, R. G. 409  
Cole, A. D. 131  
Cole, K. C. 671, 906, 1209, 1491, 1666  
Cole, Thomas 1505  
Cole, William 1651, 1724  
Coleridge, Mary 715  
Coleridge, Samuel Taylor 34, 97, 232, 265, 487, 521, 560, 652, 759, 813, 977, 1146, 1261, 1464, 1505, 1676, 1715  
Coles, Abraham 1281, 1365  
Collard, Patrick 915  
Collingwood, Robin George 239, 329, 521, 716, 745, 977, 1087, 1137, 1189, 1723  
Collins, Billy 1478  
Collins, John 1638  
Collins, Joseph 1095  
Collins, Michael 943  
Collins, Mortimer 455  
Collins, Wilkie 157, 521, 549, 655, 716  
Colman, George (The Younger) 545, 895, 978  
Colman, George (the Younger) 86  
Colton, Charles Caleb 203, 215, 438, 641, 783, 813, 1092, 1095, 1206, 1593, 1598  
Colum, Padraic 34, 73, 813  
Coman, Dale Rex 312, 592, 762, 978, 1146, 1506, 1622, 1624  
Comfort, Alex 215, 1500  
Commentary 1223  
Committee on Guidelines for Paleontological Collecting 562  
Committee on the Conduct of Science 912  
Commoner, Barry 433, 716, 755, 978, 1189, 1238, 1282, 1484, 1580  
Compton, Arthur H. 1374, 1425, 1651  
Compton, Karl Taylor 271, 338, 409, 422, 610, 1119, 1189, 1282, 1350, 1375, 1377, 1383, 1397, 1417, 1420  
Compton-Burnett, Ivy 27  
Comroe, Jr., Julius H. 1422  
Comstock, Anna Botsford 1641  
Comte, Auguste 15, 118, 198, 599, 683, 813, 1015, 1119, 1165, 1506  
Conant, James Bryant 277, 354, 716, 814, 1282, 1355, 1412, 1432  
Condon, Edward Uhler 1120, 1282  
Condorcet, Marie Jean 814, 1190, 1282  
Conduitt, John 622  
Confucius 716, 1261  
Conger, George Perrigo 1676  
Congreve, William 1231  
Conklin, Edwin Grant 254, 385, 1384  
Connell, Joseph 978  
Connolly, Cyril 169, 1370  
Conoley, Gillian 1164  
Conrad, Joseph 118, 215, 522, 943, 978, 1548, 1666, 1722  
Conrad, Pete 107  
Conrad, Timothy 562, 1648  
Conrey, B. 1735  
Conrey, J. Brian 1258  
Constable, George 1006  
Constance, L. 1574  
Constitution of the United States 1282  
Cook, J. Gordon 1551  
Cook, James H. 562  
Cook, Joseph 116, 227  
Cook, Morris L. 410  
Cook, Peter 951, 1676  
Cook, Robin 295

- Cooke, Josiah Parsons 522, 716  
 Cooley, Charles Horton 1706  
 Cooley, Hollis R. 814  
 Coolidge, Julian L. 599, 814  
 Coon, Carleton 801  
 Cooper, Bernard 1282  
 Cooper, Leon 1283, 1426, 1598  
 Cooper, Thomas 716  
 Copeland, Leland S. 1587  
 Copernicus, Nicolaus 118, 157, 633, 814, 872, 978, 1506, 1551, 1676  
 Corbett, Jim 978  
 Corey, E. J. 232  
 Cori, Carl 1397  
 Corner, E. H. J. 186  
 Cornforth, John W. 884, 1433, 1651  
 Cornu, A. 794  
 Cornwall, Barry (Bryan Waller Procter) 32, 1042  
 Cornwall, I. W. 92  
 Cort, David 643  
 Cortázar, Julio 1666  
 Cosmo Kramer 1153  
 Cossons, Sir Neil 1283  
 Couderc, Paul 1598  
 Coues, E. 1237  
 Coulson, Charles Alfred 1384  
 Couper, Archibald Scott 1598  
 Courant, Richard 815, 872, 1087  
 Cournot, Augustin 815  
 Courtney, Leonard Henry 522  
 Cousins, Norman 319, 690, 978, 1077, 1484, 1490  
 Cousteau, Jacques-Yves 455, 762, 1060, 1433, 1453  
 Coveney, Peter 188  
 Coveyou, R. R. 1225  
 Cowan, C. 1009  
 Cowan, George A. 548  
 Cowen, Richard 18, 208  
 Cowper, William 38, 95, 97, 215, 394, 438, 582, 610, 716, 978, 1022, 1708  
 Cox, Gertrude M. 15, 492, 1521  
 Cox, Sir David Roxbee 1521, 1530  
 Coxeter, H. S. M. 815  
 Crabbe, George 49, 310, 1206  
 Cram, Donald J. 239, 308, 1052  
 Cram, Jane M. 1052  
 Cramer, F. 1433  
 Cranch, Christopher Pearse 36, 549  
 Crandall, Robert W. 1169  
 Crane, H. Richard 1008  
 Crane, Hart 690, 1506  
 Crane, Stephen 1552, 1676  
 Crawford, F. Marion 522  
 Crawford, Osbert Guy Stanhope 88, 92, 1061, 1070  
 Crease, Robert P. 1120, 1598  
 Creele, August 1648  
 Crew, Henry 1718  
 Crew of Apollo 11 946  
 Crichton, Michael 259, 276, 355, 410, 620, 778, 816, 1076, 1176, 1283, 1426, 1433, 1530, 1598, 1706  
 Crichton-Browne, Sir James 108, 262, 696, 1139, 1557  
 Crick, Francis Harry Compton 105, 172, 188, 215, 376, 455, 640, 762, 816, 872, 932, 936, 937, 963, 978, 1040, 1109, 1248, 1283, 1370, 1397, 1412, 1420, 1594, 1598, 1620  
 Crimmins, Cathy 905  
 Crofton, M. W. 271, 1177  
 Croll, Oswald 185, 895, 1095, 1558  
 Croly, George 943  
 Cromer, Alan 680, 1226, 1283, 1599, 1620  
 Cromie, William J. 53, 1283, 1453  
 Cromwell, Oliver 816  
 Cronbach, L. J. 295  
 Cronenberg, David 355, 1433  
 Crookes, Sir William 233, 394, 399, 979, 1410, 1499  
 Crookshank, Francis Graham 896  
 Cropper, William N. 1120  
 Crosby, Harry 1552  
 Cross, Hardy 19, 271, 410, 411, 422, 423, 522, 816, 892, 1190, 1581  
 Crosswell, Ken 1676  
 Crothers, Samuel McChord 185, 456, 522, 779, 1283  
 Crow, J. F. 953  
 Crowley, Abraham 1556  
 Crowley, Aleister 1284, 1677  
 Crowson, Roy Albert 59, 263  
 Crowther, Greg 233  
 Crum, H. A. 1046  
 Cudmore, Lorraine Lee 78, 131, 169, 210, 1012, 1065, 1284, 1709  
 Cullen, William 239  
 Cullinane, N. M. 608  
 Culpeper, N. 261  
 Cummings, John 1523, 1527  
 Cummings, Ray 1627  
 Cunningham, Clifford J. 108  
 Cuppy, Will 37, 50, 52, 64, 70, 72, 76, 77, 78, 193, 381, 429, 507, 562, 653, 1709  
 Curie, Eve 233, 1284  
 Curie, Marie Skłodowska 239, 280, 355, 400, 979, 1198, 1284  
 Curie, Marie Skłodowska- 157  
 Cushing, Harvey 183, 1073, 1096  
 Cussler, Clive 1248  
 Cuvier, Georges 85, 182, 222, 562, 665, 762, 1039  
 Cvikota, Clarence 641  
 Cvikota, Raymond J. 26, 1558  
 Cvitanovic, Predrag 1110

- Cyrano Jones 951  
 Czapek, Frederick 762
- D**
- d'Abro, Abraham 816, 1238, 1284, 1599  
 D'Alembert, Jean Le Rond 276, 816, 1651, 1677  
 D'Avenant, Sir William 108  
 D'Israeli, Isaac 109, 704  
 da Costa, J. Chalmers 215, 544, 896, 1558  
 Dagi, Teodoro Forcht 23  
 Dahlberg, Edward 1666  
 Dalton, John 131, 398, 492, 574, 1569  
 Daly, Reginald Aldworth 1263, 1365  
 Dampier-Whetham, William 212, 643, 763, 1177, 1226, 1642  
 Dana, James Dwight 239, 582  
 Dana, Richard Henry 652  
 Dancoff, S. M. 1351  
 Danforth, Charles Haskell 575  
 Daniel, Glyn 89  
 Daniels, Farrington 643  
 Dante, Alighieri 215, 1256  
 Dantzig, Tobias 546, 689, 816, 873, 1015  
 Dark, K. R. 1599  
 Darling, David 166, 297, 510, 884, 1677  
 Darrow, Karl Kelchner 131, 410, 1120  
 Darwin, Charles Galton 817, 873  
 Darwin, Charles Robert 5, 31, 33, 57, 59, 161, 167, 178, 183, 185, 189, 215, 257, 263, 280, 281, 294, 303, 309, 377, 378, 438, 456, 492, 507, 522, 563, 571, 576, 582, 594, 638, 644, 655, 665, 671, 694, 701, 716, 794, 908, 920, 930, 959, 962, 963, 968, 979, 1027, 1049, 1056, 1081, 1166, 1177, 1207, 1231, 1263, 1284, 1356, 1361, 1469, 1496, 1500, 1530, 1564, 1571, 1576, 1599, 1652, 1706, 1727  
 Darwin, Erasmus 131, 289, 397, 399, 400, 457, 763, 908, 928, 943, 979  
 Darwin, G. H. 200, 1599  
 Darwin, Sir Francis 1284  
 Dastre, A. 884  
 Data 1285  
 Date, J. C. B. 15  
 Daumal, Rene 606, 716  
 Davidson, John 394, 925  
 Davidson, Keay 1472  
 Davidson, R. A. 168  
 Davies, John Tasman 1530, 1599  
 Davies, Paul Charles William 131, 167, 210, 403, 431, 599, 693, 701, 817, 932, 1009, 1015, 1049, 1110, 1120, 1121, 1223, 1240, 1285, 1384, 1412, 1464, 1474, 1478, 1599, 1627, 1671, 1677, 1699  
 Davies, Robertson 208, 332, 817, 1096, 1285, 1558, 1723  
 Davies, Sir John 1728  
 da Vinci, Leonardo 33, 146, 157, 203, 337, 438, 487, 492, 628, 685, 716, 816, 872, 892, 979, 1027, 1146, 1248, 1284, 1593, 1715, 1719  
 Davis, Adelle 342, 1024  
 Davis, Chandler 410, 817  
 Davis, George E. 231  
 Davis, Joel 189, 1379  
 Davis, Joseph S. 1530  
 Davis, Kenneth S. 1285  
 Davis, Philip J. 817, 873, 1169, 1201, 1600, 1627  
 Davis, Watson 1285  
 Davis, William Morris 582, 644, 1285  
 Davisson, Clinton 389  
 Davy, John 493  
 Davy, Sir Humphry 4, 11, 20, 87, 158, 227, 233, 239, 284, 329, 355, 438, 523, 569, 583, 638, 644, 665, 697, 717, 740, 745, 906, 979, 1027, 1068, 1087, 1165, 1285, 1465, 1600, 1622, 1652, 1715, 1727  
 Dawkins, Boyd 583  
 Dawkins, Richard 67, 170, 172, 316, 323, 376, 438, 457, 575, 592, 610, 681, 783, 930, 937, 955, 965, 1015, 1025, 1216, 1249, 1286, 1397, 1506, 1530, 1677, 1724  
 Dawson, Sir John William 583, 594, 980, 1082, 1087  
 Day, Clarence 189, 312, 458, 1677  
 Day, David Howard 89  
 Day, R. A. 1249  
 Day, Roger E. 1047  
 Day-Lewis, C. (Cecil) 1379  
 Day-Lewis, Cecil 873  
 Dayton, P. K. 168  
 Dean, Jr., Robert C. 306, 411  
 Deason, Hilary J. 1411  
 DeBakey, L. 900  
 De Bakey, Michael E. 630  
 de Balzac, Honoré 240, 1286  
 de Bary, Anton 1564  
 de Beauregard, Costa 1491  
 de Beauvoir, Simone 410  
 de Bergerac, Cyrano 95, 1140  
 de Bono, Edward 655, 1286, 1580  
 de Botton, Alain 1082  
 de Broglie, Louis 1492  
 de Bruijn, N. G. 818  
 de Bury, Richard 183  
 de Camp, L. Sprague 410  
 de Casseres, Benjamin 1377  
 de Castro, Adolphe 355  
 de Cervantes, Miguel 162, 285, 488, 628, 896, 1177, 1266  
 de Chambaud, J. J. Ménéret 1039  
 de Chauliac, Guy 1558  
 de Cisternay Dufay, Charles Francois 387  
 Decker, Barbara 1712

- Decker, Robert 1712  
 Dedekind, Richard 1015, 1201  
 de Duve, Christian 507  
 Dee, John 599, 790, 818, 947, 1506, 1678  
 Deetz, James 684, 1551  
 Defant, Albert 1624  
 de Fermat, Pierre 545, 1600  
 Defoe, Daniel 411, 1011, 1639  
 de Fontenelle, Bernard le Bovier 15, 109, 118, 265,  
 351, 493, 774, 873, 918, 980, 1140, 1153, 1156,  
 1552, 1652, 1677  
 De Gourmont, Rémy 1370  
 de Gourmont, Rémy 1286  
 de Grasse Tyson, Neil 127, 1587, 1600  
 De Guevara, Antonio 896  
 Dehn, Max 819  
 de Jonnes, Moreau 1530  
 de Jouvenel, Bertrand 557, 745, 818, 1177, 1433  
 Dekker, Thomas 1096  
 Delacroix, Eugene 980  
 de la Mare, Walter 1458, 1506  
 de Lamennais, Félicité Robert 1404  
 de La Mettrie, Julien Offroy 794  
 Delaney, John 763  
 de la Rue, Warren 1500  
 de la Salle, St. Jean Baptiste 1585  
 Delbrick, Max 210, 639, 1287, 1370  
 de Leeuw, A. L. 1177, 1530  
 DeLillo, Don 1678  
 Dell, J. H. 685  
 Deller, Jr., J. R. 385  
 del Rio, A. M. 1286  
 Deluc, Jean-André 523  
 de Lunay, L. 583  
 de Madariaga, Salvador 896, 1073, 1433, 1530  
 de Maistre, J. 355  
 de Maupassant, Guy 1174  
 de Maupertuis, Pierre-Louis Moreau 1381  
 Dembski, William A. 701, 967, 1384  
 de Ment, J. 553  
 Deming, William Edwards 319, 329, 438, 488, 493,  
 684, 745, 889, 1177, 1267, 1521, 1523, 1531,  
 1563  
 Democritus of Abdera 131, 143, 216  
 de Moivre, Abraham 215, 745, 1177  
 de Mondeville, Henri 544, 1558  
 de Montaigne, Michel Eyquem 644, 980, 1096  
 de Morgan, Augustus 15, 109, 198, 329, 355, 599, 644,  
 685, 699, 818, 819, 873, 918, 1065, 1121, 1138,  
 1177, 1201  
 Denckla, W. Donner 638  
 Dennett, Daniel Clement 53, 655, 756, 937, 1087  
 Dennis, F. S. 1560  
 Denton, Michael J. 458, 571  
 de Pavlovsky, G. 819  
 de Pizan, Christine 1404  
 de Queiroz, K. 1571  
 De Quincey, Thomas 1047  
 Derry, Gregory N. 1075  
 Desaguliers, J. T. 980  
 de Saint-Exupéry, Antoine 109, 196, 316, 335, 510,  
 547, 550, 1010, 1263, 1471, 1506, 1581, 1642,  
 1711, 1716  
 de Saussure, Horace-Bénédict 607  
 Descartes, René 310, 312, 315, 327, 599, 685, 819,  
 896, 913, 940, 947, 1088, 1121, 1178, 1231,  
 1287, 1567, 1652, 1723  
 DeSimone, Daniel V. 411, 423, 1581  
 de Sitter, Willem 1678  
 de Spinoza, Baruch 982  
 Dessauer John 1249  
 de Stael, Madame 819  
 de Tabley, Lord 1506  
 Deudney, Daniel 1478, 1484  
 Deuel, Leo 92  
 de Unamuno, Miguel 240, 368, 523, 1087, 1286  
 Deutsch, Armin J. 1552  
 Deutsch, David 1121  
 Deutsch, Karl W. 932, 1678  
 Deutsch, Martin 503  
 Deutsch, Morton 1535  
 Deutscher, I. 1563  
 Deutscher, Murray 166  
 Devaney, James 908  
 Devaney, Robert L. 224  
 de Vega, Lope 410  
 de Vigevano, Guido 23  
 Devine, Betsy 1433  
 Devlin, Keith 2  
 Devons, Ely 1521, 1531, 1546, 1573  
 DeVore, Irvn 459  
 de Voto, Bernard 794  
 de Vries, Peter 1678  
 Dewar, Douglas 39  
 Dewar, James 1287, 1365  
 Dewey, John 9, 101, 272, 523, 542, 655, 745, 763, 884,  
 890, 1082, 1231, 1375, 1408, 1417, 1532, 1620,  
 1627, 1652, 1709  
 DeWitt, Bryce 1209  
 Dexter, William A. 595, 794  
 Deyrup-Olsen, Ingrith 77  
 Diaconis, Persi 1178  
 Diamond, Jared 510  
 Diamond, Marian 189  
 Diamond, Neil 1010  
 Diamond, Solomon 438  
 Diamond, Stanley 83  
 Di Bacco, Babs Z. 1022

- Dibdin, Charles Isaac Mungo 233, 411  
 Dick, Thomas 118, 265, 610, 774, 1507  
 Dicke, R. H. 1110  
 Dickens, Charles 27, 98, 101, 148, 178, 186, 196, 233, 272, 403, 523, 550, 717, 778, 819, 896, 916, 980, 1027, 1224, 1237, 1532, 1558, 1642  
 Dickerson, Richard E. 1618  
 Dickinson, Emily 23, 47, 58, 158, 186, 228, 289, 548, 633, 896, 916, 980, 1059, 1287, 1507, 1558  
 Dickinson, Frances 523  
 Dickinson, G. Lowes 779, 980, 1287  
 Dickson, Frank 119  
 Dickson, Paul 295  
 Diconis, Persi 1268  
 Diderot, Denis 387, 579, 981, 1267, 1375  
 Dietrich, Marlene 510  
 Dieudonné, Jean 264, 411, 600, 818, 819, 873, 1011  
 Digges, Leonard 1047  
 Dijkstra, Edsger Wybe 546  
 Dillard, Anne 381  
 Dillard, Annie 27, 459, 981, 1169, 1628, 1678  
 Dillehay, Thomas D. 89  
 Dillingsley, H. 818  
 Dillmann, E. 819  
 Dilorenzo, Kirk 1121  
 Dimmick, Edgar L. 1558  
 Dimnet, Ernest 98  
 Dingle, Herbert 2, 390, 717, 1240, 1600  
 Diolé, Philippe 1453, 1736  
 Dirac, Paul Adrian Maurice 11, 158, 434, 611, 636, 656, 745, 818, 819, 884, 941, 981, 1110, 1121, 1209  
 Dirgo, Craig 1248  
 Disraeli, Benjamin, 1st Earl of Beaconsfield 203, 459, 550, 787, 1082, 1287, 1507  
 Ditton, Humphry 640  
 Dixon, Malcom 1040  
 Dixon, William MacNeile 1492  
 Djerassi, Carl 1459  
 Doane, R. W. 62  
 Dobie, J. Frank 1287  
 Dobzhansky, Theodosius 173, 302, 376, 459, 577, 656, 788, 936, 953, 981, 1287, 1384  
 Dock, William 355  
 Dodd, Robert 908  
 Dodge, A. Y. 411  
 Dodge, Richard Elwood 740  
 Domagk, Gerhard 253  
 Donaldson, T. B. 915  
 Donghia, Angelo 105  
 Donleavy, James Patrick 628  
 Donne, John 70, 109, 119, 262, 265, 285, 299, 381, 634, 918, 1082, 1096, 1462  
 Donoghue, M. J. 1571  
 Doob, J. L. 818  
 Dorman, Imogen 909  
 Dornan, Christopher 1352  
 Dostoevsky, Fyodor Mikhailovich 7, 449  
 Dott, Jr., Robert H. 1287  
 Douglas, A. Vibert 127, 132, 312, 1190, 1622  
 Douglas, Andrew Ellicott 981, 1642  
 Douglas, James 908  
 Douglas, Mary 1288  
 Douglas, Norman 763  
 Dowdeswell, Wilfrid Hogarth 460  
 Downy, J. C. 670  
 Doxiadis, Apostolos 873, 1170  
 Doyle, Sir Arthur Conan 22, 54, 62, 69, 71, 77, 106, 153, 155, 189, 203, 216, 240, 262, 319, 327, 332, 338, 347, 350, 351, 385, 388, 504, 523, 554, 579, 583, 625, 636, 645, 656, 672, 680, 717, 763, 820, 896, 913, 920, 941, 955, 959, 982, 1027, 1096, 1140, 1178, 1190, 1232, 1288, 1410, 1417, 1507, 1600, 1639, 1672, 1737  
 Dr. Gil 1249  
 Dr. Kemp 1433  
 Dr. Seuss (Theodor Seuss Geisel) 1500  
 Dr. Watson 89  
 Drachmann, A. G. 704  
 Drake, Daniel 737, 897, 1028, 1073, 1096, 1652  
 Drake, Frank 621  
 Draper, John William 982, 1356, 1384, 1499  
 Drees, Willem B. 1227  
 Dresden, Arnold 820  
 Dressler, Alan 1587  
 Dretske, Fred I. 158  
 Drexler, K. Eric 656, 717, 1581  
 Driesch, Hans 173  
 Drinker, Henry 710, 1662  
 Drummond, Jack Cecil 1710  
 Drummond, William, Sir 1232  
 Druyan, Ann 1515, 1554, 1692  
 Dryden, John 38, 109, 132, 203, 216, 233, 340, 368, 439, 690, 791, 897, 909, 982, 1096, 1288, 1365, 1552, 1642  
 du Bartas, Guillaume de Salluste 25, 181, 982  
 DuBois-Reymond, Emil 554  
 Dubos, René Jules 6, 368, 433, 460, 493, 792, 897, 905, 1042, 1146, 1221, 1232, 1288, 1371, 1385, 1412, 1422, 1433, 1581  
 DuBridge, Lee Alvin 411  
 Duchesne, Joseph 400  
 Duck, Stephen 46  
 Duckham, Sir Arthur 230  
 Duckworth, Eleanor 656  
 Duclaux, Pierre Émile 1366  
 Dudley, Underwood 560  
 Dudley Manlove 1140

- Duffin, R. J. 1138  
 Duffy, Carol Ann 240  
 Duffy, John C. 1097  
 du Fresnoy, Nicholas Langlet 240  
 du Hamel, Joannes Baptiste 597  
 Duhem, Pierre-Maurice-Marie 158, 645, 940, 1110, 1121, 1356, 1600  
 Dulbecco, Renato 376, 982  
 Dumas, Alexandre 1097  
 Dumas, Hal S. 411  
 Dumas, Jean Baptiste-Andre 240, 755, 982, 1028, 1222, 1361, 1652  
 Dunbar, Carl O. 1061  
 Dunbar, Paul Laurence 982  
 Duncan, Otis Dudley 439  
 Duncan, Robert 240  
 Duncan, Ronald 665  
 Dunham, William 1735  
 Dunlap, Ellen L. 1146  
 Dunlap, Knight 568  
 Dunlap, William 1462  
 Dunlop, William 1559  
 Dunn, R. A. 168  
 Dunne, Dominick 376  
 Dunne, Finley Peter 109, 544, 702, 915, 1427, 1462  
 Dunnell, Robert C. 1167  
 Dunnette, Marvin D. 1012  
 Dunning, John R. 412  
 du Noüy, Pierre Lecomte 9, 216, 645, 1028, 1080, 1166, 1288, 1385, 1433, 1465  
 Dunsany, Lord Edward John Moreton Drax Plunkett 783  
 Duprée, Hunter 1402  
 du Preez, Peter 1190  
 du Prel, Karl 1678  
 Durack, J. J. 132  
 Durand, David 329, 330  
 Durand, William Frederick 412  
 Durant, William James 107, 168, 403, 789, 1083, 1240, 1371, 1377, 1385  
 Durell, Clement V. 930, 982, 1241  
 Duren, Peter L. 306  
 Durkheim, Emile 1028  
 Durrell, Gerald M. 263  
 Durrell, Lawrence 89  
 Dürrenmatt, Friedrich 372, 622, 930, 1110, 1227  
 du Sautoy, Marcus 1170, 1258  
 Duschl, Richard Alan 1601  
 du Toit, Alex L. 292  
 Dutton, S. T. 820  
 Dwyer, Herbert A. 173  
 Dyer, Betsey Dexter 154  
 Dyer, Frank Lewis 704  
 Dyer, John 378, 1261  
 Dylan, Bob 224  
 Dyson, Freeman J. 60, 81, 403, 412, 444, 460, 511, 611, 625, 763, 780, 820, 874, 884, 920, 1079, 1110, 1122, 1166, 1190, 1204, 1209, 1239, 1288, 1385, 1422, 1434, 1484, 1490, 1492, 1557, 1581, 1678, 1699  
**E**  
 e 377  
 E = mc<sup>2</sup> 377  
 Eakin, Richard M. 1289  
 Earle, Sylvia Alice 1716  
 Easton, Elmer C. 1190  
 Easton, William 656  
 Eastwood, Clint 786  
 Eaton, Burnham 31  
 Eben, Aubrey 1289  
 Ebert, D. 1053  
 Eckert, Allan W. 982  
 Eckstein, Gustav 763  
 Eco, Umberto 299, 690, 1015, 1075, 1667  
 Eddington, Sir Arthur Stanley 132, 142, 179, 203, 216, 276, 279, 302, 345, 356, 390, 403, 431, 446, 460, 486, 488, 493, 515, 524, 542, 566, 571, 577, 595, 670, 690, 718, 745, 754, 774, 782, 794, 803, 821, 874, 890, 892, 909, 921, 932, 940, 947, 963, 983, 1008, 1011, 1028, 1039, 1049, 1054, 1083, 1110, 1122, 1140, 1146, 1163, 1178, 1198, 1209, 1222, 1227, 1241, 1289, 1361, 1385, 1427, 1461, 1474, 1476, 1478, 1492, 1500, 1507, 1550, 1565, 1601, 1618, 1628, 1652, 1679, 1699, 1702, 1718  
 Eddy, Mary Baker 368, 627, 628, 1377  
 Edelman, Gerald M. 1289  
 Edelstein, Ludwig 1122  
 Eden, Sir Anthony 356  
 Edey, Maitland 796  
 Edgeworth, Francis Ysidro 279, 439, 746, 1178, 1232, 1532  
 Edgeworth, Maria 240  
 Edison, Thomas 351, 356, 1621  
 Edison, Thomas Alva 493, 579  
 Editor 774, 789, 1727  
 Editorial 228, 507, 763, 1398, 1581, 1679  
 Editor of the Louisville Journal 181, 265, 342, 1585  
 Edwards, A. W. F. 1532  
 Edwards, Harold M. 821  
 Edwards, Llewellyn Nathaniel 412  
 Edwards, R. Y. 953  
 Edwards, Tyron 821, 1532  
 Efron, Bradley 1532  
 Egerton, E. N. 983  
 Egerton, Sarah 412  
 Egler, Frank E. 277, 579, 697, 718, 913, 1227, 1289, 1434



- Egrafov, M. 874  
 Egyptian Myth 1696  
 Ehlers, Vernon 262  
 Ehrenberg, A. S. C. 319, 1190  
 Ehrenfest, Paul 1122  
 Ehrenreich, Barbara 163, 1146  
 Ehrensvärd, Gosta Carl Henrik 1576  
 Ehrlich, Gretel 27, 740, 1552  
 Ehrlich, Paul 493  
 Ehrmann, Max 1679  
 Eigen, Manfred 932  
 Eilenberger, Gert 821  
 Einstein, Albert 1, 2, 5, 11, 132, 142, 143, 186, 196, 203, 216, 256, 272, 277, 313, 329, 338, 340, 345, 356, 390, 401, 403, 435, 446, 447, 449, 485, 488, 524, 560, 569, 576, 611, 622, 656, 672, 682, 703, 718, 746, 763, 775, 821, 893, 921, 930, 955, 969, 983, 1028, 1083, 1088, 1091, 1111, 1122, 1147, 1191, 1204, 1209, 1226, 1227, 1232, 1241, 1244, 1249, 1258, 1289, 1290, 1350, 1361, 1366, 1371, 1385, 1403, 1427, 1429, 1434, 1459, 1465, 1492, 1500, 1532, 1549, 1550, 1591, 1592, 1601, 1602, 1621, 1622, 1628, 1652, 1667, 1729  
 Einstein, Jacob 15  
 Eiseley, Loren C. 27, 85, 89, 92, 228, 306, 351, 356, 397, 460, 511, 563, 718, 763, 795, 1054, 1140, 1239, 1386, 1716  
 Eisenhart, Churchill 697, 1532  
 Eisenhower, Dwight David 196, 412, 1398  
 Eisenschiml, Otto 339, 637, 656, 1079, 1097, 1290, 1723  
 Eisner, T. 54  
 Ekert, Artur 1210  
 Elder, Joseph 1422  
 Eldredge, Niles 322, 460, 507  
 Eldridge, Paul 216, 340, 371, 493, 524, 690, 861, 1232, 1576  
 Elgerd, Olle I. 423  
 Eliot, George (Mary Ann Evans Cross) 12, 27, 55, 146, 524, 628, 656, 778, 874, 916, 960, 983, 1065, 1163, 1178, 1507, 1603, 1628, 1653  
 Eliot, T. S. (Thomas Stearns) 61, 505, 628, 656, 665, 693, 1073, 1162, 1261, 1559, 1628, 1679, 1699  
 Elliot, Hugh 1679  
 Ellis, Brian 890  
 Ellis, Havelock 822, 960, 1532  
 Elton, Charles S. 80, 383, 433, 1067, 1571, 1737  
 Elton, G. R. 1070  
 Embree, Alice 1581  
 Embury, Emma 550  
 Emelyanov, A. S. 1290, 1434  
 Emerson, Ralph Waldo 20, 33, 55, 57, 85, 88, 98, 101, 106, 107, 109, 119, 132, 158, 186, 196, 200, 204, 222, 228, 233, 241, 255, 258, 263, 302, 340, 378, 395, 404, 412, 461, 493, 524, 550, 560, 574, 576, 583, 598, 600, 622, 628, 657, 672, 685, 700, 704, 706, 718, 746, 779, 789, 795, 820, 913, 983, 1038, 1042, 1059, 1067, 1097, 1123, 1140, 1158, 1191, 1261, 1290, 1361, 1387, 1406, 1418, 1453, 1462, 1465, 1471, 1473, 1474, 1507, 1532, 1587, 1622, 1679, 1716, 1719, 1728  
 Emerson, William 1730  
 Emmeche, Claus 173, 1291  
 Emmerson, G. S. 423  
 Emmet, William LeRoy 412, 423  
 Empedocles of Acragas 395, 943, 1454  
 Empiricus, Sextus 204  
 Empson, William 1478  
 Enarson, Harold L. 319  
 Engard, Charles J. 1680  
 England, Terry 1434  
 English, Thomas Dunn 1642  
 Enriques, Federigo 1366  
 Enzensberger, Hans Magnus 1016  
 Epictetus 1232  
 Epps, John 356  
 Epstein, P. S. 1618  
 Erath, Vinzenz 611  
 Erdős, Paul 611, 822, 1171, 1259  
 Errera, Leo 1653  
 Erzinclioglu, Zakaria 85  
 Esar, Evan 95, 348, 378, 583, 595, 606, 652, 1716  
 Escher, M. C. 822, 874, 1371  
 Esquivel, Laura 1653  
 Estling, Ralph 1680  
 Euclid of Alexandria 746, 1201  
 Eudoxus of Cnidus 1552  
 Euler, Leonhard 1016, 1029, 1172, 1680  
 Euripides 216, 600, 1016, 1022  
 Eustace, R. 113, 997  
 Evanovich, Janet 1178  
 Evans, Bergen 439, 645, 1201  
 Evans, Howard Ensign 55, 430, 984, 1053  
 Evans, Sebastian 412  
 Eve, A. S. 170  
 Everett, Edward 119, 719, 1291, 1588, 1653  
 Everitt, W. L. 423  
 Eves, Howard W. 822  
 Ewing, John 801  
 Eysenck, Hans Jurgen 1434
- F**  
 Faber, Harold 719  
 Fabilli, Mary 1016  
 Fabre, Jean-Henri 47, 397, 600  
 Fagan, Brian 89  
 Fahrenheit, Daniel Gabriel 1620  
 Fairbairn, A. M. 822

- Falconer, William 1552  
 Falk, Donald 1496  
 Falletta, Nicholas 1065  
 Fana, C. 461  
 Faraday, Michael 133, 200, 241, 388, 494, 525, 554,  
 645, 652, 672, 746, 874, 960, 963, 1029, 1081,  
 1562, 1576, 1603  
 Farb, Peter 789  
 Farber, Eduard 241  
 Farber, Eric A. 608  
 Farmer, Philip José 1702  
 Farnes, Patricia 1404  
 Farquhar, George 413  
 Farr, William 1532  
 Farrar, John 822  
 Farrell, Hugh 233  
 Farrington, Benjamin 1410  
 Farris, Jean 178, 791  
 Faul, Carol 583  
 Faul, Henry 583, 1586  
 Faulkner, William 1434  
 Fauset, Jessie Redmon 173  
 Faust 1124  
 Fawcett, Edgar 30  
 Fechner, Gustav 323  
 Feibleman, James K. 747, 1295, 1434  
 Feigl, H. 1291  
 Feinberg, Gerald 763  
 Feinberg, J. G. 133  
 Feinstein, Alvin R. 261  
 Fejer, M. M. 331  
 Feleki, László 704  
 Feller, William 1179  
 Fenger, Carl Emil 1546, 1560  
 Ferguson, Arthlyn 1124  
 Ferguson, Eugene S. 336, 423  
 Ferguson, Kitty 451, 890, 1016, 1532  
 Ferguson, Marilyn 1667  
 Fermi, Enrico 217, 984, 1068  
 Fermi, Laura 548  
 Fernel, Jean 24, 611  
 Ferré, Nels F. S. 1292, 1376  
 Ferrer, Francisco 1244  
 Ferris, G. F. 960  
 Ferris, Timothy 163, 297, 299, 494, 543, 572, 756, 764,  
 932, 1210, 1292, 1478, 1485, 1492, 1549, 1567,  
 1588, 1667, 1680  
 Fersman, A. E. 672, 1232  
 Feuer, Michael J. 291  
 Feuerbach, Ludwig 755, 984, 1500  
 Fevre, R. W. 984  
 Feyerabend, Paul K. 461, 525, 657, 984, 1198,  
 1232, 1266, 1292, 1356, 1398, 1403, 1413,  
 1434, 1577, 1708  
 Feynman, Richard P. 81, 88, 133, 134, 154, 162, 301,  
 313, 339, 356, 372, 390, 402, 404, 435, 494, 505,  
 553, 554, 608, 612, 622, 626, 657, 673, 683, 719,  
 746, 758, 775, 822, 823, 921, 932, 955, 1016, 1029,  
 1068, 1069, 1088, 1092, 1111, 1124, 1141, 1179,  
 1191, 1210, 1216, 1266, 1292, 1352, 1371, 1398,  
 1413, 1427, 1435, 1465, 1490, 1577, 1581, 1591,  
 1593, 1603, 1618, 1653, 1662, 1667, 1680, 1737  
 Fibiger, Johannes 199  
 Ficino, Marsilio 1147  
 Fiedler, Edgar R. 557, 1164, 1239  
 Field, Edward 1680  
 Field, Eugene 65, 339, 1097  
 Fielding, Henry 323, 544, 985, 1097  
 Fieller, E. C. 1706  
 Fienberg, Stephen E. 1533  
 Figenbaum, Mitchell 224  
 Fillery, Frank 332  
 Finch, James Kip 413  
 Findley, Thomas 702, 1559  
 Finlay, Victoria 775  
 Finney, D. J. 1524  
 Finniston, Sir Monty 1435  
 Firsoff, Valdemar Axel 1485  
 Fischbach, Gerald D. 189  
 Fischer, D. H. 1216  
 Fischer, Emil 228, 241, 1293  
 Fischer, Ernst Peter 439  
 Fischer, Martin H. 329, 357, 525, 645, 719, 737, 822,  
 1029, 1352, 1377, 1603, 1637  
 Fischer, Robert B. 719  
 Fish, J. C. L. 423, 425  
 Fishback, Margaret 653  
 Fisher, H. A. L. 755  
 Fisher, Irving 1260  
 Fisher, Sir Ronald Aylmer 4, 23, 217, 319, 331, 439,  
 494, 578, 620, 665, 719, 823, 965, 1012, 1224,  
 1225, 1245, 1356, 1418, 1429, 1522, 1524, 1533,  
 1563, 1573  
 Fiske, John 795, 1240, 1293  
 Fitch, G. D. 823  
 Fittag, R. 275  
 Fitz-Randolph, Jane 1091  
 FitzGerald, Edward 196  
 Fitzgerald, F. Scott 579, 1533  
 Fitzgerald, Penelope 1435  
 Flammarion, Camille 120, 265, 381, 764, 874, 943,  
 985, 1006, 1471, 1474, 1552, 1680  
 Flanders, Michael 50, 507, 631  
 Flanders, Ralph E. 413  
 Flannery, Kent V. 83, 92  
 Flannery, Maura C. 9, 170  
 Flaubert, Gustave 49, 79, 182, 254, 302, 332, 351, 373,  
 377, 399, 791, 906, 924, 1294, 1387, 1696

- Fleck, Ludwik 719  
 Flecker, James Elroy 1454, 1508  
 Fleiss, Joseph L. 743, 1524  
 Fleming, Alexander 84  
 Fleming, Donald 962  
 Fleming, Ian 926  
 Fleming, J. A. 1191  
 Fleming, Sir Alexander 357, 1076  
 Fletcher, Colin 921  
 Fletcher, John 310, 972  
 Fletcher, Joseph 1245  
 Flexner, Abraham 146, 697, 897, 1080, 1191, 1413  
 Flinn, Alfred D. 423  
 Florian, Douglas 47, 48, 62, 65, 66  
 Florio, John 985, 1097  
 Florman, Samuel C. 413, 423, 447, 787, 1260  
 Flory, Paul J. 241  
 Flower, Sir William Henry 953  
 Fock, Vladimir Alexandrovich 345  
 Fontenelle, Bernard Le Bovier 600  
 Forbes, A. 915  
 Forbes, Edward 308, 592, 764, 781, 969, 1042, 1204, 1294, 1497  
 Forbes, J. D. 1179  
 Ford, E. B. 966  
 Ford, Henry 637  
 Ford, John 1097  
 Ford, Joseph 224  
 Ford, Kenneth W. 985  
 Forder, Henry G. 823  
 Foreman, Dave 383  
 Forrester, Jay Wright 275  
 Forssmann, Werner 628  
 Forster, E. M. (Edward Morgan) 1524, 1642  
 Forsyth, A. R. 719, 823  
 Fort, Charles 109, 319, 1263, 1294  
 Fosdick, Harry Emerson 956, 1387  
 Foss, Sam Walter 148  
 Fossey, Dian 70  
 Foster, Alan Dean 1435  
 Foster, Bishop 697  
 Foster, G. C. 1111  
 Foster, Hannah W. 1083  
 Foster, Sir Michael 342, 526, 719, 985, 1356, 1366, 1418  
 Foucault, Michel 764  
 Fourcroy, Antoine-François 128, 1653  
 Fourier, (Jean Baptiste-) Joseph 204, 343, 357, 631  
 Fournier d'Albe, E. E. 390  
 Fowler, Peter J. 92  
 Fownes, George 241  
 Fox, Robin 1294, 1435  
 Fox, Russell 319, 890  
 Fox, Sir Theodore 1098  
 Fraenkel, Aviezri S. 985  
 France, Anatole (Jean Jacques Brousson) 86, 526, 1366, 1413, 1681  
 France, M. Mendés 1173  
 Francis, Peter 1712  
 Franck, Georg 1294  
 Frank, Julia Bess 334  
 Frankel, Felice 390, 775, 937, 1049, 1227  
 Frankland, A. 823, 1567  
 Franklin, Alfred 665  
 Franklin, Benjamin 34, 388, 494, 693, 747, 823, 1294, 1425, 1585  
 Franklin, W. S. 823, 1125  
 Franks, Felix 1716  
 Fraser, Julius Thomas 1125, 1628  
 Fraunhofer, Joseph von 1508  
 Frayn, Michael 153, 1011, 1681  
 Frazer, Sir James George 747, 921  
 Frazier, A. W. 1191  
 Frederick the Great 228, 1653  
 Fredrickson, A. G. 608, 1191  
 Fredrickson, G. 694  
 Fredrickson, Hal 198  
 Free, E. E. 407, 1366  
 Freeland, E. Harding 255  
 Freeman, Ira M. 134  
 Freeman, Linton C. 1533  
 Freeman, R. Austin 24, 320, 526, 747, 1097, 1179, 1249  
 Frege, Friedrich Ludwig Gottlob 102, 329, 385, 526, 783, 824  
 Freke, John 388  
 French, John 183  
 French Apothegm 1295  
 Frere, John Hookam 128, 640  
 Frere, John Hookham 1063, 1237  
 Fresenius, C. R. 5  
 Freud, Sigmund 173, 645, 700, 1294, 1387, 1399, 1435  
 Freudenthal, Hans 329  
 Freund, C. J. 306, 413  
 Freund, Ida 1294  
 Frey, Robert W. 653  
 Freyssinet, E. 413  
 Fridovitch, Irwin 399  
 Friedel, Robert 424  
 Friedenberg, Edgar Z. 1376  
 Friedman, Herbert 109, 1471  
 Friedman, Milton 148, 645  
 Friend, Julius W. 747, 1295  
 Frisch, Max 1581  
 Frisch, Otto 134, 313  
 Fritzschn, Harald 1681  
 Fromm, Erich 1295

- Frost, Robert 47, 62, 110, 120, 224, 234, 285, 289, 631, 884, 909, 911, 943, 1067, 1227, 1295, 1479, 1508, 1588, 1603, 1681, 1699
- Froude, James Anthony 148, 204, 212, 439, 526, 690, 747, 1179, 1362, 1387, 1628
- Fruton, Joseph S. 166
- Fry, Christopher 943
- Fry, Harold Shipley 234
- Fry, Thornton C. 1179
- Frye, Northrop 673
- Fuertes, Louis Agassiz 1223
- Fulbright, James William 1295
- Fulford, Robert 907
- Fuller, R. Buckminster 234, 296, 336, 357, 511, 795, 985, 1435
- Fuller, Sarah Margaret 433
- Fuller, Thomas 85, 324, 368, 622, 720, 1098, 1139, 1462, 1465, 1638
- Fuller, Wallace H. 1473
- Fung, Y. C. B. 424
- Furth, Harold P. 84
- Futuyma, Douglas J. 462
- G**
- Gäbor, Dennis 178, 413, 1295, 1582
- Gage, Simon Henry 526
- Gahan, A. B. 960
- Gaiman, Neil 617
- Galbraith, John Kenneth 414, 704, 1295, 1582
- Gale, Barry 462
- Gale, Richard M. 1629
- Galilei, Galileo 120, 280, 294, 526, 600, 612, 947, 1029, 1064, 1147, 1153, 1233, 1552, 1556, 1588, 1654, 1667, 1681
- Galilei, Vincenzo 1654
- Galison, Peter 697
- Gallup, George 1533
- Galston, Arthur William 1436
- Galsworthy, John 212, 217, 897, 1266
- Galton, Sir Francis 374, 450, 462, 747, 764, 795, 1198, 1436, 1533, 1629
- Gamow, George 163, 313, 390, 404, 431, 462, 690, 747, 795, 941, 1008, 1009, 1075, 1111, 1125, 1222, 1238, 1508, 1588, 1697, 1700, 1718
- Gann, Ernest K. 1533
- Gaposchkin, Sergei 1012
- Gardner, Earl Stanley 527, 1629
- Gardner, John 27, 51, 79
- Gardner, John W. 695
- Gardner, Martin 179, 824, 1075, 1125, 1172, 1266, 1296, 1436, 1725
- Garfield, James A. 1454
- Garman, Charles E. 1387
- Garrels, Robert M. 583
- Garrett, A. B. 757
- Garrison, W. M. 764
- Garrod, Archibald 1296, 1366, 1413, 1425
- Garstang, Walter 31, 43, 48, 50, 64, 278, 636
- Garth, Sir Samuel 897, 985
- Garwin, R. L. 337
- Gass, Fredrick 1016
- Gassendi, Pierre 134, 824
- Gastel, Barbara 1422
- Gatty, M. S. 1158
- Gaudry, Jean-Albert 1060
- Gauss, Johann Carl Friedrich 567, 600, 690, 720, 824, 874, 893, 921, 1172, 1256, 1436, 1479, 1577, 1654
- Gay, John 36, 58, 60, 65, 72, 985, 1179
- Gay-Lussac, Joseph Louis 18, 196, 357, 494, 527, 577, 747, 913, 1125, 1233, 1257, 1603
- Geary, R. C. 374
- Geddes, Patrick 462
- Gee, Samuel 1137
- Geertz, Clifford 83
- Geikie, Sir Archibald 445, 637, 1356, 1427, 1457
- Gelernter, David 1422
- Gell, Alfred 720
- Gell-Mann, Murray 1, 201, 435, 1210, 1436, 1556
- Geminus of Rhodes 110
- General Motors 1169
- Geoffroy the Elder 398
- Geordi 1125
- George, T. N. 563
- George, William H. 224, 527, 1249, 1603
- Gerard, John 1158
- Gerhardt, C. 1466
- Germain, Sophie 824
- Gerould, Katherine Fullerton 584, 1296, 1721
- Gesenius, Wilhelm 1427
- Gettings, Fred 1040
- Ghalioungui, Paul 1080
- Gibbon, Edward 747, 824, 1179
- Gibbs, J. Willard 645, 1112, 1249, 1352, 1708
- Gibran, Kahlil 110, 324, 720, 890, 926, 928, 1016, 1436, 1466, 1479
- Gibson, Charles R. 390
- Gibson, William Hamilton 194
- Gibson, William Sidney 584
- Giddings, Franklin H. 494, 527
- Gideonse, H. D. 1296
- Giere, Ronald 697
- Gilbert, G. K. 595, 646, 665, 720
- Gilbert, Sir William Schwenck 439, 463, 527, 790, 824, 1065, 1179, 1268, 1553, 1603, 1638
- Gilbert, William 357, 791, 927, 1179
- Gilbertus, Anglicus 1559
- Gildersleeve, Virginia Crocheron 1404

- Giles, Roscoe C. 146, 1561  
Gilkey, Langdon 152, 1387  
Gill, Eric 1296  
Gillette, H. P. 424  
Gillilan, Strickland 915  
Gillispie, Charles Coulston 986, 1387  
Gillmor, R. E. 414  
Gilman, Charlotte Perkins 31, 332, 527  
Gilman, Peter A. 1555  
Gilmer, Ben S. 306  
Ginger, Ray 1296  
Gingerich, Owen 1223  
Ginsey, Gurney 1016  
Giraudoux, Jean 511, 1682  
Girtanner, Christopher 234, 439  
Gisbourne, Thomas 1098  
Gish, D. T. 463  
Gissing, George 86, 1180, 1268, 1533  
Gladilin, V. N. 258  
Glaessner, M. F. 1461  
Glaisher, James Whitbread Lee 874, 1011, 1422  
Glanvill, Joseph 824  
Glaser, Christophe 241, 253, 608  
Glasgow, Ellen 285  
Glashow, Sheldon L. 338, 390, 400, 623, 775, 1069, 1090, 1436, 1604, 1718  
Glasow, Arnold 668  
Glass, H. Bentley 357, 1296  
Glasser, Allen 294  
Glazkov, Yuri 764  
Gleason, Andrew M. 824, 1201  
Gleason, Henry Allan 1158  
Glegg, Gordon L. 306, 414  
Gleck, James 224, 495, 505, 691, 802, 1069, 1399, 1436  
Gleiser, Marcello 1682  
Glenn, Jr., John 1479  
Gloag, John 194  
Glob, Peter Vilhelm 92  
Glover, Townend 193  
Gluckman, Max 1296  
Goddard, Robert H. 104, 439, 543, 680, 1198, 1264, 1297, 1508, 1604  
Godwin, William 825  
Goeppert-Mayer, Maria 134, 1125  
Gogarty, Oliver St. John 698, 1559  
Gold, Thomas 433, 527  
Goldanskii, Vitalii 1055  
Goldenweiser, Alexander 272, 646, 1436  
Golder, H. Q. 414  
Goldhaber, Maurice 1604  
Goldsmith, Oliver 344  
Goldstein, A. 1437  
Goldstein, Herbert 1565  
Goldwyn, Samuel 680  
Goleman, Daniel 907  
Gombrich, Ernst Hans 5, 931  
Gonek, S. 1172  
Gonseth, Ferdinand 495  
Good, I. J. 1180, 1524  
Good, John Mason 485, 584  
Goodale, Dora Read 550  
Goodale, Elaine 550  
Goody, Graeme 527  
Goode, George Brown 953  
Goodenough, Ursula 1508  
Goodfield, June 662, 1072, 1729  
Goodman, Ellen 787  
Goodman, Nelson 1466  
Goodman, Nicholas P. 1604  
Goodspeed, Edgar J. 612, 1387  
Goodstein, Reuben L. 825  
Goodwin, Brian Carey 173, 789, 907  
Gorbunov, Max 319, 890  
Gordon, Alexander 92  
Gore, Al 260, 1582  
Gore, George 495, 528, 720, 1217, 1233, 1466, 1654  
Gore, Rick 173  
Gorky, Maxim 1070, 1297  
Gornick, Vivian 1378, 1437  
Gortner, Ross Aiken 1297  
Görtner, Thomas 298  
Goudsmit, Samuel A. 1501  
Gould, Donald 463  
Gould, Hannah Flagg 1042  
Gould, Laurence M. 789, 1297  
Gould, Stephen Jay 29, 105, 200, 225, 303, 305, 306, 337, 357, 375, 429, 440, 463, 478, 508, 528, 592, 595, 612, 626, 637, 657, 664, 673, 764, 885, 894, 907, 921, 931, 933, 966, 986, 1017, 1025, 1191, 1217, 1244, 1297, 1376, 1399, 1413, 1420, 1423, 1470, 1574, 1604, 1672, 1721  
Gowers, Timothy 874, 1172  
Goya, Francisco Jose 673  
Grace, Eugene G. 414  
Gracian, Baltasar 1098, 1180  
Graham, Aelred 612  
Graham, L. A. 196, 555, 759, 782, 825, 875, 1076, 1138  
Graham, Loren R. 447  
Graham, Neill 1209  
Graham, Ronald L. 825  
Grainger, Elena 223  
Granick, Samuel 357  
Grant, Claud 342  
Grant, Robert 120  
Granville, Peter 584  
Grassé, Pierre P. 154, 173, 225, 466, 700, 1061, 1298

- Grassi, Horatio 265  
 Grassmann, Hermann 825  
 Graton, L. C. 258  
 Gratzler, Walter Bruno 1604  
 Graves, Richard 544, 1206  
 Gray, Asa 584  
 Gray, George W. 337, 986, 1147, 1238, 1437, 1654  
 Gray, Thomas 55, 98, 986, 1042, 1298  
 Greedman, D. A. 933  
 Green, Celia 86, 329, 495, 1058, 1112, 1249, 1533  
 Greenberg, J. Mayo 764  
 Greene, Brian 691, 986, 1112, 1125, 1217, 1241, 1366  
 Greene, Edward L. 624  
 Greene, Graham 466  
 Greenspoon, David Harry 274  
 Greenstein, George 320, 612, 913, 1508  
 Greenstein, Jesse L. 127, 528  
 Greenwood, H. J. 933  
 Greenwood, M. 1533  
 Greer, Scott 1029  
 Gregg, Alan 4, 368, 495, 528, 646, 1029, 1098, 1249  
 Gregory, Dick 986  
 Gregory, J. W. 584  
 Gregory, John 897, 1098, 1533  
 Gregory, Olinthus 893  
 Gregory, Sir Richard Arman 279, 357, 528, 646, 707,  
 720, 922, 986, 1029, 1207, 1298, 1362, 1420,  
 1427, 1485, 1497, 1592, 1654, 1723  
 Grew, Nehemiah 608, 1030, 1233  
 Gribbin, John 4, 1112, 1228, 1240, 1604, 1700  
 Griffin Jay 1080  
 Griffiths, Trevor 300  
 Grimaux, L. E. 1466  
 Grindal, Bruce 82, 291  
 Grinnel, Frederick 1387  
 Grinnell, George Bird 584  
 Grinter, L. E. 424  
 Groen, Janny 1495  
 Grondal, Florence Armstrong 110, 634, 1509  
 Gross, David 158, 555, 1126  
 Gross, S. D. 1559  
 Grosseteste, Robert 1048  
 Grove, Sir William 1237, 1298  
 Grover Snood 148  
 Gruber, Howard E. 1298  
 Gruenberg, Benjamin C. 414, 1298  
 Gübelin, Eduard 929  
 Guest, Judith 217  
 Guiducci, Mario 1725  
 Guillen, Michael 825, 875  
 Guinzelli, Guido 33  
 Guiterman, Arthur 466, 1147, 1509  
 Gull, Sir William Withey 897, 1098, 1388  
 Gumperson, R. F. 1180  
 Guruprasad, Venkata 825  
 Gutenberg, Beno 183, 309  
 Guterson, David 1712  
 Guth, Alan 163, 297, 404, 1298, 1682  
 Gutzwiller, M. C. 1735  
 Guy, Richard K. 825  
 Guyau, Jean-Marie 560  
 Guye, Charles Eugene 1298
- H**  
 Haag, Joel 1008  
 Haas, W. H. 1080  
 Haber, Fritz 3, 242  
 Haber, Heinz 313, 511, 1490  
 Habera, Audrey 1533  
 Habington, William 1509  
 Hachamovitch, Moshe 1  
 Hackett, L. W. 485  
 Hacking, Ian 502, 1163, 1166, 1501  
 Hadamard, Jacques 351, 657, 825  
 Haeckel, Ernst 383, 467, 986, 1091  
 Hafemeister, David 260  
 Hafiz, Mohammed Shems-ed-Deen 234  
 Hageman, Samuel M. 1147  
 Haggard, H. Rider 943  
 Haggard, Howard W. 897, 1298  
 Hagstrom, Warren O. 1423  
 Hailey, Arthur 1534  
 Halacy, Jr., D. S. 1682  
 Halbach, Mary Jayne 242  
 Haldane, John Burdon Sanderson 59, 173, 199, 228,  
 242, 343, 528, 673, 765, 826, 1158, 1388, 1423,  
 1466, 1604, 1682  
 Haldane, John Scott 612, 930, 1622  
 Haldane, R. B. 1241  
 Hale, George Ellery 120, 698, 775, 791, 1485, 1520,  
 1682  
 Hale, Susan 332  
 Hales, Stephen 890, 986, 1017, 1030  
 Half, Robert 352  
 Haliburton, Thomas C. 144  
 Hall, A. D. 1299  
 Hall, Alfred Rupert 721, 1299, 1356, 1410  
 Hall, Asaph 1362, 1406  
 Hall, G. Stanley 826  
 Hall, J. 584  
 Hall, John 134  
 Hall, Marie Boas 1299, 1356  
 Halle, John 24, 291  
 Halle, Louis J. 46  
 Halley, Edmond 110, 266  
 Halmos, Paul R. 484, 826, 1191, 1654  
 Halsted, Anna Roosevelt 1462  
 Halsted, George Bruce 600, 826

- Hamerton, Philip Gilbert 414  
Hamilton, Edith 1605  
Hamilton, L. L. 424  
Hamilton, Sir William Rowan 16, 345, 358, 600  
Hamilton, W. 911  
Hamilton, Walton 704  
Hamilton, William D. 966  
Hammer, P. C. 88, 280  
Hammersley, J. 875  
Hamming, Richard W. 277, 374, 1180, 1201  
Hammond, Allen Lee 404, 1141  
Hammond, H. P. 424  
Hammond, Henry 1180  
Hammond, John Hays 424  
Hammond, Kenneth R. 1164  
Hancock, William Keith 1534  
Hand, D. J. 1534  
Handler, Philip 168, 1299  
Hanham, H. J. 1582  
Hankel, Hermann 826  
Hankins, Arthur Preston 1588  
Hankla, Susan 1161  
Hanson, Elayne Clipper 1022  
Hanson, Norwood Russell 529, 1030, 1112, 1126  
Hans Solo 641  
Harari, Haim 1008  
Harari, Josué V. 1299  
Hardenberg, Friedrich von 875  
Hardin, Garrett 506, 613, 1388  
Harding, Rosamund E. M. 674, 1437  
Hardy, G. H. (Godfrey Harold) 506, 827, 875, 1017, 1021, 1046, 1172, 1399, 1682, 1727  
Hardy, Thomas 7, 44, 310, 1147, 1299, 1454, 1469, 1509, 1642, 1725  
Hare, Hobart Amory 529, 1569  
Harington, John 1704  
Harishchandra 674  
Harjo, Joy 1509  
Harker, Alfred 748  
Harkness, William 987, 1708  
Harman, Willis 1299  
Harnwell, G. P. 1437  
Harré, Rom 907  
Harrington, Eldred 827  
Harrington, John W. 595, 1299, 1621  
Harrington, Sir John 110  
Harrington, Thomas 121, 208, 739, 1624  
Harris, A. J. 424  
Harris, Anita 585  
Harris, Errol E. 1180, 1299  
Harris, Joel Chandler 1462  
Harris, John 266, 1556  
Harris, Ralph 558  
Harris, Sidney 374  
Harris, Sydney J. 721  
Harris, William Torrey 827  
Harrison, B. 1241  
Harrison, Edward Robert 225, 391, 445, 657, 666, 691, 721, 1180, 1211, 1682, 1700  
Harrison, George R. 938  
Harrison, Harry 529  
Harrison, Jane 368, 1299  
Harrison, R. J. 905  
Harrison, Tinsley R. 1098  
Harrison, Will 607  
Harrow, Benjamin 134  
Hart, Charles William 309  
Hart, Joseph 76  
Harte, Francis Bret 148, 563  
Harth, Erich 721  
Hartley, David 20  
Hartley, H. Q. 1539  
Hartley, L. P. 1070  
Hartwell, Leland H. 987  
Harvey, William 24, 181, 255, 387, 630, 721, 987, 1030, 1299, 1371, 1707  
Harwit, Martin 358  
Haskins, C. P. 1399  
Hasselberg, K. B. 1126  
Hastings, C. S. 1588  
Hauffman, Paul 698, 827  
Hauge, Bernt K. 1221  
Hauge, Philip 1299  
Haught, James A. 1683  
Haughton, Samuel 1629  
Hauy, Abbé René Just 926  
Havel, Václav 1300  
Havemann, Joel 189  
Hawkes, Christopher 89  
Hawkes, Jacquetta 89  
Hawking, Stephen William 81, 179, 276, 298, 340, 404, 435, 450, 613, 640, 674, 686, 755, 885, 1070, 1211, 1300, 1407, 1468, 1485, 1492, 1605, 1629, 1668, 1672, 1683, 1700  
Hawkins, D. 1191  
Hawkins, Francis Bisset 1534  
Hawkins, Gerald S. 467, 1697  
Hawkins, Michael 1427, 1683  
Hawksworth, D. L. 1663  
Hawthorne, Nathaniel 388, 433, 629, 792, 1643  
Hay, John 639, 1643  
Hayes, Brian 657, 827, 876  
Hayflick, Leonard 1683  
Hayford, F. Leslie 1534  
Hayne, Paul H. 1643  
Haynes, Margaret 1683  
Hays, Carl V. 408, 1188, 1498  
Hayward, Jeremy 1300

- Hazlitt, William Carew 87, 544, 579, 987, 1098, 1300, 1454, 1559, 1638, 1668, 1728
- Heaney, Robert P. 182
- Hearn, Lafcadio 918, 926, 1509
- Heath-Brown, R. 1259
- Heath-Stubbs, John 1638
- Heaviside, Oliver 330, 623, 783, 827, 876, 885, 1605, 1654
- Heberden, William 1099
- Hediger, Heini 1736
- Hegel, Georg Wilhelm Friedrich 1509
- Heidegger, Martin 1126, 1582
- Heidel, W. A. 1300
- Heidmann, Jean 373
- Heilbronner, Robert 558
- Heiles, Carl 620
- Heim, F. 225
- Hein, Piet 1069
- Hein, Robert 1509, 1697
- Heine, Heinrich 987, 1509, 1643
- Heinlein, Robert A. 20, 55, 60, 70, 102, 147, 161, 272, 301, 342, 440, 503, 529, 575, 748, 796, 827, 953, 987, 1046, 1126, 1300, 1408, 1437, 1460, 1485, 1495, 1534, 1563, 1605, 1654, 1683
- Heise, David R. 204
- Heisenberg, Werner Karl 84, 134, 159, 196, 204, 278, 342, 395, 448, 495, 657, 741, 748, 765, 987, 1009, 1030, 1069, 1112, 1126, 1192, 1211, 1214, 1217, 1228, 1249, 1300, 1367, 1371, 1388, 1429, 1466, 1476, 1479, 1621, 1622, 1664, 1668, 1726
- Heiss, E. D. 1577
- Heitler, W. 1605
- Heizer, Robert F. 93
- Hele-Shaw, H. S. 721
- Heller, Joseph 12, 368, 827, 1192
- Heller, Walter 148
- Hellerstein, Herman 630
- Hellman, C. Doris 266, 666
- Hellmund, R. E. 425
- Helmuth, William Tod 25, 154, 1073, 1168, 1559, 1561
- Helvetius, Claude Adrien 217
- Hemans, Felicia D. 289, 1159, 1643
- Hemingway, Ernest 50, 757
- Hempel, Carl G. 827
- Henderson, Archibald 1684
- Henderson, John R. 657
- Henderson, Lawrence 272, 1042, 1301
- Hendrick, Ellwood 708
- Henkel, R. E. 1522
- Henle, Jacob 640
- Henle, James M. 1017
- Henley, William Ernest 987
- Hennig, W. 1571
- Henry, John 555
- Henry, Joseph 358, 1301
- Henry, Patrick 558
- Henry, William 737, 906
- Henslow, John Stevens 186
- Heppenheimer, T. A. 1485, 1510
- Heraclitus 987, 1553, 1629, 1671
- Herbart, Johann Friedrich 674, 827
- Herbert, Frank 383, 721
- Herbert, George 110, 234, 414, 1567, 1577, 1643
- Herbert, Nick 885, 1180, 1573
- Herbert, Sir Alan 1716
- Herford, Oliver 42, 467
- Hering, Constantine 1046
- Hermes, Hans 828
- Hermite, Charles 601
- Herodotus 217, 601
- Herold, Don 545, 641
- Herophilus 629, 897, 1099
- Herrick, Robert 311, 613, 708, 924, 1139, 1510, 1585
- Herschel, Friedrich Wilhelm 316, 634, 674, 988, 1007, 1141, 1156, 1510, 1588
- Herschel, Sir John Frederick William 22, 121, 266, 313, 488, 555, 585, 693, 721, 748, 755, 765, 796, 829, 918, 922, 987, 1030, 1081, 1165, 1192, 1256, 1301, 1408, 1510, 1605, 1654, 1725
- Hersh, Reuben 817, 873, 1169, 1201, 1600, 1627
- Hershko, Avram 368
- Hersh Reuben 829
- Herskovits, Melville Jean 83
- Herstein, I. N. 829, 1192
- Hertz, Heinrich 435, 488, 693, 829, 889, 893, 913, 1301, 1410
- Hertz, Rabbi Richard 1388
- Herwitz, Daniel 1408
- Herzen, Aleksandr 1062, 1301
- Heschel, Abraham J. 182, 898, 1073, 1099, 1250
- Hesiod 196, 212
- Hess, Elmer 448, 898
- Hess, Harry 1043
- Hess, Walter 1053
- Hesse, Hermann 829
- Hesse, Mary B. 20, 741
- Hester, Thomas R. 93
- Heurnius 1092
- Hewish, Antony 796
- Hewitt, Barnard 898
- Hewitt, Philip C. 585
- Hey, Nigel S. 511, 922, 1057, 1141, 1262, 1474, 1479, 1486
- Heyerdahl, Thor 1043
- Heyl, Paul R. 623, 765, 1127
- Heyward, DuBose 217
- Heywood, V. H. 1574
- Heyworth, Sir Geoffrey 529



- Hicks, Beatrice Alice 425  
Higgins, Bryan 135  
Highet, Gilbert 1437  
High school chemistry student 199  
Hilbert, David 159, 485, 569, 601, 666, 686, 789, 803,  
829, 913, 1021, 1064, 1127, 1192, 1201, 1228,  
1239, 1565  
Hildebrand, Wolfgang 266  
Hilger, Adam 737  
Hill, Archibald V. 358, 448, 721  
Hill, Thomas 613, 830  
Hillaby, John 585  
Hillel, Daniel 1147  
Hillery, Herbert 1061  
Hillis, W. Daniel 1388  
Hilton, James 1605  
Hilton, John 1059  
Hilts, Philip 1302  
Hinds, Norman E. A. 796  
Hine, Reginald Leslie 488  
Hinkley, D. V. 1530  
Hinschelwood, Sir Cyril 228, 242, 741, 1031, 1302,  
1684, 1702  
Hippocrates 1, 187, 200, 253, 331, 434, 440, 567, 898,  
1099, 1302, 1561  
Hirsch, Nathaniel David 606  
Hitchcock, Alfred 311  
Hitchcock, Edward 554, 563  
Hitching, Francis 358, 564  
Hitler, Adolf 1302  
Hoagland, Hudson 567, 1302, 1427  
Hoagland, Mahlon 1466  
Hoban, Russell 264  
Hobbes, Thomas 330, 440, 529, 601, 613, 686, 1623  
Hobson, E. W. 830  
Hocking, R. 1302  
Hocking, W. E. 1425  
Hodge, Paul W. 506  
Hodges, Wilfrid 830  
Hodgkin, Alan L. 1007  
Hodgson, Leonard 1302  
Hodgson, Ralph 110, 1510  
Hodnett, Edward 20, 81, 320, 529, 560, 1192  
Hoefler, Don C. 657  
Høeg, Peter 1629  
Hoel, P. G. 1534  
Hoffer, Eric 212, 242, 530, 946, 1217, 1466, 1582  
Hoffman, Jeffrey 909  
Hoffman, Paul 830, 1414  
Hoffman, Roald 1668  
Hoffmann, Banesh 391, 446, 485, 757, 1112, 1492  
Hoffmann, Friedrich 339, 488, 898, 1099  
Hoffmann, Hans 1466  
Hoffmann, Roald 228, 234, 242, 938, 1225, 1400, 1618  
Hofmann, A. W. 242, 560  
Hofstadter, Douglas 225, 272, 1017, 1075  
Hofstadter, Douglas R. 1593  
Hogan, Graig J. 1619  
Hogan, James P. 1437  
Hogan, John 1684  
Hogben, Lancelot 414, 830, 1534  
Holgate, Thomas F. 831  
Holland, John 402, 1012  
Holland, W. J. 193, 1011  
Hölldobler, Bert 57, 954  
Holloman, J. Herbert 425  
Holmes, Arthur 10  
Holmes, Bob 765  
Holmes, Charles N. 909  
Holmes, Harry N. 234, 242  
Holmes, John Haynes 1684  
Holmes, Jr., Oliver Wendell 212, 467, 831, 1534  
Holmes, Oliver Wendell 12, 24, 25, 52, 63, 101, 102,  
148, 189, 204, 267, 272, 276, 292, 324, 339, 430,  
484, 485, 530, 568, 629, 638, 666, 668, 722, 757,  
765, 783, 831, 899, 916, 922, 960, 1017, 1052,  
1073, 1092, 1099, 1168, 1180, 1302, 1400, 1464,  
1510, 1588, 1623, 1655, 1668  
Holt, Michael 1605  
Holton, Gerald 358, 435, 722, 748, 988, 1031, 1242,  
1303, 1357, 1380, 1400  
Holz, Daniel E. 298  
Homer (Smyrns of Chios) 286, 944, 1141  
Honsberger, Ross 831  
Hood, Thomas 332, 340, 414, 544, 550, 944, 1059,  
1206, 1463, 1585, 1638  
Hooke, Robert 47, 149, 320, 495, 801, 916, 988, 1031,  
1461, 1477, 1524, 1535  
Hooker, Richard 1180  
Hooker, Worthington 530  
Hooper, Judith 64, 190, 467  
Hoover, Herbert 414, 425, 1498  
Hoover, T. J. 425  
Hooykaas, Reijer 1388  
Hopfield, John 1718  
Hopkins, Frederick Gowland 166, 286, 1052, 1721  
Hopkins, Gerard Manley 267, 302, 1510  
Hopkins, Harry 547, 1524, 1535  
Hopkinson, John 722, 831  
Hopper, Grace Murray 748  
Hopwood, Arthur Tindell 258  
Horace (Quintus Horatius Flaccus) 149, 988, 1510,  
1535, 1726  
Horgan, J. 1303  
Horn, Alfred Aloysius 1070  
Hornaday, William Temple 28, 508, 1722  
Horne, R. A. 243  
Horowitz, Norman H. 512, 1475

- Horrobin, David F. 1217  
 Horsfield, Brenda 1043  
 Horton, F. 400  
 Horton, Robin 1605  
 Hosmer, William 1039  
 Hospers, John 748  
 Hotelling, Harold 1535  
 Houot, Georges 1454  
 Housman, A. E. (Alfred Edward) 7, 1629  
 Housman, Alfred Edward 988  
 Hovey, Richard 1510  
 Howard, Leland O. 430  
 Howard, Neale E. 110  
 Howard, Robert West 1062  
 Howe, E. W. 272, 1164, 1181  
 Howe, Roger 1593  
 Howell, G. K. 1648  
 Howell, Scott 1648  
 Howells, William Dean 1100  
 Howison, G. H. 831  
 Howland, W. E. 415  
 Hoyle, Geoffrey 631, 1127, 1303, 1606  
 Hoyle, Sir Fred 88, 110, 116, 121, 163, 174, 263, 306, 320, 358, 387, 467, 488, 512, 572, 631, 635, 658, 722, 748, 776, 796, 885, 890, 1031, 1058, 1083, 1112, 1127, 1147, 1192, 1201, 1217, 1303, 1486, 1510, 1582, 1605, 1606, 1629, 1664, 1668, 1684, 1697  
 Hoyt, William Graves 376  
 Hsi, Chu (Zhu Xi) 1461  
 Hsu, Francis L. K. 789  
 Hubbard, Elbert 149, 154, 705, 783, 1233, 1303, 1438, 1561  
 Hubbard, Gardiner G. 1303  
 Hubbard, John 831  
 Hubbard, Kin 576, 1074  
 Hubbard, Ruth 958, 1303  
 Hubble, Edwin Powell 121, 722, 913, 1007, 1031, 1228, 1250, 1303, 1438, 1479, 1486, 1589, 1606, 1684  
 Hudson, Hilda Phoebe 831  
 Hudson, Jeffrey 1423  
 Hudson, Robert P. 369  
 Hudson, William Henry 283, 988  
 Huebner, Jay S. 1127  
 Hufeland, Christoph Wilhelm 1100  
 Huff, Darrell 330, 342, 1535  
 Huggins, Charles 1438  
 Huggins, Sir William 358, 674, 988, 1007, 1499, 1520, 1606  
 Hughes, Richard 876  
 Hugo, Victor 28, 77, 102, 194, 197, 217, 225, 302, 530, 564, 601, 658, 682, 696, 701, 776, 791, 876, 916, 922, 988, 1007, 1079, 1080, 1303, 1454, 1511, 1668, 1716, 1735, 1737  
 Huheey, James E. 6  
 Huizinga, Johan 1303  
 Hull, David L. 170, 258, 1438  
 Hulme, Keri 899  
 Hume, David 5, 204, 217, 279, 495, 1017, 1181, 1304, 1707  
 Humphrey, Hubert H. 1147  
 Humphries, W. J. 1065  
 Hungerford, H. B. 61  
 Hunt, Leigh 50  
 Hunter, Evan 1181  
 Hunter, John 495  
 Hunter, Mark 505  
 Hunter, Robert 1157  
 Huntington, Edward V. 1049  
 Huntington, Ellsworth 1222  
 Huntley, Henry Edwards 159  
 Huntley, Henry Edwin 832  
 Hurdis, James 63  
 Hurley, Patrick M. 592, 1629  
 Hurston, Zora Neale 899, 1250  
 Husserl, Edmund 530, 1438  
 Hussey, Russell C. 223  
 Hutchison, Sir Robert Grieve 899, 1100, 1577, 1708  
 Huth, Edward Janavel 899, 1423  
 Hutton, James 223, 280, 326, 592, 1147, 1233, 1572, 1606, 1630, 1712  
 Hutton, W. 948, 988  
 Huxley, Aldous 3, 135, 149, 174, 197, 330, 467, 530, 547, 598, 601, 614, 681, 703, 722, 741, 832, 915, 1017, 1075, 1181, 1304, 1351, 1371, 1566, 1577, 1582, 1593, 1655, 1702  
 Huxley, Elspeth 1218  
 Huxley, Julian 33, 74, 78, 121, 170, 190, 341, 352, 405, 468, 530, 578, 674, 885, 944, 953, 1193, 1245, 1304, 1374, 1378, 1388, 1511  
 Huxley, Thomas Henry 5, 28, 83, 121, 161, 170, 174, 182, 183, 205, 243, 272, 282, 315, 327, 385, 395, 405, 415, 440, 469, 484, 495, 531, 542, 543, 560, 585, 646, 658, 666, 674, 686, 722, 738, 739, 749, 755, 758, 777, 780, 796, 832, 876, 885, 899, 922, 925, 931, 962, 988, 1007, 1031, 1049, 1054, 1062, 1093, 1127, 1137, 1181, 1225, 1305, 1351, 1352, 1357, 1362, 1389, 1406, 1410, 1414, 1425, 1429, 1577, 1606, 1630, 1655, 1702, 1707, 1716  
 Huygens, Christiaan 190, 267, 512, 601, 723, 948, 989, 1048, 1141, 1148, 1153, 1156, 1181, 1511, 1668, 1684, 1705  
 Hyerdahl, Thor 1157  
 Hynek, J. Allen 1673  
**I**  
 Ian 1438  
 Ibn Khaldun 601

- Ice-T 7  
 Icke, Vincent 1127  
 Ihde, Aaron J. 234  
 Imhof, Peter 1438  
 Indiana Jones 93  
 Infeld, Leopold 277, 403, 560, 614, 656, 672, 1191, 1227, 1290, 1366, 1532, 1602, 1667  
 Inge, William Ralph 1655  
 Inge, William Ralph 149, 254, 876, 1083, 1389, 1684  
 Ingelow, Jean 944, 1043, 1643  
 Ingemann, Bernhard S. 1643  
 Ingersoll, Robert G. 682, 1307  
 Ingle, Dwight J. 658, 723, 1193, 1423  
 Ingram, Jay 1438  
 Inose, Hiroshi 320  
 Inscription 350, 1071, 1427  
 Intergovernmental Panel on Climate Change (IPCC) 260  
 Ionesco, Eugene 691, 1684  
 Irving, Washington 1643  
 Irwin, James 1148  
 Irwin, Keith Gordon 990  
 Isaac, Gylan Llwylyn 93  
 Isaacs, Bernard 12  
 Isidorus 960  
 Israel, Werner 179  
 Issigonis, Sir Alec 832  
 Ivic, A. 1259
- J**  
 Jacks, L. P. 531, 1307  
 Jackson, Helen Hunt 1057  
 Jackson, Hughlings 205  
 Jackson, James 1100  
 Jacob, François 469, 958, 1053, 1307, 1420  
 Jacobi, Abraham 1228  
 Jacobi, Karl Gustav Jacob 614, 832, 1017, 1307  
 Jacobs, Joseph 149  
 Jacobson, Ethel 1511  
 Jacoby, Harold 111  
 Jaffe, Bernard 1250, 1577  
 Jahoda, Marie 1535  
 James, Henry 369, 531, 1638  
 James, P. D. 495, 1181  
 James, William 49, 68, 205, 258, 272, 320, 440, 488, 531, 585, 614, 646, 658, 666, 723, 749, 780, 990, 1031, 1167, 1224, 1307, 1606, 1685, 1700  
 Jamin, E. V. 893  
 Jammer, Max 1479  
 Janssen, Johannes 243  
 Jaspers, Karl 668  
 Jastrow, Joseph 1198, 1307, 1606  
 Jastrow, Robert 299, 469, 614, 944, 1389, 1685, 1700  
 Jauncey, G. E. M. 1732  
 Jeans, Sir James Hopwood 111, 116, 121, 135, 296, 302, 391, 397, 425, 431, 675, 723, 765, 796, 832, 933, 938, 940, 948, 1007, 1032, 1040, 1045, 1076, 1088, 1112, 1127, 1148, 1228, 1238, 1308, 1378, 1479, 1511, 1550, 1630, 1685, 1700  
 Jeffers, Robinson 8, 18, 111, 122, 135, 164, 373, 470, 572, 578, 833, 909, 1148, 1308, 1427, 1511, 1655, 1685, 1700, 1705  
 Jefferson, Thomas 187, 243, 441, 496, 629, 723, 909, 1181, 1308, 1376  
 Jefferys, William H. 160  
 Jeffrey, C. 1574  
 Jeffreys, Sir Harold 531, 778, 833, 1032, 1475, 1501  
 Jekyll, Joseph 1100  
 Jenkin, Fleeming 135  
 Jenkins, Edward B. 334  
 Jenner, Edward 1207  
 Jennings, Elizabeth 28  
 Jennings, Herbert Spencer 320, 765, 796, 1685  
 Jensen, Elwood V. 1438  
 Jerome, Fred 504  
 Jerome, Jerome K. 28, 369, 899, 1457  
 Jerrold, Douglas William 1139  
 Jespen, G. L. 1623  
 Jespersen, James 1091  
 Jesus Christ 1100  
 Jevons, William Stanley 5, 217, 260, 327, 441, 496, 646, 724, 749, 832, 922, 1018, 1080, 1250, 1308, 1466  
 Jewett, Frank B. 415  
 Jewett, Sarah Orne 1023  
 Jhabvala, Ruth Praver 369  
 Jinchu, Hu 73  
 Joad, Cyril Edwin Mitchinson 1088, 1308, 1686  
 Joffe, A. F. 1308  
 Johanson, Donald 796  
 John of Salisbury 217, 1100, 1233  
 John Shade 1492  
 Johnson, Athol A. W. 256  
 Johnson, Eric 415  
 Johnson, Ernest 1561  
 Johnson, George 315, 405, 749, 1069, 1112  
 Johnson, Harry G. 1250, 1381  
 Johnson, James Weldon 415  
 Johnson, Lyndon B. 1148, 1486, 1535  
 Johnson, Matthew 93  
 Johnson, Palmer O. 1535  
 Johnson, Philip 98, 470, 968  
 Johnson, Samuel 6, 16, 185, 197, 218, 311, 313, 694, 724, 741, 758, 833, 1018, 1059, 1100, 1233, 1308, 1463  
 Johnson, Severance 107  
 Johnson-Laird, P. N. 20  
 Johnston, Eric 348  
 Johnston, Francis E. 833

- Johnston, Helen 743  
 Johnston, James Finlay Weir 155  
 Joint Statement of Religious Leaders 1389  
 Joly, John 358, 405  
 Jones, Barry 1582  
 Jones, F. Wood 317  
 Jones, Franklin P. 1536  
 Jones, Frederick Wood 1380  
 Jones, J. S. 1053  
 Jones, Raymond F. 783, 1655  
 Jones, Richard G. 264  
 Jones, Rufus M. 1308  
 Jones, Sir Harold Spencer 111, 512  
 Jones, Steve 1032, 1308, 1378  
 Jones, Thomas P. 738  
 Jones, Thomas Rymer 156  
 Jones, William 653  
 Jones J. 1559, 1561  
 Jonsen, Albert 1100  
 Jonson, Ben 398, 635, 781, 944, 1032, 1463, 1655  
 Joos, Georg 1233, 1606  
 Jordan, David Starr 724, 1309  
 Joseph, George Gheverghese 17  
 Joseph, Lawrence E. 571  
 Joslin, Rebecca R. 382  
 Josselyn, John 1639  
 Joubert, Joseph 2, 85, 783, 1046, 1493  
 Joule, James Prescott 405  
 Jowett, Benjamin 784  
 Joyce, James 17, 267, 286, 579, 631, 918, 1048, 1113, 1211, 1215, 1511, 1568, 1701  
 Judson, Horace 174  
 Jukes, Thomas Hughes 376  
 Jung, Carl G. 7, 149, 212, 282, 306, 328, 451, 691, 695, 700, 710, 786, 1309, 1460, 1467, 1490, 1566  
 Jungck, J. R. 431  
 Juster, Norton 149, 254, 681, 960, 1018, 1239, 1669  
 Jutila, M. 1172  
 Juvenal (Decimus Junius Juvenal) 990
- K**
- Kac, Mark 833, 1138, 1181  
 Kaczynski, Theodore 1309  
 Kadane, Joseph 155  
 Kadanoff, Leo P. 749  
 Kaempffert, Waldemar 1389  
 Kafka, Franz 1309, 1559  
 Kahn, Fritz 1148  
 Kahn, S. J. 1536  
 Kaku, Michio 641, 1211, 1568, 1637, 1672, 1686  
 Kaminsky, Kenneth 165, 1018  
 Kanigel, Robert 264, 833  
 Kant, Immanuel 205, 243, 489, 496, 686, 833, 885, 990, 1233, 1404, 1479, 1630
- Kapitza, Pyetr Leonidovich 496, 569, 1309  
 Kaplan, Abraham 749, 834, 890, 933, 1166, 1193, 1536  
 Kaplan, Ellen 691  
 Kaplan, Robert 691  
 Karanikas, Alexander 1372  
 Karch, Carroll S. 641, 1458  
 Karlin, Samuel 933  
 Karpansky, L. 6  
 Karpinski, L. C. 834  
 Kasner, Edward 315, 560, 573, 686, 691, 834, 876, 1065, 1181, 1234  
 Kass-Simon, G. 1404  
 Katsaros, Kristina 320  
 Katscher, F. 1439  
 Kauffman, Stuart A. 17, 174, 766  
 Kaufmann, William J., III 1228, 1669  
 Kay, Marshall 627  
 Kaysen, Carl 1582  
 Keane, Bill Joseph 632  
 Keate, George 95  
 Keating, J. P. 1258  
 Keats, John 111, 181, 225, 288, 395, 550, 944, 1378, 1512  
 Keegan, John 149  
 Keel, William C. 572  
 Keeler, Charles 607  
 Keeney, Ralph 23  
 Kehoe, Alice Beck 93  
 Keill, John 122, 382, 614, 1156, 1512  
 Keillor, Garrison 614  
 Keith, Arthur 470  
 Kekulé, Friedrich August 136, 359, 658, 1052  
 Keller, Evelyn Fox 1309  
 Keller, Helen 601, 834, 1309  
 Kellogg, Vernon 170  
 Kellogg, Vernon L. 55, 1309  
 Kelly, J. L. 670  
 Kelvin, Lord William Thomson 87, 136, 159, 187, 682, 686, 701, 710, 738, 756, 766, 767, 776, 834, 876, 885, 891, 911, 933, 936, 956, 1018, 1063, 1066, 1148, 1218, 1309, 1553, 1606, 1619, 1624, 1669, 1708  
 Kemble, William H. 375  
 Kemeny, John 2  
 Kendall, Maurice G. 743, 1536  
 Kendall, May (Emma Goldworth) 49  
 Kendrew, John 1166  
 Kennedy, Donald 1423  
 Kennedy, Florynce 1  
 Kennedy, John F. 1043, 1310, 1486  
 Keosian, J. 243  
 Kepes, Gyorgy 1372  
 Kepler, Johannes 111, 122, 205, 359, 434, 601, 614, 627, 634, 658, 796, 835, 922, 990, 1048, 1153, 1486, 1490, 1589, 1656, 1686, 1730

- Kernan, F. C. 642  
 Kerr, Jean 639  
 Kerridge, D. F. 1524  
 Kerry, John 724  
 Kettering, Charles Franklin 225, 531, 658, 699, 705, 724, 1193, 1245, 1250, 1310  
 Kevan, D. Keith McE. 1575  
 Keynes, John Maynard 22, 273, 532, 658, 1182, 1623  
 Keyser, Cassius Jackson 415, 449, 567, 641, 705, 835, 876, 1203, 1225, 1240, 1310, 1607, 1617, 1686  
 Khayyam, Omar 16  
 Kiddle, Alfred W. 425  
 Kielan-Jaworowska, Zofia 1062  
 Kiepenheuer, Karl 1193  
 Killian, Jr., James R. 415, 1439  
 Kilmer, Joyce 918  
 King, Alexander 623  
 King, B. C. 1160  
 King, Ben 378, 471  
 King, Blake 307, 705  
 King, G. C. P. 1160  
 King, Jerry P. 9, 835, 877  
 King, Jr., Martin Luther 1310, 1389, 1400  
 King, Lester C. 293  
 King, W. J. 445  
 King, Willford 1536  
 King, William H. 1101  
 Kingdon, Clifford W. 666  
 Kingsley, Charles 98, 145, 288, 350, 415, 532, 585, 635, 749, 757, 990, 1310, 1418, 1439, 1724, 1731  
 Kington, Miles 185  
 Kipling, Lockwood 34  
 Kipling, Rudyard 70, 102, 254, 291, 311, 415, 425, 471, 532, 545, 561, 899, 1023, 1205, 1310, 1457, 1697  
 Kirby, William 430, 1310  
 Kirby, William F. 55, 60  
 Kircher, Athanasius 13  
 Kirchmayer, George Caspard 42  
 Kirchoff, Gustav Robert 893  
 Kirklin, John 1561  
 Kirkpatrick, Clifford 395, 1311  
 Kirkpatrick, Sidney D. 425  
 Kirkup, James 286  
 Kirshner, Robert P. 111, 316, 1686  
 Kistiakowsky, George B. 741  
 Kitaigorodski, Aleksandr Isaakovich 1607  
 Kitcher, Philip 318  
 Kitchiner, William 1589  
 Kitts, David B. 1062  
 Klaproth, Martin Heinrich 243, 401  
 Klarreich, E. 907, 1259  
 Klee, Paul 33, 703, 1372  
 Klein, Felix 199, 276, 315, 377, 602, 835  
 Klein, William 1018  
 Kleiner, Israel 1549  
 Kline, Morris 9, 602, 836, 877, 886, 1018, 1049, 1250, 1311, 1546  
 Kliuchevsky, V. O. 1311  
 Kluckhohn, Clyde 84, 496, 1166  
 Kneale, W. 374  
 Knickerbocker, William Skinkle 1357, 1418  
 Knight, David 243, 1311  
 Knight, Norman L. 1454  
 Knopf, Alfred A. 585, 592  
 Knopoff, L. 586  
 Knuth, Donald E. 658, 825, 1311, 1372  
 Koch, Howard 18  
 Koerner, Jon 682  
 Koestler, Arthur 179, 307, 320, 471, 532, 578, 693, 797, 941, 946, 1071, 1372, 1381, 1439, 1607, 1686  
 Kofahl, R. E. 1311  
 Kohl, Philip L. 1071  
 Köhler, Wolfgang 1311  
 Kolb, Edward W. (Rocky) 104, 112, 159, 572, 675, 933, 990, 1032, 1311, 1439, 1686  
 Kolmogorov, Andrei N. 1182  
 Kolthoff, I. M. 6  
 Kornberg, Arthur 229, 244, 936, 1439  
 Körner, T. W. 359  
 Koshland, Jr., Daniel E. 1312, 1536  
 Kosko, Bart 1182, 1476  
 Kough, A. 532  
 Kovalevskii, V. O. 1738  
 Kowal, Charles T. 106  
 Koyré, Alexandre 441, 837, 1128  
 Krafft, Katia 1712  
 Kragh, Helge 159  
 Kramers, Hendrick Anthony 1211  
 Krantz, David L. 659  
 Krantz, Steven 566, 877  
 Krass, F. 749  
 Kratovil, Robert 532  
 Kraus, Arthur Lawrence 136  
 Kraus, Jack 52, 389, 639  
 Kraus, John 1223  
 Kraus, Karl 25, 267, 339, 899, 1372  
 Krauss, Lawrence M. 136, 797, 1113, 1211, 1242, 1257, 1312, 1630, 1637, 1686, 1725  
 Krebs, Hans Adolf 766  
 Kreutzberg, E. C. 1266  
 Kreymborg, Alfred 1471  
 Krieger, A. 1663  
 Kroeber, Alfred Louis 84, 1312  
 Kronecker, Leopold 1018  
 Kronenberger, Louis 1350  
 Kropotkin, Peter Alekseyevich 724, 938, 1251, 1414

- Kruger, Otto 1418  
 Krumbein, W. C. 321  
 Kruskal, William 1525, 1536  
 Krutch, Joseph Wood 28, 56, 61, 68, 83, 149, 766, 990,  
 1113, 1414, 1512, 1582, 1721  
 Kruyt, Hugo Rudolph 1376  
 Kubie, L. S. 1312  
 Kubler, George 1071  
 Kubler-Ross, Elisabeth 899  
 Kuhn, Thomas S. 9, 307, 359, 532, 698, 1032, 1064,  
 1113, 1312, 1357, 1367, 1439, 1607  
 Kühnert, Franz 112, 384  
 Kuiper, Gerard P. 1154  
 Kunckel, Johann 244  
 Kundera, Milan 1218  
 Kunin, Robert 708  
 Kunitz, Stanley 1687  
 Kunz, F. L. 1687  
 Kurten, Bjorn 348  
 Kusch, Polykarp 724, 1113, 1312  
 Kyburg, Jr., H. E. 1182  
 Kyte, Frank 348
- L**
- L. L. Cool J. 1242  
 L'Amour, Louis 336  
 La Bruyère, Jean 1101  
 Ladenburg, Rudolf 1113  
 Laennec, René-Théophile-Hyacinthe 1547  
 Lagen, Doug 738  
 LaGuardia, Fiorello 1536  
 Laitinen, H. A. 234  
 Lakatos, Imre 837, 877, 1357, 1607  
 Lake, Philip 293  
 Lalande, Jérôme 614  
 Lamarck, Jean-Baptiste Pierre Antoine 10, 136, 174,  
 258, 359, 441, 508, 614, 675, 724, 990, 1234,  
 1497, 1630, 1656, 1709  
 Lamb, Charles 254, 294, 1313, 1463, 1493, 1585  
 Lamb, J. C. 738  
 Lamb, Sir Horace 553, 837, 1662  
 Lamb, William 1101  
 Lambert, Johann Heinrich 572, 593, 615, 646, 797,  
 916, 919, 1234, 1475, 1512, 1687  
 Lamy, Étienne 1404  
 Land, Edwin 922  
 Landau, Edmund 757  
 Landau, Lev 797, 1218  
 Landauer, Rolf 1640  
 Landé, Alfred 351  
 Landes, K. K. 929  
 Landor, Walter Savage 1043  
 Landsberg, Peter Theodore 1313  
 Lang, Andrew 340, 1313, 1536  
 Langer, R. E. 837  
 Langer, Susanne Knauth 16, 532, 659, 877, 1032  
 Langley, John Newport 146, 780  
 Langley, Samuel Pierpoint 595, 1553, 1709  
 Lanier, Sidney 1719  
 Lao Tzu 150, 1687  
 Lapin, Lawrence 1537  
 Laplace, Pierre Simon 22, 122, 180, 205, 218, 273,  
 359, 387, 532, 623, 675, 683, 724, 750, 837, 991,  
 1080, 1182, 1362, 1556, 1656  
 Lapp, Ralph E. 1313  
 Lappe, Marc 431  
 Lapworth, Charles 174, 586, 1630, 1672  
 Larcom, Lucy 1043, 1719  
 Large, E. C. 766, 1352, 1418  
 Larrabee, Eric 123, 1128, 1313, 1439  
 Larrabee, Harold A. 724  
 Lasker, Albert D. 1251  
 Lasota, Jean-Pierre 180  
 Lasserre, Francois 838  
 Laszlo, E. 1607  
 Latham, Peter Mere 20, 244, 273, 311, 339, 369, 489,  
 496, 532, 724, 938, 1059, 1101, 1168, 1569  
 La Touche, Mrs. 102  
 Latour, Bruno 532, 1407  
 Laudan, Larry 304, 708, 1313  
 Lauden, Larry 313, 1607  
 Laurence, William Leonard 143  
 Laut, Agnes C. 533  
 Lavoisier, Antoine Laurent 229, 234, 244, 395, 441,  
 496, 533, 659, 675, 698, 741, 776, 877, 906, 960,  
 1256, 1313, 1357, 1467, 1571  
 Lavrov, Pyotr 1198  
 Lawrence, D. H. (David Herbert) 33, 50, 75, 79, 192,  
 299, 489, 615, 797, 1211, 1716  
 Lawrence, Ernest 1199  
 Lawrence, Jerome 40  
 Lawrence, Louise de Kiriline 991  
 Lawrence Ernest O. 569  
 Lawson, Alfred William 1656  
 Lawson, Andrew C. 436, 595  
 Layton, Jr., Edwin T. 336, 416  
 Leach, Edmund Ronald 84  
 Leacock, Stephen 102, 123, 136, 150, 432, 948, 1537  
 Leakey, Mary 93, 344, 702, 797, 1071  
 Leakey, Richard Erskine 564, 802, 1167, 1497  
 Lear, Edward 67, 944  
 Leary, Timothy 1314  
 Lebesgue, Henri 877, 878  
 Le Bon, Gustave 1656  
 Lebowitz, Fran 16, 512, 1314, 1440  
 Lec, Stanislaw 838, 1669, 1728  
 LeCam, Lucien 838  
 Leclerc, George-Louis, Comte de Buffon 87

- Leclerc, Georges-Louis, Comte de Buffon 627, 991, 1079, 1314  
 LeConte, John 725, 1263  
 Le Conte, Joseph 797  
 Le Corbusier (Charles-Edouard Jeanneret) 95, 98, 416  
 Ledbetter, B. G. 1454  
 Lederer, Charles 1080  
 Lederman, Leon 4, 136, 245, 391, 497, 659, 914, 991, 1113, 1400, 1440, 1595, 1608, 1687  
 Lee, Gerald Stanley 787  
 Lee, Hannah Farnham 206  
 Lee, Nathaniel 1512  
 Lee, Oliver Justin 267, 1032, 1428  
 Lee, Robert Edwin 40  
 Lee, Stan 693  
 Lee, Tsung Dao 1367  
 Lee-Hamilton, Eugene J. 1043  
 Le Févre, Nicaise 547  
 Le Févre, Nicholas 244, 960, 1716  
 Leggett, A. J. 1218  
 Legrain, G. 631  
 Le Guin, Ursula K. 436, 1263, 1313, 1669  
 Lehman, Robert C. 623  
 Lehmer, Derrick Henry 878  
 Lehn, Jean-Marie 229, 235, 245  
 Lehrer, Keith 273  
 Lehrer, Tom 334  
 Leiber, Jr., Fritz 1703  
 Leibniz, Gottfried Wilhelm 102, 136, 159, 212, 359, 497, 602, 615, 683, 759, 838, 1018, 1182, 1707  
 Leidy, Joseph 508  
 Leighton, Robert B. 88, 134, 372, 390, 404, 435, 555, 612, 673, 683, 719, 746, 775, 823, 1069, 1124, 1210, 1413, 1618, 1662, 1680  
 Leland, Charles G. 34, 41, 551  
 Lemaire, Eugene 245  
 Lemaître, Abbé Georges 136, 296, 405, 1687  
 Lemelson, Jerome 705  
 Lemery, Nicolas 183, 245  
 Lemke, J. 1352  
 Lemoine, Emile 838  
 Lemon, Harvey Brace 700, 725, 838  
 Le Noble, William J. 244  
 Lenstra, Jr., H. W. 1202  
 Leon, Mark 1440  
 Leonard, Jonathan Norton 235, 512, 1440  
 Leonov, Aleksei 1480  
 Leopold, Aldo 283, 284, 471, 1647  
 Leovy, Conway B. 1154  
 Lerner, Max 1314, 1376, 1582  
 Le Sage, Alan Rene 532  
 LeShan, Lawrence 1406  
 Leslie, John 838  
 Leslie, Sir John 675  
 Lessing, Gotthold Ephraim 4  
 Lester, B. L. 348  
 Lettsom, J. C. 1092  
 Leucippus 1224  
 Levenson, Thomas 1263  
 Levi, Primo 59, 60, 164, 180, 235, 245, 373, 401, 647, 725, 1440, 1470, 1550  
 Levi-Setti, Riccardo 1648  
 Lévi-Strauss, Claude 512, 1357, 1418  
 Levine, George 780  
 Levins, Richard 206  
 Levinson, Leonard Louis 607  
 Levinson-Lessing, F. Y. 1440  
 Levitt, Norman 838  
 Levy, David H. 267, 1512  
 Levy, Hyman 1656  
 Levy, Matthys 275  
 Lewes, G. H. 246  
 Lewin, Roger Amos 105, 471, 564, 802, 1053, 1222  
 Lewis, C. S. (Clive Staples) 324, 472, 683, 933, 991, 1049, 1128, 1183, 1380, 1389, 1566  
 Lewis, Clarence Irving 489, 725, 1183, 1537  
 Lewis, Denslow 900  
 Lewis, Don 374  
 Lewis, Edwin Herbert 137, 391, 395, 398, 399, 1128, 1624, 1732  
 Lewis, Gilbert Newton 246, 391, 891, 934, 1033, 1083, 1193, 1314, 1389, 1440, 1480, 1619, 1656, 1726  
 Lewis, John S. 766, 1486  
 Lewis, Lucille 1023  
 Lewis, Sinclair 246, 308, 878, 1441  
 Lewis, Wyndham 767, 1314  
 Lewontin, Richard C. 206, 472, 1608  
 Ley, Willy 659  
 Leyden, John 1643  
 Libby, Walter 1357  
 Libby, Willard F. 246  
 Libchaber, Albert 838  
 Libes, Antoine 1608  
 Lichtenberg, Georg Christoph 20, 123, 206, 246, 725, 839, 891, 917, 1018, 1113, 1314, 1608  
 Lieber, Lillian R. 102, 150, 839  
 Liebling, A. J. 693  
 Liebson, Morris 1128  
 Lightman, Alan 956, 1441, 1630  
 Lightner, Alice 944  
 Lilienthal, David E. 405, 1583  
 Lillich, Robert 375  
 Lilly, John 701  
 Lincoln, Abraham 324, 1183  
 Lindbergh, Anne Marrow 1454  
 Lindbergh, Anne Morrow 508, 956  
 Lindbergh, Charles A. 1721

- Lindbergh, Charles H. 1703  
 Lindley, David 391, 839, 934, 1081, 1113, 1128, 1212,  
 1242, 1314, 1367, 1608  
 Lindley, Dennis V. 1183, 1467  
 Lindon, J. A. 1021, 1242  
 Lindsay, R. Bruce 405, 839  
 Lindsay, S. E. 426  
 Lindsay, Vachel 63, 449  
 Linnaeus, Carl (von Linné) 185, 187, 497, 576, 960,  
 969, 991, 1159, 1169, 1263, 1460, 1547  
 Lipe, William D. 1071  
 Lipmann, Fritz 505  
 Lippmann, Walter 787, 1046, 1225, 1537, 1547  
 Lipps, Jere 916  
 Lipscombe, William N. 307  
 Litin, Edward M. 1097  
 Little, Arthur D. 246, 426  
 Little, T. M. 1218  
 Littlewood, John E. 1727  
 Lloyd, C. G. 961  
 Lloyd, David 934  
 Lloyd, Seth 137, 1687  
 Lloyd George, David, 1st Earl of Dwfors 1537  
 Lobachevskii, Nikolai Ivanovich 839  
 Locke, John 16, 137, 212, 632, 659, 691, 839, 948,  
 1019, 1046, 1183, 1267, 1314, 1497, 1703, 1730  
 Locke, William John 878  
 Lockyer, Joseph Norman 623, 1141, 1500  
 Lodge, Sir Oliver 137, 391, 445, 446, 666, 878, 1113,  
 1129, 1199, 1608, 1656, 1672  
 Loeb, Jacques 170, 767  
 Loehle, Craig 568, 725  
 Loewy, A. G. 168  
 Loftus, Elizabeth 497  
 Lomonosov, Mikhail 497  
 London, Jack 435, 767, 910  
 Lonergan, Bernard J. F. 359, 913  
 Long, Roger 123  
 Longacre, William A. 1537  
 Longair, Malcolm 180, 1033, 1589  
 Longfellow, Henry Wadsworth 33, 35, 36, 40, 42, 43,  
 53, 95, 98, 193, 218, 286, 288, 289, 290, 311,  
 551, 625, 919, 944, 991, 1019, 1043, 1071, 1101,  
 1154, 1455, 1473, 1512, 1553, 1644, 1687, 1722  
 Lonsdale, Dame Kathleen 309, 1033  
 Loomis, Elisha S. 686  
 Loomis, Frederic Brewster 1352  
 Loos, Anita 246  
 Lorand, Arnold 1429  
 Lorentz, Hendrik Antoon 922  
 Lorenz, Konrad 174, 647, 767, 992, 1315  
 Lote, Christopher J. 575  
 Louderback, G. D. 586  
 Louis, Pierre-Charles-Alexandre 1033, 1537  
 Lovecraft, H. P. (Howard Phillips) 923, 1403, 1461  
 Lovejoy, Thomas E. 284, 416  
 Lovelace, Richard 63  
 Lovell, James A. 945  
 Lovell, Sir Alfred Charles Bernard 1375, 1589  
 Lovelock, James Ephraim 174, 324, 548, 571, 767,  
 1162  
 Lovins, Amory B. 1583  
 Lowell, Amy 1471  
 Lowell, James Russell 37, 190, 307, 1455, 1644  
 Lowell, Percival 321, 360, 513, 659, 675, 757, 797,  
 803, 840, 956, 1038, 1154, 1202, 1315, 1475,  
 1487, 1512, 1727, 1730  
 Lower, Lennie 332, 426  
 Lowie, Robert H. 1367  
 Lowry, Malcolm 1712  
 Lubbock, Sir John 57, 267, 992, 1033, 1261, 1315, 1455  
 Lubchenco, Harold A. 1152  
 Lucas, William F. 840  
 Luciano, Giano 13, 489  
 Lucretius 144, 209, 326, 687, 791, 923, 948, 992, 1050,  
 1487, 1687, 1701  
 Ludlum, Robert 1183, 1537  
 Ludmerer, Kenneth M. 1101, 1623  
 Ludwig, Carl Friedrich Wilhelm 936  
 Lugosi, Bela 76  
 Lukasiewicz, J. 533  
 Lull, Richard Swann 473  
 Luminet, Jean-Pierre 127  
 Lundberg, G. A. 1315  
 Lunn, Arnold 473  
 Luria, Salvador Edward 273, 936  
 Luther, Martin 1101  
 Luther Standing Bear 992  
 Luttrell, Henry 1463  
 Lydston, George Frank 1023, 1207  
 Lyell, Sir Charles 206, 304, 379, 473, 509, 564, 586,  
 992, 1497, 1630  
 Lyly, John 900  
 Lynch, Gary 1315, 1390  
 Lynch, John Joseph 379, 755  
 Lynd, Robert 33  
 Lynd, Robert Wilson 448  
 Lysaght, Sidney R. 1315, 1380  
 Lyttleton, R. A. 660, 1315
- M**  
 MacArthur, Robert H. 1075, 1315  
 Macartney, Frederick T. 473  
 Macaulay, Robert B. 568  
 Macaulay, Rose 1265  
 Macaulay, Thomas Babington 71, 595, 725  
 MacCready, Paul 1476  
 MacDonald, George 551



- Macdonald, Sharon 1352  
 MacFadden, Bernard 545  
 Macfie, Ronald Campbell 137, 142, 615, 886, 938, 992, 1316, 1512  
 Mach, Ernst 16, 137, 206, 281, 352, 441, 489, 497, 533, 637, 647, 660, 676, 725, 840, 893, 923, 992, 1033, 1083, 1093, 1129, 1161, 1193, 1242, 1251, 1316, 1353, 1358, 1656, 1687, 1728  
 Mach, Ernst 1609  
 Machen, Arthur 1403  
 Machover, Maurice 647  
 Mackay, Charles 112, 416, 1568  
 Mackenzie, Colin 247  
 Mackin, J. Hoover 451  
 MacLane, Saunders 810, 840  
 Maclaurin, Colin 726, 993, 1083  
 Maclaurin, W. R. 705  
 MacLeish, Archibald 50, 1149, 1493, 1701  
 MacLennan, Hugh 1475  
 MacLeod, G. Preston 553  
 MacLeod, Ken 1058  
 MacPhail, Sir Andrew 1102  
 Macpherson, James 1553  
 Macquer, Pierre Joseph 230, 1358  
 MacRobert, Alan 164, 1218  
 Macvey, John W. 1480  
 Macy, Arthur 1033  
 Maddox, John Royden 164, 360, 387, 936, 1194  
 Maeterlinck, Maurice 473, 687, 1493  
 Maffei, Paolo 1317  
 Magendie, Francois 1317  
 Magna Carta 191  
 Magnus, Albertus 1057  
 Magueijo, Joao 1239  
 Mahadeva, M. 958  
 Maier, N. R. F. 533  
 Mailer, Norman 336, 426, 693  
 Maimonides, Moses 441, 1129, 1609  
 Maine, Sir Henry 647  
 Maisey, John 50, 710  
 Majone, G. 1383  
 Makarov, Oleg 1487  
 Malcolm, Andrew H. 620  
 Malin, David 112  
 Malin, Michael 1154  
 Mallarme, Stephane 341  
 Mallove, Eugene F. 798, 1251, 1491  
 Malmer, Mats P. 1663  
 Malthus, Thomas Robert 1163, 1609  
 Mamet, David 503  
 Mandela, Nelson 1222  
 Mandelbrot, Benoit 1317  
 Mandino, Og 1513  
 Manfreda, Margurite Lucy 1023  
 Mangan, James Clarence 95  
 Manilius, Marcus 286, 1471  
 Manin, Yu I. 1202  
 Mann, Charles C. 1120, 1598  
 Mann, Thomas 138, 247, 324, 369, 767, 840, 926, 938, 1050, 1071, 1553, 1631  
 Mannheim, Karl 708  
 Manning, Henry Parker 602  
 Manning, P. E. 900  
 Manning, Richard 993  
 Mansfield, Katherine 33  
 Mansfield, Lord, William Murray 212  
 Mao Zedong 1568  
 Mara Corday 1317  
 Marcellus 705  
 Marcet, Jane Haldimand 1405  
 Marcet, Mrs. Jane Haldimand 296  
 March, Robert H. 1317  
 Marconi, Guglielmo 705  
 Marcus, Adrienne 1114  
 Marcy, Geoffrey 1141  
 Margalef, Ramón 385  
 Margenau, Henry 321, 956, 1317, 1406  
 Marguerite of Valois 1390  
 Margulis, Lynn 28, 474, 638, 767, 1006, 1317  
 Marinatos, Spyridon 485  
 Maritain, Jacques 1129, 1317  
 Mark, Herman F. 1223  
 Mark O'Brian 1445  
 Marlowe, Christopher 22, 726, 1142  
 Marquesas Islanders 1697  
 Marquis, Don 56, 61, 62, 64, 474, 798, 1687, 1705  
 Marschall, Laurence A. 112, 1033  
 Marsh, George Perkins 993, 1464  
 Marsh, O. C. 564  
 Marshall, Alfred 385, 533, 705, 1317, 1538, 1595  
 Marshall, T. H. 448  
 Marsland, Douglas 1033  
 Martel, Yann 1441  
 Marten, Michael 977  
 Martial (Marcus Valerius Martialis) 1585  
 Martin, Calvin Luther 742  
 Martin, Charles-Noël 47, 170, 1487, 1623  
 Martin, Florence Holcomb 910  
 Martin, Jr., Thomas L. 778  
 Martin, M. 130  
 Martin, Thomas Commerford 704  
 Martin, Walter 900  
 Martinson, Harry Edmund 31  
 Marton, Ladislaus 1048  
 Marvell, Andrew 602  
 Marvin, Ursula 1149  
 Marx, Carl M. 926  
 Masefield, John 767

- Masini, Count Vincenzo 400  
 Maslow, A. H. 1423  
 Mason, Frances 993, 1647  
 Mason, James 1317  
 Mason, Rick 1631  
 Mason, William 417  
 Massey, Raymond 282  
 Massey, William A. 211  
 Massinger, Philip 25, 1102, 1207, 1237, 1560  
 Masson, David 1149, 1688  
 Masters, Dexter 218, 1183  
 Masters, William H. 1376  
 Mathematical Sciences Education Board 199, 276  
 Mather, Cotton 291, 369, 900, 1059, 1102, 1639  
 Mather, Increase 18  
 Mather, John C. 164  
 Mather, Kirtley F. 726, 755, 768, 1362, 1390, 1420  
 Mathews, Albert P. 768  
 Mathews, G. B. 691  
 Matsen, F. Albert 1318  
 Matthew, William Diller 1060, 1609  
 Matthews, Albert 8  
 Matthews, J. A. 1499  
 Matthews, L. 635  
 Matthews, Marian 1023  
 Mattingly, P. F. 430  
 Maturin, Charles R. 792  
 Maugham, W. Somerset 24, 900  
 Mauldin, Bill (William) Henry 750  
 Maunder, Edward Walter 267, 1471, 1589  
 Maury, Matthew Fontaine 533, 1261, 1455, 1456, 1717, 1722  
 Maxim, Hiram S. 225  
 Maxwell, Gavin 543  
 Maxwell, James Clerk 138, 192, 346, 446, 497, 555, 574, 632, 750, 776, 840, 934, 938, 948, 1019, 1218, 1257, 1318, 1414, 1418, 1428, 1441, 1480, 1493, 1499, 1538, 1619, 1726  
 May, Donald C. 489  
 May, Robert M. 374  
 May, Rollo 696  
 Mayer, Joseph 1441  
 Mayer, Julius Robert von Joseph 632  
 Mayer, Robert 1553  
 Mayes, Jr., Harlan 1609  
 Maynard Smith, John 474  
 Mayo, Charles Horace 200, 484, 900, 1023, 1102, 1137, 1441, 1638  
 Mayo, John 1609  
 Mayo, William J. 247, 360, 484, 533, 639, 676, 900, 917, 1074, 1423, 1561  
 Mayow, John 786  
 Mayr, Ernst 175, 441, 474, 576, 711, 737, 931, 1067, 1251, 1367, 1497, 1569, 1572  
 Mazlish, Bruce 787  
 Mazur, Barry 840, 1019, 1022  
 McAleer, Neil 1688  
 McArthur, Peter 30, 34, 533, 705  
 McBirney, Alexander R. 1712  
 McCabe, Joseph 372, 768, 1390  
 McCarthy, Mary 534, 1318  
 McCloskey, D. N. 1522  
 McCloud, James 476  
 McCord, David 1268  
 McCormack, Thomas J. 568  
 McCrea, William Hunter 298  
 McCullers, Carson 324  
 McCullough, David 417  
 McCune, Francis K. 426  
 McDuff, Dusa 841  
 McElwee, Tom 544  
 McEwan, Ian 726  
 McGee, Jr., H. A. 230  
 McGinn, Colin 190  
 McGonagall, William 191  
 McGregor, James 52  
 McKay, Christopher 1717  
 McKee, Christopher F. 321, 1613  
 McKenzie, John L. 1390  
 McKibben, Bill 318, 993  
 McKuen, Rod 81  
 McLaughlin, Mignon 334  
 McLennan, Deborah A. 1067  
 McLennan, Evan 993  
 McLuhan, Eric 907  
 McLuhan, Marshall 907, 1318  
 McMenamin, Dianna 564  
 McMenamin, Mark 564  
 McNeil, I. Joseph 632  
 McNemar, Quinn 1268  
 McPhee, John 593, 595  
 McReynolds, J. W. 699  
 McShane, E. J. 699  
 Mead, George H. 489, 1228  
 Mead, Margaret 84, 1318  
 Meadows, Dennis L. 1583  
 Meadows, Donella H. 1583  
 Mechnikov, Ilya 679  
 Medawar, J. S. 476  
 Medawar, Sir Peter Brian 170, 175, 276, 294, 307, 314, 327, 360, 476, 497, 626, 647, 668, 676, 693, 878, 1033, 1062, 1199, 1218, 1234, 1251, 1318, 1367, 1372, 1400, 1409, 1414, 1418, 1423, 1441, 1468, 1609, 1657  
 Mehlberg, Henry 1631  
 Meitzen, August 1538  
 Meixner, J. 1619  
 Melancon, Robert 200

- Melandri, E. 1380  
 Meldola, R. 993  
 Mellanby, Kenneth 1403  
 Mellor, J. W. 321, 558, 841  
 Melnechuk, Theodore 1215  
 Melrose, A. R. 952  
 Melville, Herman 20, 53, 71, 104, 192, 247, 372, 564,  
 629, 961, 993, 1044, 1047, 1156, 1319, 1362,  
 1372, 1455, 1553, 1639, 1644, 1688, 1703  
 Mencke, J. B. 841  
 Mencken, H. L. (Henry Louis) 112, 291, 300, 435, 534,  
 615, 628, 660, 878, 900, 993, 1056, 1072, 1102,  
 1129, 1319, 1390, 1442, 1476, 1609, 1703  
 Mendeléeff, Maria 1428  
 Mendeleyev, Dmitry 247, 360, 497, 647, 683, 886,  
 1078, 1319, 1442  
 Mendés, Michel 841  
 Menzel, Donald H. 1419  
 Mephisto 1129  
 Merchant, Carolyn 1405  
 Mercier, André 1378  
 Merck, George 901  
 Meredith, George 948, 1034, 1320  
 Meredith, Owen (Edward Robert Bulwer-Lytton, 1st  
 Earl Lytton) 206, 238, 246, 290, 779, 975, 1176,  
 1276, 1504, 1641  
 Meredith, Patrick 1089  
 Merezhkovskii, Konstantine 1564, 1609  
 Mermin, Norman David 191, 1114  
 Mernissi, Fatima 1390  
 Merrill, William 586  
 Merriman, Gaylord M. 778  
 Merritt, Dixon Lanier 42  
 Mersenne, Marin 13  
 Merton, Robert King 360  
 Merton, Thomas 784  
 Merz, John Theodore 218, 841  
 Metrodorus of Chios 513  
 Metropolis, Nicholas C. 1375  
 Metsler, William Joseph 632  
 Metz, William D. 404  
 Meunier, M. S. 911  
 Meydendauer, A. 926  
 Meyer, Adolf 1102  
 Meyer, Agnes 1183, 1320  
 Meyer, Walter 841  
 Meyers, Jr., G. J. 1538  
 Meyerson, Emile 405, 559, 750  
 Miall, Andrew 934  
 Miall, L. C. 534  
 Michalson, Carl 615  
 Mitchell, John 180  
 Michelson, Albert Abraham 750, 1114, 1353  
 Michener, James A. 417, 556, 577, 1194, 1712  
 Middendorf, W. H. 705  
 Middleton, Thomas 19  
 Midgley, Mary 575, 1218  
 Miksch, W. F. 1525  
 Milgrom, Mordehai 316  
 Mill, John Stuart 22, 206, 750, 841, 993, 1166, 1320  
 Millay, Edna St. Vincent 382, 534, 551  
 Miller, G. A. 841  
 Miller, Henry 226, 280  
 Miller, Henry George 931  
 Miller, Hugh 20, 79, 206, 302, 305, 379, 564, 586, 596,  
 676, 687, 695, 758, 798, 942, 1062, 1137, 1142,  
 1234, 1380, 1713  
 Miller, Jr., G. Tyler 1050  
 Miller, Jr., Walter M. 379  
 Miller, Kenneth R. 476, 1391  
 Miller, Perry 798  
 Miller, Robert C. 1455  
 Miller H. 1102  
 Millikan, Robert Andrews 278, 360, 392, 615, 1129,  
 1320, 1391, 1425, 1657  
 Mills, Enos A. 1640  
 Milne, A. A. (Alan Alexander) 30, 180, 361, 542, 554,  
 660, 1577, 1640  
 Milne, Alan Alexander 379  
 Milne, Edward Arthur 451, 1320  
 Milton, John 13, 95, 99, 152, 209, 218, 226, 268, 513,  
 545, 551, 707, 726, 919, 934, 945, 994, 1044,  
 1047, 1092, 1463, 1513, 1589, 1631, 1644, 1724  
 Minale, Marcello 507  
 Minelli, A. 375  
 Miner, Virginia Scott 776  
 Minkowski, Hermann 699, 1493  
 Minnaert, M. 1034  
 Minnick, Wayne C. 1234  
 Minot, George R. 693, 726, 901  
 Minto, Walter 726, 841, 1688  
 Mirowski, P. 842  
 Mishima, Yukio 1044  
 Misner, Charles W. 159, 1631  
 Mitchell, Margaret 253, 417, 1719  
 Mitchell, Maria 6, 112, 123, 184, 223, 504, 561, 676,  
 687, 726, 750, 910, 1034, 1039, 1320, 1405,  
 1442, 1513, 1589  
 Mitchell, Silas Weir 361, 497  
 Mittag-Lefler, Gosta 842  
 Mittasch, Alwin 247  
 Mitton, Simon 1223  
 Mizner, Wilson 1251  
 Modjeski, Ralph 842  
 Moeller, Therald 236  
 Mohapatra, Rabindra 1129  
 Moir, David Macbeth 35  
 Moissan, Henri 395

- Moleschott, Jacob 556, 994  
 Molière (Jean-Baptiste Poquelin) 781, 1102, 1139, 1142  
 Molloy, Les 1473  
 Momaday, N. Scott 1149  
 Moment, Gairdner B. 330  
 Monboddo, Lord James Burnett 842  
 Monnett, J. 594  
 Monod, Jacques 175, 218, 726, 798, 966, 1320  
 Montagna, William 627, 905  
 Montagu, Ashley 190, 1320  
 Montagu, George 969  
 Montague, C. E. 1149  
 Montague, James J. 396, 939  
 Montessori, Maria 1443  
 Montgomery, Arthur 587  
 Montgomery, H. 1259  
 Montgomery, James 42, 45, 67  
 Montgomery, Lucy Maud 726  
 Montgomery, Robert 994, 1044  
 Mooch 910  
 Moody, Paul 476  
 Moog, Florence 1730  
 Moore, A. D. 307  
 Moore, Anthony R. 668  
 Moore, Benjamin 1391  
 Moore, Dudley 951  
 Moore, George 71, 788  
 Moore, H. P. 1623  
 Moore, James R. 907  
 Moore, John A. 304, 1353, 1391  
 Moore, John N. 349  
 Moore, Marianne 280  
 Moore, Mary 623  
 Moore, Merrill 1102  
 Moore, Patrick 263  
 Moore, Thomas 35, 61, 945, 1513, 1644  
 Mora, P. T. 768  
 Moravcsik, M. J. 1353  
 Mordell, Louis Joel 842, 878  
 Mordida, B. J. 168  
 More, Hannah 1102  
 More, Louis Trenchard 587, 1321  
 Moreland, J. P. 1089  
 Morgan, Charles 727  
 Morgan, Frank 602  
 Morgan, John 901  
 Morgan, Lloyd 1321  
 Morgan, Robert 1138  
 Morgan, Thomas Hunt 1129  
 Morgenstern, Oskar 153, 264, 1369  
 Morison, George S. 417, 426, 1163  
 Morley, Christopher 16, 316, 332, 417, 627, 878  
 Morley, John 1st Viscount Morley of Blackburn 476, 994  
 Moroney, M. J. 150, 330, 620, 1183, 1525, 1538, 1578  
 Morowitz, Harold J. 1619  
 Morris, Desmond 476, 798, 1219  
 Morris, George P. 1644  
 Morris, H. M. 619  
 Morris, Henry 259, 304, 321, 477, 564, 593  
 Morris, Joseph F. 901  
 Morris, Richard 406, 1034, 1631, 1688, 1705  
 Morris, Robert Tuttle 544, 1074  
 Morris, Simon Conway 768, 1061  
 Morrison, A. Cressy 994  
 Morrison, D. E. 1522  
 Morrison, Foster 934  
 Morrison, Jim 939  
 Morrison D. C. 764  
 Morrow, James 1130, 1321  
 Morrow, Jeff 1142  
 Morrow, Lance 1391  
 Morrow, Prince Albert 1495  
 Morse, Harold Marston 842  
 Morton, Henry Vollam 879  
 Morton, Jack A. 307  
 Morton, Oliver 1149, 1154  
 Morton, Ron L. 1498  
 Moscovici, S. 1321  
 Moser, David 1212  
 Moser, Leo 16  
 Moses, L. E. 1523  
 Moss, Lawrence 1460  
 Moss, W. W. 1573  
 Mosteller, Frederick 1267, 1268  
 Motherwell, William 994  
 Motohashi, Yoichi 1172, 1259  
 Mott-Smith, Morton Joseph 632  
 Motto 1321  
 Motz, Lloyd 218, 1443  
 Moulton, Forest Ray 406, 534, 1050, 1234, 1472, 1487, 1554, 1589, 1657  
 Moulton, Lord 1034  
 Moultrie, John 842  
 Moynihan, Sir Berkeley 361, 615  
 Mozans, H. J. (John Augustine Zahm) 1405  
 Mr. Gregory 1538  
 Mr. Silva 375  
 Mr. Spock 1067  
 Muggeridge, Malcolm 477, 768, 1184  
 Muir, John 13, 29, 30, 39, 40, 56, 57, 67, 68, 69, 73, 74, 147, 159, 324, 333, 379, 398, 509, 551, 588, 606, 607, 652, 682, 702, 710, 744, 777, 915, 929, 945, 951, 969, 994, 1149, 1159, 1261, 1264, 1269, 1456, 1458, 1473, 1548, 1554, 1644, 1688, 1713  
 Muir, M. M. Pattison 247, 742  
 Muirden, James 123  
 Mukaiyama, Teruaki 192  
 Mullaney, James 776, 1513, 1590

- Muller, Herbert J. 24, 1321  
 Muller, Hermann Joseph 768, 954  
 Müller, Johannes 1034  
 Müller, Paul 1079  
 Mulliken, R. S. 197  
 Mullis, Kary B. 660  
 Mulock, Dinah Maria (Mrs. Craik) 36  
 Mumford, David 784, 1728  
 Mumford, E. 901  
 Mumford, Lewis 706, 727, 1321  
 Mundell, Carole 1215  
 Munger, Theodore 1321  
 Muppets 1443  
 Murchie, Guy 571, 575, 768, 1493  
 Murdin, Paul 123, 1010  
 Murphy, Michael 1077  
 Murray, Bruce 1155, 1480  
 Murray, Margaret 93  
 Murray, Robert Fuller 417  
 Muses, Charles 842  
 Musser, George 432, 995  
 Myers, Frederic William Henry 727  
 Myers, Norman 1722  
 Myers, Robert J. 708  
 Myrdal, Gunnar 727  
 Myrdal, Sigrid 1405
- N**
- Nabokov, Vladimir 65, 138, 294, 947, 1242, 1631  
 Nahin, Paul J. 1573  
 Nahmias, André 635  
 Nansen, Fridtjof 145, 652  
 Narby, Jeremy 559, 1724  
 Narrator 143  
 Nash, John F. 1623  
 Nash, Ogdan 36, 37, 38, 41, 45, 52, 53, 62, 63, 65, 66,  
 67, 69, 72, 76, 77, 80, 102, 332, 430, 508  
 Nashe, Thomas 324  
 National Academy of Sciences 1443  
 National Geographic Society 268  
 National Society of Professional Engineers 308  
 Navidi, W. C. 933  
 Neal, Patricia 1353  
 Neaves, Lord Charles 477  
 Needham, James G. 175, 769  
 Needham, Joseph 755, 1054, 1321  
 Nehru, Jawaharla 1194  
 Nekrasov, Nikolai 1321  
 Nelkin, Dorothy 304, 1424  
 Nemerov, Howard 1391  
 Nernst, Walther 247, 637  
 Neugebauer, Otto 123  
 Neuman, James R. 1538  
 Neumann, John von 1609  
 Newcomb, Simon 112, 124, 727  
 Newell, A. 1322, 1609  
 Newell, Homer E. 944  
 Newman, H. H. 477  
 Newman, James Roy 199, 315, 560, 573, 686, 691, 834,  
 842, 876, 1065, 1181, 1234, 1568  
 Newman, John Henry 477  
 Newman, Joseph S. 247, 254, 318, 588, 798, 939, 1149,  
 1174, 1648  
 Newman, M. H. A. 843  
 Newman, Michael 1709  
 Newman, Paul 314  
 Newman, Sir George 1074  
 Newman, William I. 514  
 Newton, Roger G. 1322  
 Newton, Sir Charles Thomas 1071  
 Newton, Sir Isaac 144, 330, 361, 441, 498, 534, 556,  
 602, 623, 632, 647, 776, 779, 879, 886, 949, 995,  
 1034, 1040, 1130, 1234, 1480, 1590,  
 1631, 1657, 1688  
 Neyman, Jerzy 441  
 Nicholas Bourbaki 1202  
 Nicholas of Cusa 1566  
 Nicholls, Elizabeth L. 562  
 Nicholson, Jack 615  
 Nicholson, Norman 268, 565, 568, 1701, 1703  
 Nicolle, Charles 441, 1663  
 Niebuhr, Barthold Georg 361  
 Nielsen, Kai 1083  
 Nietzsche, Friedrich 4, 99, 197, 206, 218, 226, 711, 798,  
 843, 1114, 1130, 1194, 1322, 1498, 1610, 1689, 1703  
 Nightingale, Florence 150, 534, 1023  
 Nilson, Lars Fredrik 1204  
 Ninotchka 1443  
 Nirenberg, Marshall W. 1199  
 Nixon, Richard M. 150, 1487  
 Nizer, Louis 1610  
 Nobel, Alfred 361, 915  
 Nobel Prize Medal 1322  
 Noble, D. F. 1578  
 Noble, Edmund 727  
 Noble, Elmer R. 1068  
 Noble, Glenn A. 1068  
 Nolan, James Joseph 1  
 Noll, Ellis D. 1130  
 Noll, Walter 843, 1594, 1595  
 Nordenholt, George F. 843  
 Nordmann, Charles 648, 843  
 Norfolk, Timothy S. 843  
 Norse, Elliot A. 1717  
 North, Roger 96  
 Northrop, Eugene 843  
 Norton, John K. 1563  
 Norton, Robert 1266

Norton, Thomas 13  
 Novalis (Friederich von Hardenberg) 182, 1610  
 Noyes, Alfred 268, 287, 1513, 1590, 1689  
 Nuland, Sherwin B. 369, 1103, 1459  
 Nunn, T. F. 1575  
 Nuttall, Thomas 187, 1159  
 Nye, Bill 24, 268, 588, 596

**O**

O. Henry (William Sydney Porter) 150, 844, 1539  
 O'Brien, Flann 939  
 O'Brien, Katharine 199, 602, 844  
 O'Brien, M. P. 426  
 O'Connor, Flannery 1463  
 O'Donoghue, Michael 1585  
 O'Keefe, J. A. 1264  
 O'Malley, Austin 534, 1561  
 O'Malley, John R. 1072  
 O'Meara, Stephen James 1155  
 O'Neil, William Matthew 1034  
 O'Neill, Eugene 1322  
 O'Neill, Gerard K. 917, 1488  
 O'Rourke, P. J. 995, 1323  
 Oates, Joyce Carol 190, 1689  
 Oberth, Hermann 1322, 1487  
 Obruchev, Vladimir 534, 931  
 Ochoa, Severo 166, 769  
 Ockels, Wubbo 1480  
 Oemler, Marie Conway 193  
 Oersted, Hans Christian 751, 1057, 1730  
 Ogilvie, Sir Heneage 1560, 1561  
 Ogutsch, Edith 90, 641  
 Oken, Lorenz 29, 1735  
 Olah, George A. 248  
 Oldfield, E. 85  
 Oldham, Richard Dixon 844, 1458  
 Olds, Edwin G. 1578  
 Old Woman 1513  
 Oliver, Bernard M. 513  
 Oliver, David 893  
 Oliver, Mary 660, 995  
 Olson, Harry F. 20  
 Olson, S. L. 259  
 Olson, Sigurd F. 1228  
 Olson, Steve 175  
 Oman, John 844, 1130, 1610  
 Onnes, Heike Kamerlingh 891  
 Oort, Jan Hendrik 1513  
 Oparin, Alexander Ivanovich 248, 477, 513, 727,  
 769, 1055  
 Oppenheim, Abraham Naftali 1563  
 Oppenheimer, Frank 742, 1669  
 Oppenheimer, J. Robert 142, 160, 273, 361, 392, 429,  
 489, 503, 534, 546, 569, 667, 706, 727, 751, 769,

798, 844, 995, 1040, 1050, 1114, 1130, 1194,  
 1237, 1243, 1251, 1322, 1353, 1372, 1376, 1407,  
 1467, 1583, 1610, 1703  
 Oreskes, Naomi 727, 934  
 Organisation for Economic Co-Operation and  
 Development 1583  
 Orgel, Irene 615  
 Orland, Harold 1657  
 Orr, Louis 1323  
 Ortega y Gasset, José 1375, 1495, 1669  
 Orton, James 995  
 Orwell, George (Eric Arthur Blair) 1034,  
 1071, 1539  
 Osborn, Fairfield 384  
 Osborn, Henry Fairfield 284, 477, 565, 1063  
 Osborne, John 799  
 Osbourn, E. S. 1577  
 Osiander, Andrew 113, 648  
 Osler, Sir William 24, 175, 181, 184, 248, 256, 273,  
 324, 340, 369, 371, 386, 442, 534, 545, 576, 609,  
 637, 727, 738, 901, 905, 915, 1024, 1035, 1074,  
 1103, 1234, 1323, 1495, 1549,  
 1657, 1669  
 Ostwald, Friedrich Wilhelm 138, 229, 248, 1323  
 Ott, Susan 786  
 Outwater, Alice 68  
 Overhage, Carl F. J. 780  
 Overstreet, Harry Allen 1717  
 Ovid 206, 223, 226, 287, 901, 919, 1104, 1160, 1561,  
 1713  
 Owen, Ed 1035  
 Owen, John 1104  
 Owen, Sir Richard 348  
 Oz 652  
 Ozick, Cynthia 534

**P**

Packard, Norman 226  
 Packe, Christopher 248  
 Page, Jake 961  
 Page, Leigh 1243  
 Page, Ray 844  
 Pagel, Bernard 124  
 Pagels, Heinz R. 406, 751, 769, 844, 995, 1114, 1130,  
 1212, 1229, 1323, 1403, 1419, 1514, 1657, 1664,  
 1669, 1689, 1705, 1710  
 Paglia, Camille 93, 905, 1323  
 Pagnol, Marcel 417  
 Pain, Roger H. 952  
 Paine, Thomas 445, 1084  
 Pais, Abraham 1131  
 Palade, George E. 1669  
 Paley, William 219, 616, 1392  
 Palissy, Bernard 588

- Pallister, William Hales 30, 31, 34, 39, 47, 49, 51, 54, 56, 64, 76, 86, 138, 248, 349, 396, 398, 513, 535, 596, 607, 1091, 1156, 1194, 1323, 1707
- Palmer, Tim 1261
- Palmieri, M. 1229
- Panek, Richard 1590
- Paneth, F. A. 912
- Panofsky, Wolfgang 498
- Panunzio, Constantine 1324
- Papert, Seymour 660, 844, 1237, 1594
- Papoulis, Athanasios 1610
- Pappas of Alexandria 636
- Papperitz, E. 844
- Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim) 13, 116, 498, 901, 1104
- Paré, Ambroise 268, 489, 616
- Paretsky, Sara 1560
- Parin, V. V. 1324
- Park, Ruth 301
- Parker, Barry 164, 303, 1689
- Parker, E. N. 791, 1554
- Parker, F. W. 1019
- Parker, Francis Wayland 103
- Parkhurst, D. F. 1522
- Parkington, J. E. 1235
- Parkinson, Cornelia 1547
- Parkinson, James 565, 1068
- Parkinson, John 1104
- Parr, William 369
- Parrot, Max 442, 1074
- Parsons, Talcott 361, 535, 1610
- Parsons, William Barclay 427
- Parton, H. N. 1353, 1375
- Pasachoff, Jay M. 382, 1514
- Pascal, Blaise 184, 206, 448, 616, 648, 687, 691, 799, 844, 879, 1184, 1235, 1262, 1459, 1554, 1568, 1658, 1689, 1705, 1728
- Pascual, Jordan 616
- Pastan, Linda 17
- Pasternak, Boris 919
- Pasteur, Louis 21, 81, 206, 219, 309, 361, 451, 498, 503, 535, 738, 769, 1324, 1351, 1443, 1592, 1610, 1658, 1689
- Pattee, H. H. 769
- Patten, W. 1475
- Patten, William 676
- Patterson, Colin 477
- Patterson, John W. 304
- Pattison, Eliot 336
- Pauli, Wolfgang 6, 392, 569, 616, 1008, 1009, 1212, 1257
- Pauling, Linus 248, 309, 606, 954
- Paulos, John Allen 154, 330, 546, 567, 935, 1019, 1400, 1539
- Pavlov, Ivan Petrovich 190, 345, 498, 535, 667, 728, 739, 769, 902, 914, 969, 1035, 1137, 1204, 1324
- Payne-Gaposchkin, Cecelia 1430
- Payne-Gaposchkin, Celia 287, 676, 1219
- Peabody, A. P. 1252
- Peabody, Francis Weld 261, 369, 902, 1443
- Peacock, R. 303
- Peacock, Thomas Love 51, 1162, 1324, 1571
- Peacocke, Arthur 616
- Peale, Rembrandt 1168
- Pearl, Judea 620, 1184
- Pearse, A. S. 1194, 1444
- Pearson, E. S. 1184, 1539
- Pearson, Karl 295, 498, 535, 676, 751, 845, 879, 1047, 1202, 1245, 1325, 1362, 1407, 1414, 1539
- Peat, D. 1085, 1274
- Peat, F. David 1212
- Peattie, Donald Culrose 155, 175, 253, 433, 478, 568, 770, 912, 995, 1149, 1325, 1496, 1514, 1645, 1689, 1722
- Peebles, Curtis 106, 676
- Peebles, Phillip James Edwin 298
- Peers, John 219, 535
- Peirce, Benjamin 435, 845
- Peirce, Charles Sanders 229, 442, 648, 660, 845, 1019, 1184, 1219, 1235, 1325, 1410, 1426, 1658, 1690, 1707
- Peltier, Leslie C. 268, 287, 1514, 1590
- Pendry, John 1194
- Penjer, Michael 558
- Penman, Sheldon 953
- Penn, Granville 588
- Penrose, Roger 9, 124, 160, 957, 1632, 1658
- Penzias, Arno 124, 1690
- Pepper, Stephen 21
- Percival, Thomas 1104
- Percy, Walker 1467
- Perelman, S. J. (Sidney Joseph) 1444
- Perelman, Sidney Joseph 332, 1563, 1586
- Perfect, D. C. 879
- Perkins, Harry C. 1330
- Perl, Martin 1325
- Perl, Martin L. 660
- Perrett, J. 770
- Perrin, Jean 1539
- Perrin, Noel 73
- Perry, Georgette 1008
- Perry, Lilla Cabot 1713
- Perry, Ralph Barton 1444
- Persius 370
- Perutz, Max F. 1252, 1325
- Petchenik, Barbara Bartz 802
- Peter, Lawrence J. 891
- Peters, Ted 996

- Peterson, Ivars 845, 957, 1075, 1224, 1475  
 Peterson, Roger Tory 42  
 Petit, Jean-Pierre 728, 1610  
 Petrarch (Francesco Petrarca) 902, 996, 1237  
 Petroski, Henry 192, 417, 427, 1114  
 Pettie, George 207  
 Philip Morrison 624  
 Philips, J. D. 602, 845, 1648  
 Phillips, Adam 32  
 Phillips, John 728  
 Phillips, Philip 94  
 Phillips, Wendell 580  
 Philolaus 1019  
 Philpotts, Eden 728  
 Phylis Morrison 624  
 Piaget, Jean 427  
 Picard, Charles Emile 845, 1050  
 Pickering, James Sayre 799  
 Pickering, William H. 418  
 Pickover, Clifford A. 845  
 Piechowski, Otto Rushe 1514  
 Pierce, J. R. 320  
 Pieri, Mario 846  
 Pierpont, James 692, 846  
 Pigford, R. L. 230  
 Pindar, Paean IX 382  
 Pines, David 1131  
 Pinker, Steven 264  
 Pinter, Harold 1703  
 Piozzi, Hester Lynch 1104  
 Pippard, A. B. 1619  
 Pirandello, Luigi 535  
 Pirenne, M. H. 1137  
 Pirie, N. W. 782  
 Pirquet von Cesenatico, C. P. 18  
 Pirsig, Robert M. 275, 321, 498, 602, 648, 1326, 1415, 1583, 1632  
 Pisarev, Dmitry 535  
 Pittendreigh, Jr., W. Maynard 314  
 Pittendrigh, Colin S. 168  
 Planck, Max 153, 201, 361, 432, 447, 490, 498, 535, 543, 561, 632, 648, 660, 677, 709, 751, 776, 996, 1035, 1131, 1184, 1212, 1222, 1326, 1367, 1392, 1444, 1562, 1592, 1594, 1623, 1658  
 Plaskett, J. S. 799  
 Plath, Sylvia 249  
 Plato 103, 124, 182, 197, 219, 300, 370, 382, 499, 603, 616, 649, 679, 879, 891, 949, 1019, 1104, 1164, 1184, 1326, 1405, 1464, 1514, 1554, 1632, 1690  
 Platonov, Andrei 787  
 Platt, John R. 728, 1150, 1202, 1207, 1549  
 Platt, Sir Robert 1252  
 Plattes, Gabriel 1456  
 Plautus 535  
 Playfair, John 565, 588, 596, 607, 752, 923, 1262, 1610, 1632  
 Playfair, William 621, 1540, 1573  
 Pliny (C. Plinius Secundus) 32, 905, 996, 1019, 1475  
 Plotinus 207, 603, 1020, 1632  
 Plum, David 910  
 Plummer, Andrew 249  
 Plutarch 341, 1105, 1265  
 Podolsky, Boris 1326  
 Poe, Edgar Allan 42, 164, 197, 846, 1105, 1194, 1326, 1514, 1658, 1690, 1720, 1725  
 Pohl, Frederik 197, 219  
 Poiani, Eileen L. 846  
 Poincaré, Henri 10, 84, 88, 103, 138, 160, 190, 219, 343, 374, 382, 394, 442, 446, 448, 499, 536, 558, 561, 603, 625, 633, 649, 681, 692, 696, 752, 846, 879, 919, 935, 996, 1035, 1050, 1114, 1131, 1184, 1194, 1257, 1260, 1326, 1362, 1376, 1428, 1444, 1460, 1467, 1480, 1515, 1594, 1610, 1706  
 Poincaré, Lucien 392, 569, 1199  
 Poinot, Louis 1632  
 Poisson, Simeon-Denis 847  
 Polanyi, Michael 362, 536, 661, 752, 847, 1327, 1392, 1415, 1444, 1670, 1690, 1732, 1738  
 Polkinghorne, John 1213, 1392  
 Pollak, Henry O. 848  
 Pollard, William 1150  
 Pólya, George 341, 343, 362, 603, 626, 661, 670, 848, 879, 914, 1174, 1195  
 Polyakov, Alexander 616  
 Polybius 207  
 Pomerance, Carl 1169  
 Pomfret, John 442  
 Pompidou, Georges 573  
 Ponnampertuma, Cyril 770  
 Pontecorvo, Bruno 1008  
 Pontoppidan, Erich 1457  
 Pool, Ithiel de Sola 1353  
 Poovey, Mary 848  
 Pope, Alexander 7, 42, 68, 86, 87, 99, 139, 220, 226, 255, 273, 324, 373, 499, 513, 551, 848, 925, 996, 1020, 1035, 1051, 1092, 1235, 1327, 1493, 1515, 1645, 1690, 1725  
 Pope John Paul II 1392  
 Pope Pius XI 1  
 Pope Pius XII 1378, 1392, 1583  
 Popper, Karl R. 79, 212, 249, 298, 338, 362, 442, 448, 478, 490, 499, 616, 649, 661, 728, 958, 1035, 1089, 1185, 1195, 1219, 1327, 1358, 1363, 1368, 1378, 1392, 1444, 1611, 1670, 1726  
 Porta, John Baptista 790  
 Porter, George 1195, 1351  
 Porter, Roy 902  
 Porterfield, Austin L. 1328



- Portier, Paul 499, 1565  
 Posner, Michael I. 190  
 Poteat, William Louis 1328  
 Potter, Stephen 1074  
 Poullain de la Barre, François 1405  
 Pound, Roscoe 954, 1564  
 Powell, Cecil 296  
 Powers, Henry 917  
 Powers, Richard 1328  
 Pownall, Thomas 1646  
 Poynting, John Henry 254, 649, 729, 752, 770, 907, 935, 996  
 Praed, Winthrop 1328  
 Prakash, Satya 207  
 Pratchett, Terry 13, 29, 617, 667, 776, 1185, 1612  
 Pratt, C. C. 1328  
 Pratter, Frederick 848  
 Prelog, V. 249  
 Prelutsky, Jack 37, 41, 75, 80, 193, 349, 350  
 Prescott, William Hickling 1328  
 President's Science Advisory Committee 694  
 Preston, Richard 1138  
 Preston, Thomas 729  
 Prestwich, Joseph 596  
 Pretorius, D. A. 597  
 Pribram, Karl 1328  
 Price, Bartholomew 848, 1235  
 Price, C. 729  
 Price, Derek John de Solla 1424, 1444, 1540  
 Price, Don K. 1368, 1381  
 Price, P. W. 1053  
 Priest, Graham 661  
 Priestley, J. B. 1612  
 Priestley, Joseph 12, 207, 220, 362, 399, 499, 580, 649, 684, 729, 997, 1328, 1354, 1368, 1659  
 Prigogine, Ilya 338, 617, 886, 1328, 1632, 1690  
 Primas, Hans 249, 1444  
 Prince Philip (Philip Mountbatten), Duke of Edinburgh 1722  
 Prince Philip (Phillip Mountbatten), Duke of Edinburgh 333  
 Pringle, John R. 349  
 Pringle, Thomas 72  
 Pringsheim, Alfred 848, 850, 880, 1612  
 Prior, Matthew 86, 113, 1105, 1185, 1329  
 Pritchett, V. S. 1329  
 Proclus 848, 1020  
 Procter, Bryan Waller 1724  
 Proctor, Richard A. 124, 588, 617, 687, 1709  
 Professor Barnhardt 314  
 Professor Hubert J. Farnsworth 1664  
 Professor Oliver Lindenbrook 1441  
 Proschan, Frank 1540  
 Protheroe, Chester F. 249  
 Proudfit, David Law 478  
 Proust, J. L. 276  
 Proust, Marcel 160, 661, 902, 1646  
 Prout, Curtis 1329  
 Prout, William 249, 397  
 Proverb 629, 1072, 1092, 1105, 1639  
 Proverb, Chinese 1105  
 Proverb, German 1105  
 Proverb, Italian 1105  
 Proverb, Scottish 325  
 Proverb, Spanish 14  
 Prudhomme, Sully 113, 235  
 Prusiner, Stanley B. 1445  
 Pryanishnikov, D. N. 729  
 Ptolemy 113, 1515  
 Puckett, Andrew 1540  
 Pugh, Emerson M. 190  
 Puiseux, P. 923  
 Pulitzer, Joseph 677  
 Pupin, Michael 1150  
 Purcell, Edward 1488  
 Purcell, Rosamond 29, 478  
 Purchas, Samuel (the Younger) 58  
 Putnam, H. 1632  
 Putter, A. 770  
 Puzo, Mario 573, 1540  
 Pycraft, W. P. 176  
 Pyke, Sandra W. 1246, 1421  
 Pynchon, Thomas 150, 375, 1540  
 Pythagoras of Samos 757, 770
- Q**
- Quammen, David 997  
 Quarles, Francis 1106  
 Queneau, Raymond 187, 537, 778, 1165, 1172, 1736  
 Quetelet, Adolphe 150, 1329  
 Quicke, D. L. 711  
 Quine, Willard Van Orman 742, 848, 1132, 1329, 1460  
 Quinet, Edgar 1329  
 Quinton, Anthony M. 282
- R**
- Rabelais, François 1106  
 Rabi, Isidor Isaac 386, 499, 537, 729, 953, 1115, 1132, 1329, 1407, 1426, 1670, 1690, 1703  
 Rabinow, Jacob 707, 1195  
 Rabinowitch, Eugene 799, 1091, 1382  
 Racker, Efraim 362  
 Rae, John A. 418  
 Raether, H. 1084  
 Raichle, Marcus E. 190  
 Raiffa, Howard 23  
 Raine, Kathleen Jessie 249  
 Rainich, G. Y. 1467

- Raju, Poolla Tirupati 153  
 Raleigh, Sir Walter 1593  
 Raman, Chandrasekhar Venkata 160, 949, 997, 1132  
 Ramanujan, Srinivasa 435  
 Ramon y Cajal, Santiago 1445  
 Ramón y Cajal, Santiago 184, 537, 729, 786, 1080,  
 1195, 1403, 1690  
 Ramsay, Sir William 12, 13, 161, 250, 294, 362, 729,  
 1199, 1219, 1329, 1501, 1670  
 Ramsey, Frank Plumpton 1185  
 Ramsey, James B. 1547  
 Rand, Ayn 1690  
 Randall, J. H. 1329  
 Randall, Merle 1619  
 Randi, James 1329  
 Rankin, William H. 945  
 Rankine, William John Macquorn 418, 568, 699, 891  
 Ransom, John Crowe 546  
 Rapoport, Anatol 790, 1066, 1196  
 Rashevsky, Nicolas 176, 1079  
 Raup, David Malcolm 509, 1612  
 Raven, Charles E. 1392  
 Ravetz, J. R. 1329  
 Rawlings, Majorie Kinnan 906  
 Rawnsley, Hardwicke Drummond 418  
 Ray, John 301, 311, 370, 620, 627, 629, 639, 802, 1024,  
 1092, 1106, 1139, 1639  
 Raymo, Chet 124, 262, 677, 730, 799, 1229, 1330,  
 1393, 1415, 1428, 1470, 1515, 1554, 1671, 1691  
 Raymond, Eric S. 1196  
 Ray Stantz 346  
 Read, Herbert 891  
 Read, Herbert Harold 597, 1264  
 Reade, Winwood 478, 617, 1488, 1691  
 Reagan, Ronald W. 1, 442  
 Recorde, Robert 146, 667, 849, 1235, 1252, 1670  
 Reddy, Francis 160  
 Redfern, Martin 597, 1142  
 Redfield, Casper L. 707  
 Redfield, Roy A. 151, 1185  
 Redi, Francesco 161, 770  
 Reed, Ishmael 1691  
 Reed, T. D. 1663  
 Rees, Martin John 113, 139, 1112, 1115  
 Rees, Mina 849  
 Reese, C. L. 230  
 Reeve, F. D. 1229  
 Reeves, Hubert 275, 300, 886, 1697  
 Regnault, Noël 949, 1069, 1578, 1728  
 Reich, Charles A. 1583  
 Reichenbach, Hans 210, 220, 346, 362, 730, 785, 1051,  
 1132, 1185, 1252, 1393, 1494, 1586, 1633, 1659,  
 1691  
 Reid, Constance 880  
 Reid, Thomas 25, 677, 849, 880, 1467  
 Reines, Frederick 1009  
 Reis, Johann Philipp 250  
 Reiser, Anton 1612  
 Reiss, H. 1619  
 Remek, Vladimir 145  
 Remsen, Ira 1691  
 Renan, Ernest 1330, 1363, 1378, 1428, 1659  
 Renard, Jules 902  
 Renard, Maurice 1691  
 Renaudot, Eusébe 396  
 Reswick, J. B. 336  
 Rexroth, Kenneth 784  
 Rey, Hans Augusto 997  
 Reynolds, H. T. 891, 1540  
 Reynolds, Osborne 1373  
 Reynolds, William C. 1330  
 Rhazes 1074  
 Rheticus, Georg Joachim 113  
 Rhinehart, Luke (George Cockcroft) 220  
 Rhodes, Cecil 1515  
 Rhodes, Frank H. T. 537  
 Rice, Laban Lacy 1393  
 Rich, Adrienne 919, 1406  
 Richards, Dickinson W. 1612  
 Richards, Ellen Henrietta Swallow 250  
 Richards, Ivor Armstrong 1330, 1445  
 Richards, Mary Caroline 677  
 Richards, Theodore William 143, 250, 957, 1330, 1691  
 Richardson, Lewis 687  
 Richardson, Moses 849  
 Richardson, Owen Willans 1132  
 Richardson, Samuel 23, 1024, 1330  
 Richet, Charles 23, 250, 649, 730, 997, 1252, 1269,  
 1331, 1358, 1368, 1408, 1445, 1612, 1659  
 Richter, Charles 1458  
 Richter, Curt P. 1256  
 Richtmyer, Floyd Karker 362  
 Rickard, Dorothy 400  
 Ricklefs, R. 1707  
 Rickover, Hyman G. 151, 433, 1584  
 Ridley, B. K. 624, 1163  
 Ridley, Matt 181, 580, 1331  
 Riemann, Bernhard 278  
 Riggs, Arthur Stanley 799  
 Riley, James Whitcomb 39, 61, 63, 379, 969, 1554  
 Rilke, Ranier Maria 287, 1515  
 Rindler, Wolfgang 1243, 1691  
 Rindos, David 1368  
 Riordan, Michael 316, 1229  
 Ritchie, Arthur David 280, 328, 730, 1378  
 Ritsos, Yannis 341  
 Rivers, Joan 626  
 Rivers, Pitt 362

- Robb, Alfred Arthur 139, 556  
 Robbins, Herbert 815, 1087  
 Robbins, R. Robert 160  
 Robbins, Tom 945  
 Roberts, Catherine 176, 478  
 Roberts, Michael 1091, 1132  
 Roberts, W. Milnor 490  
 Robertson, Howard P. 499  
 Robertson, Percival 565, 588  
 Robinson, Arthur H. 802  
 Robinson, Arthur L. 1213  
 Robinson, Edwin Arlington 113  
 Robinson, Geoffrey 605  
 Robinson, Howard A. 1115  
 Robinson, James Harvey 730, 1252, 1363  
 Robinson, Lewis Newton 1547  
 Robinson, Sir Robert 1331  
 Robinson, Victor 902, 1059, 1150  
 Rodbell, Martin 770  
 Roddenberry, Gene 1488  
 Roe, Anne 1354, 1445  
 Roe, Jr., E. D. 568  
 Roebing, John 192  
 Roelofs, Howard Dykema 1393  
 Rogers, Eric 1115, 1243  
 Rogers, G. F. C. 427  
 Rogers, Jr., Hartley 1066  
 Rogers, Will 370, 573, 621, 1540, 1547  
 Rohault, Jacques 207, 220, 223  
 Rohrich, Fritz 1578  
 Roller, Duane H. D. 435, 722, 748, 1031, 1303  
 Rolleston, George 997  
 Rollins, R. C. 1575  
 Romains, Jules 629, 902  
 Romanoff, Alexis Lawrence 182, 311, 537, 629, 902,  
 1235, 1252, 1331, 1368, 1541, 1578, 1612, 1659  
 Röntgen, Wilhelm Conrad 499, 849, 1132, 1732  
 Roosevelt, Franklin Delano 273, 1024, 1072  
 Roosevelt, Theodore 328  
 Root, R. K. 176  
 Rorty, Richard 887, 1115  
 Roscoe, Henry E. 139, 1078  
 Rose, Steven Peter Russell 166  
 Rosenbaum, R. A. 849  
 Rosenblatt, Roger 103  
 Rosenfeld, A. H. 1009, 1692  
 Rosenthal-Schneider, Ilse 1430  
 Ross, John 1620  
 Ross, Sir Ronald 792, 945, 1331, 1363  
 Rosseau, Jean-Jacques 207  
 Rosseland, Svein 923, 1039  
 Rossetti, Christina Georgina 40, 551, 1044  
 Rossi, Hugo 334, 1730  
 Rossman, Joseph 542, 707, 730  
 Rostand, Jean 176, 1358  
 Roszak, Theodore 1196, 1331, 1445  
 Rota, Gian-Carlo 170, 184, 625, 849, 850, 880, 1066,  
 1186, 1612  
 Roth, V. Louise 1557  
 Rothman, Milton A. 683, 730, 1445  
 Rothman, Tony 82, 139, 325, 500, 633, 1213, 1243,  
 1332, 1445, 1612, 1621, 1691  
 Rothschild, Lord Nathaniel Mayer 1409  
 Rous, Francis 325  
 Rouse, Irving 259  
 Rousseau, Jean-Jacques 433  
 Roux, Joseph 1332  
 Rowan-Robinson, Michael 667, 1590  
 Rowland, Henry Augustus 139, 752, 923, 1424, 1550  
 Rowling, J. K. 338, 1166  
 Roy, Gabrielle 1463  
 Royce, Josiah 687, 730  
 Rozeboom, W. W. 1522  
 Rózsa, Péter 850  
 Rubin, Harry 211, 1332  
 Rubin, Vera 543, 1691  
 Rubinstein, Anton 681  
 Rucker, Rudy 692, 1091  
 Rucker, Rudy (Rudolph von Bitter Rucker) 298  
 Rudberg, Eric Gustaf 280  
 Ruderman, M. A. 1009, 1691  
 Rudloe, Jack 80  
 Rudner, Richard 22  
 Rudwick, Martin J. S. 589, 1063  
 Rudzewicz, Eugene 63  
 Ruelle, David 367, 1115  
 Ruffini, Remo 180  
 Rukeyser, Muriel 139  
 Rumford, Benjamin 500  
 Rumsfeld, Donald 1703  
 Runyon, Damon 220  
 Runyon, Richard P. 1534  
 Ruse, Michael 330, 478, 1332, 1445  
 Rush, J. H. 771  
 Rushton, John Phillipe 1446  
 Ruskin, John 96, 99, 193, 194, 542, 952, 1332, 1458  
 Russell, Bertrand 406  
 Russell, Bertrand Arthur William 3, 79, 103, 125, 201,  
 207, 273, 321, 448, 479, 537, 603, 617, 677, 701,  
 730, 752, 757, 771, 784, 787, 799, 849, 850, 887,  
 891, 914, 929, 941, 1012, 1020, 1051, 1066,  
 1077, 1084, 1132, 1163, 1166, 1188, 1196, 1203,  
 1219, 1235, 1243, 1245, 1332, 1350, 1363, 1379,  
 1401, 1415, 1419, 1541, 1592, 1613, 1633, 1659,  
 1672, 1692, 1701, 1717, 1732  
 Russell, Cheryl 442  
 Russell, Henry Norris 997, 1039, 1115, 1196  
 Russell, L. K. 1733

- Russell, Peter 1515  
 Russell, Richard Joel 605  
 Russell, Sir E. John 500  
 Russell, Sir Edward John 1477  
 Russen, David 1488  
 Russo, Richard 941  
 Rutherford, Ernest 139, 362, 392, 396, 406, 500, 1012, 1269, 1403, 1502  
 Rutherford, Mark (William Hale White) 1554  
 Ryder-Smith, Roland 1590  
 Ryle, Gilbert 788  
 Ryle, Martin 125
- S**
- Saaty, Thomas L. 436  
 Sabatier, Paul 250  
 Sabbagh, K. 1259, 1736  
 Sabin, Albert 1446  
 Sabloff, Jeremy 91  
 Sacks, Oliver W. 370, 396, 629, 902, 1074  
 Sackville-West, V. 800  
 Saffman, P. G. 1662  
 Safonov, V. 363  
 Sagan, Carl 14, 82, 106, 125, 180, 191, 212, 223, 261, 268, 287, 300, 307, 309, 342, 406, 451, 479, 500, 513, 514, 548, 572, 575, 617, 639, 649, 661, 708, 710, 731, 753, 802, 914, 928, 997, 1020, 1055, 1115, 1150, 1172, 1204, 1207, 1213, 1219, 1257, 1332, 1373, 1375, 1393, 1401, 1446, 1470, 1475, 1488, 1515, 1554, 1564, 1584, 1621, 1659, 1664, 1670, 1692, 1697, 1725  
 Sagan, Dorion 28, 474, 638, 767, 1006, 1317  
 Sage, M. 547  
 Saint-Hilaire, Étienne Geoffroy 506  
 Saint Augustine of Hippo 561, 1106, 1633  
 Saint Avvaiyar 731  
 Sakaki, Nanao 325  
 Sakharov, Andrei 514, 800  
 Salam, Abdus 635  
 Salamone, Frank 82, 291  
 Salisbury, J. Kenneth 418  
 Salmon, Merrilee H. 90  
 Salsburg, David S. 1522, 1546  
 Salter, William T. 171  
 Salthe, Stanley N. 171  
 Salvadori, Mario 275  
 Salzberg, Hugh W. 927  
 Salzberg, Paul 308  
 Sammonicus, Serenus 903  
 Samuel, Arthur L. 788  
 Samuels, Ernest 1541  
 Samuelson, Bengt, I. 731  
 Samuelson, Paul A. 1167  
 Samuelsson, Bengt I. 363  
 Sanborn, Kate 29  
 Sand, George 696  
 Sand, George (Amantine-Lucile-Aurore Dupin) 418  
 Sandage, Allan 113, 572, 1133, 1333, 1692  
 Sandburg, Carl 103, 1020, 1071, 1456  
 Sandell, E. B. 6  
 Sanderson, R. T. 1078  
 Sands, Matthew 612  
 Sands, Matthew L. 88, 372, 390, 404, 435, 555, 673, 683, 719, 746, 775, 823, 1069, 1210, 1413, 1618, 1662, 1680  
 Sanger, Margaret 178  
 Santayana, George (Jorge Augustín Nicolás Ruiz de Santillana) 226, 300, 617, 731, 851, 887, 1333, 1373, 1613, 1633, 1692  
 Sapp, Jan 1565  
 Sappho 40, 945  
 Sarewitz, Daniel 739, 1252  
 Sarnak, P. 1260, 1736  
 Sarnoff, David 1252, 1333  
 Sarpi, Fra Paolo 949  
 Sarton, George 250, 502, 851, 880, 1199, 1358, 1525  
 Sarton, May 1051  
 Sartre, Jean-Paul 160, 1186  
 Saslaw, William C. 572  
 Sattler, R. 1659  
 Saunders, W. E. 509, 997  
 Savage, D. E. 1548  
 Savage, Jay Mathers 479  
 Savage-Rumbaugh, Sue 105, 1053  
 Savory, Theodore 961  
 Sawyer, Walter Warwick 851  
 Saxe, John Godfrey 1036  
 Sayer, Lewis L. 256  
 Sayers, Dorothy L. 113, 162, 537, 997, 1613  
 Sayre, G. Armington 185  
 Scalera, Mario 1253  
 Scaliger, Joseph 598  
 Scarlett, Earle P. 903  
 Scatchard, George 1333  
 Schaaf, Fred 1556  
 Schaefer, Bradley E. 1472  
 Schaefer, Jack 74  
 Schaffer, E. A. 479  
 Schaller, George B. 73  
 Schawlow, Arthur 114  
 Scheele, Carl Wilhelm 250  
 Schegel, Richard 1613  
 Schenck, Jr., Hilbert 699  
 Schiaparelli, G. V. 1155  
 Schickel, Richard 1637  
 Schiebinger, Londa 1025, 1333  
 Schild, Alfred 1066, 1253

- Schiller, Ferdinand Canning Scott 220, 363, 784, 1186, 1334, 1613, 1693
- Schlegel, Friedrich 1133
- Schlesinger, Frank 114
- Schlichter, Dean 852
- Schmidt, Frank L. 1522
- Schmidt, O. Y. 1199
- Schmitz, Jacqueline T. 1024
- Schneer, Cecil J. 537, 1334
- Schneider, Don 114
- Schneider, Herman 1150
- Schneider, Nina 1150
- Schölzer, Ludwig 1541
- Schön, Donald A. 1253, 1613
- Schopenhauer, Arthur 104, 220, 677
- Schramm, David N. 316, 321, 1613
- Schreiber, Georg 379
- Schreiber, Hermann 379
- Schrieber, Hermann 997
- Schrire, Carmel 90
- Schrödinger, Erwin 140, 254, 392, 500, 667, 694, 753, 756, 771, 782, 852, 891, 998, 1066, 1133, 1213, 1334, 1354, 1401, 1408, 1424, 1459, 1470
- Schubert, Hermann Cäsar Hannibal 852
- Schuchert, C. 537
- Schuffe, J. A. 1578
- Schukarev, A. N. 1240
- Schumacher, Ernst Friedrich 788, 1467, 1584
- Schuster, Sir Arthur 84, 406, 1726
- Schützenberger, Marcel-Paul 852
- Schuyler, Montgomery 192
- Schwartz, David 379
- Schwartz, John 363, 1334
- Schwarzschild, Martin 753
- Schweitzer, Albert 49, 53, 1060
- Schweizer, Karl W. 1359
- Sciama, Dennis 935, 1243
- Scott, Chas F. 427
- Scott, Dave 108
- Scott, Sir Walter 145, 220, 597, 1106
- Scott Cary 486, 689, 1469
- Scottie 18
- Scotty 1133
- Scripps, Edwin W. 617
- Scriven, Michael 504, 756
- Scrope, George Poulett 207, 589, 1150, 1713
- Seab, C. G. 620
- Seares, Frederick H. 301
- Sears, Francis Weston 432
- Sears, Paul Bigelow 176, 998
- Seaton, G. L. 1525
- Second World War Health Slogan 301
- Sedgewick Seti 1151
- Sedgwick, Adam 589, 952
- Sedwizoj, Michal 373
- Seebach, D. 1570
- Seegal, David 1106
- Seeger, Peggy 418
- Seeger, Raymond J. 1613
- Seely, Bruce E. 418
- Segal, Erich 1541
- Segerstrale, Ullica 264
- Seifert, H. S. 1620
- Seifriz, William 1334, 1446
- Seignobos, Charles 1219
- Selden, John 1106
- Selye, Hans 221, 308, 314, 363, 784, 917, 998, 1036, 1446, 1671
- Selzer, Richard 781, 1469, 1470, 1560, 1562
- Sendivogius, Michael 1660
- Seneca (Lucius Annaeus Seneca) 96, 268, 370, 634, 708, 852, 903, 998, 1106, 1516, 1728
- Serge, Corrado 881, 1428
- Serge, Lang 852
- Serling, Rod 677
- Serres, Michel 1199
- Servetus, Michael 786
- Service, Robert William 145, 1516, 1704
- Serviss, Garrett P. 945, 1516
- Seton, Ernest Thompson 731
- Severinus, Petrus 505, 731
- Seward, A. C. 1264
- Seward, John 732
- Sexton, Anne 32, 66, 67, 223, 1151, 1456
- Shadwell, Thomas 311, 370, 852, 1560
- Shaffer, Peter 151
- Shaftesbury, Anthony Ashley Cooper 160
- Shakespeare, William 10, 14, 37, 38, 39, 40, 41, 43, 44, 51, 58, 59, 70, 71, 78, 87, 107, 114, 125, 151, 181, 194, 207, 213, 221, 226, 269, 292, 311, 325, 341, 370, 374, 379, 386, 418, 442, 506, 514, 546, 551, 578, 621, 628, 667, 681, 688, 757, 779, 781, 784, 792, 852, 887, 903, 910, 945, 949, 998, 1020, 1036, 1051, 1068, 1074, 1084, 1092, 1106, 1139, 1162, 1174, 1186, 1202, 1235, 1257, 1269, 1463, 1472, 1516, 1554, 1586, 1623, 1633, 1639, 1704, 1719, 1733
- Shaler, Nathaniel Southgate 208, 380, 742, 1151
- Shamos, Morris H. 537
- Shapere, Dudley 538, 1089
- Shapiro, Harry L. 1334
- Shapiro, Karl Jay 1541
- Shapiro, Paul 63
- Shapiro, Robert 451, 763, 771, 1335
- Shapley, Harlow 114, 125, 140, 227, 300, 396, 708, 800, 853, 1142, 1469
- Sharp, David 65
- Sharpe, Tom 294

- Shaw, Alan 178, 682, 1548  
 Shaw, George Bernard 4, 7, 162, 171, 177, 197, 213,  
 250, 255, 294, 301, 318, 363, 370, 392, 418, 436,  
 479, 490, 514, 538, 565, 617, 629, 678, 792, 853,  
 903, 926, 967, 998, 1064, 1066, 1196, 1200,  
 1203, 1207, 1219, 1243, 1335, 1393, 1428, 1541,  
 1562, 1613, 1639, 1660  
 Shaw, James B. 853  
 Shaw, William R. 434  
 Shchatunovski, Samuil 881  
 Sheckley, Robert 1446  
 Sheeham, William 1155  
 Shelah, Saharon 282  
 Sheldrick, Daphne 284  
 Shelley, Mary 251, 732, 946, 1335, 1446, 1646  
 Shelley, Percy Bysshe 60, 114, 221, 269, 380, 552,  
 607, 634, 692, 887, 946, 1044, 1159, 1205, 1335,  
 1693, 1713, 1729  
 Shenstone, W. A. 1714  
 Shepherd, Alan 108  
 Shepherd, Linda Jean 1660  
 Sheridan, Richard Brinsley 1106  
 Shermer, Michael 732, 1335  
 Sherrington, Sir Charles 211, 480, 771, 1007  
 Sherrod, P. Clay 125, 1516  
 Sherwood, Thomas 1186  
 Shewhart, Walter Andrew 427, 559  
 Shimony, Abner 1066  
 Shindler, Tom 1713  
 Shipman, T. 96  
 Shlain, Leonard 1373  
 Shoemaker, Eugene 106  
 Shoemaker, Sydney 229  
 Sholander, Marlow 343, 803  
 Shore, Jane 1472  
 Shrady, George 1424  
 Shu, Frank H. 1336  
 Shulman, Max 695  
 Shulman, Milton 881  
 Shute, John 96  
 Shute, Nevil 419  
 Sidgwick, N. V. 235  
 Siegel, Eli 105, 140, 406, 442, 538, 604, 661, 753, 853,  
 931, 1142, 1336, 1480, 1693  
 Siekevitz, P. 168  
 Sigerist, Henry E. 363, 669, 1562  
 Sigma Xi 448  
 Sigurdsson, Haraldur 1446  
 Silberling, N. J. 22  
 Silesius, Angelus 1634  
 Silk, Joseph 114, 165, 402, 1693  
 Silliman, G. S. 910  
 Sillman, Benjamin 125, 732  
 Silone, Ignazio 380  
 Silver, Brian L. 140, 251, 574, 732, 887, 1220, 1336,  
 1359, 1373, 1401, 1447, 1614  
 Simes, James 634  
 Simmonds, Sophia 166  
 Simmons, Charles 262, 342, 370, 629  
 Simmons, George F. 853  
 Simon, Anne W. 1268  
 Simon, H. 1196  
 Simon, Herbert Alexander 327, 363, 1196, 1336, 1672  
 Simonson, Roy 1474  
 Simpson, George Gaylord 71, 171, 177, 480, 565, 771,  
 800, 1054, 1061, 1089, 1336, 1502, 1572, 1575  
 Simpson, Michael A. 1424  
 Simpson, N. F. 1197  
 Sindermann, Carl J. 1406  
 Singer, Charles 771, 892, 1337  
 Singer, June 1704  
 Singer, Kurt 1116  
 Singh, Jagjit 1698  
 Sinnott, E.W. 771  
 Sinsheimer, Robert L. 1447  
 Sir Joseph 94, 914  
 Sir Joseph Whemple 1071  
 Sissman, Louis Edward 1107  
 Sizzi, Francisco 1153  
 Skinner, B. F. (Burrhus Frederick) 1550  
 Skinner, Burrhus Frederick 1416  
 Skinner, Cornelia Otis 481  
 Skinner, Frank W. 429  
 Skolimowski, Henryk 1416, 1614  
 Skwara, T. 566  
 Slater, John C. 1614  
 Sleator, William 566  
 Slichter, Chas. S. 419  
 Slobodkin, Lawrence B. 1467  
 Slonim, Morris James 151, 1268  
 Slosson, Edwin E. 184, 399, 753, 853, 1337, 1614  
 Smart, Christopher 99, 1555  
 Smedley, F. E. 538  
 Smellie, William 962  
 Smiles, Samuel 259  
 Smit, Eefke 1495  
 Smith, Adam 1337  
 Smith, Adam (George J. W. Goodman) 1020  
 Smith, Bertha Wilcox 47  
 Smith, Betty 251  
 Smith, Beverly 1250  
 Smith, David 1229  
 Smith, David Eugene 853  
 Smith, E. E. 1067  
 Smith, George Otis 538, 1467  
 Smith, Godfrey 924  
 Smith, Goldwin 589  
 Smith, Henry J. S. 104, 604, 1133

- Smith, Henry Preserved 1337  
 Smith, Homer W. 433, 1253, 1447  
 Smith, J. B. L. 51  
 Smith, John Pye 589  
 Smith, Langdon 30, 481  
 Smith, Logan Pearsall 732, 1480, 1516, 1547, 1693  
 Smith, Miles 608  
 Smith, R. B. 427  
 Smith, Reginald H. 1542  
 Smith, Robert Angus 140  
 Smith, Robertson 650  
 Smith, Sydney 104, 140, 1337  
 Smith, Theobald 363, 732, 1253  
 Smith, W. B. 854  
 Smith, Walter Chalmers 251  
 Smith, Willard A. 427  
 Smith, William 566  
 Smith, William Jay 76  
 Smithers, Sir David 200  
 Smokler, H. E. 1182  
 Smolin, Lee 180, 1337  
 Smollett, Tobias George 539, 903, 924, 1107  
 Smoot, George 165, 556, 1472, 1698  
 Smullyan, Raymond 17, 107, 618, 957  
 Smuts, Jan Christiaan 772, 1693  
 Smuts, Jan Christian 1660  
 Smyth, Francis Scott 371  
 Smyth, H. D. 1374  
 Smyth, Nathan A. 998, 1337  
 Smythe, Daniel 58, 910, 1517  
 Snedecor, G. W. 1525  
 Nelson, Kenneth 140  
 Snicket, Lemony (Daniel Handler) 1717  
 Snow, Charles Percy 251, 401, 419, 539, 753, 1134, 1337, 1376, 1401, 1430, 1447, 1584  
 Snyder, Carl H. 732  
 Snyder, Gary 168, 434  
 Snyder, Solomon 500  
 Sobel, Dava 621  
 Sober, Elliott 256  
 Sockman, Ralph W. 732  
 Soddy, Frederick 140, 255, 396, 406, 732, 739, 1337  
 Södergran, Edith 669  
 Sollas, William Johnson 589, 597  
 Solzhenitsyn, Aleksandr Isayevich 428, 881  
 Somerville, Mary 125, 279, 618, 634, 854, 1337, 1476  
 Sommerfield, Arnold 436, 776, 1620  
 Sontag, Susan 384, 669  
 Sophocles 181, 892, 935, 1224, 1584  
 Sorokin, Pitirim A. 1338  
 Soulé, Michael E. 1584  
 Sousa, Wayne 978  
 South, Robert 1186  
 Southerne, Thomas 639  
 Southgate, Theresa 1164  
 Spallanzani, Lazzaro 1447  
 Spark, Muriel 1338  
 Spaulding, Albert C. 90, 94  
 Spearman, Charles 892  
 Speiser, A. 854  
 Spencer, Herbert 481, 566, 635, 661, 732, 772, 999, 1081, 1089, 1338, 1363, 1374, 1380, 1428, 1457  
 Spencer, Lilian White 288, 289, 290  
 Spencer, Theodore 887  
 Spencer-Brown, George 428, 854, 1236, 1338, 1595, 1660  
 Spengler, Oswald 854, 1542  
 Spengler, Sylvia J. 167  
 Spenser, Edmund 41, 127, 803, 999, 1517, 1646, 1693, 1698  
 Sperry, Roger Wolcott 1393  
 Spilhaus, Athelstan 1045  
 Spinoza, Baruch de 203  
 Sporn, Philip 428  
 Sprat, Thomas 706  
 Squire, John Collings 800  
 St. Bernard of Clairvaux 1646  
 St. Clair, George 953  
 St. John, Nicholas 7  
 Stabler, E. Russell 855  
 Stace, C. 1575  
 Stace, Walter Terence 1394  
 Stackman, Elvin 449  
 Stalin, Joseph 419, 1542  
 Stallo, John Bernard 406  
 Stallone, Sylvester 855  
 Stamaty, Mark Alan 1542  
 Stamp, Josiah 151, 321, 1525, 1542  
 Standage, Tom 1142  
 Standen, Anthony 177, 235, 392, 776, 784, 892, 1116, 1134, 1447  
 Stanhope, Charles 618  
 Stanier, R. Y. 481  
 Stanislaus, Leszczynski (Stanislaus I) 1338  
 Stansfield, William D. 1338, 1415  
 Stanton, Elizabeth Cady 1107  
 Stapledon, Olaf 1213, 1238, 1394, 1517  
 Stapp, Paul 25  
 Starkey, W. L. 419  
 Starling, E. H. 542  
 Starling, Ernest Henry 1138  
 Starr, Paul 903  
 Starr, Victor P. 1555  
 Stassen, Harold E. 419  
 Statius, Publius 287  
 Stedman, Edmund Clarence 140  
 Steef, Duncan 1725  
 Steele, Joel Dorman 407, 618, 949, 999

- Steen, Lynn Arthur 10  
 Steensen, Niels 160  
 Stein, Gertrude 1520  
 Steinbeck, John 104, 171, 650, 733, 800, 855, 904,  
     1036, 1220, 1646  
 Steiner, Rudolf 1621  
 Steinhardt, Paul 1682  
 Steinman, D. B. 192  
 Steinmetz, Charles Proteus 428, 855  
 Stekel, Wilhelm 1542  
 Stenger, Victor J. 500, 733, 1009, 1040, 1213, 1215,  
     1338, 1401, 1494, 1614, 1620  
 Stengers, I. 1328  
 Sterling, John 1646  
 Stern, S. Alan 1693  
 Sterne, Laurence 442, 650, 733, 791, 855, 1036, 1339,  
     1464, 1542  
 Sterrett, The Right Reverend Frank W. 419  
 Stetson, Harlan T. 443  
 Steve Banning 90  
 Stevens, Peter S. 1075  
 Stevens, Rosemary 1496  
 Stevenson, Adlai E. 140, 384, 999, 1584  
 Stevenson, Robert Louis 419, 539, 630, 1010, 1107,  
     1339, 1456, 1542, 1614, 1634, 1729  
 Steward, J. H. 1339  
 Stewart, Alan 151  
 Stewart, Dugald 855, 881  
 Stewart, Ian 618, 661, 733, 855, 881, 935, 1036, 1069,  
     1173, 1202, 1220, 1253, 1260, 1339, 1670  
 Stewart, R. W. 261  
 Stigler, Stephen M. 321, 1542  
 Stinton, D. 661  
 Stockbridge, Frank B. 171, 772  
 Stocking, Martha 935  
 Stoddard, Richard Henry 1044  
 Stoker, Bram 29, 1339  
 Stokes W. 1547  
 Stoll, Clifford 114  
 Stoller, Robert 254  
 Stone, David 1468  
 Stone, John 702  
 Stone, Marshall H. 856  
 Stone, Peter Bennet 1043  
 Stone, Richard O. 537  
 Stone, Samuel John 556  
 Stoney, George Johnstone 1020, 1557  
 Stoppard, Tom 17, 22, 140, 151, 322, 445, 539, 561, 618,  
     742, 1045, 1186, 1200, 1460, 1555, 1578, 1665  
 Stott, Henry G. 428  
 Stout, Rex 1542  
 Straus, Bernard 371  
 Strauss, Maurice B. 364, 1717  
 Streatfield, Mr. Justice Geoffrey 539  
 Street, Arthur 911  
 Streeter, B. H. (Burnett Hillman) 1394  
 Strehler, Bernard 325  
 Strindberg, August 21  
 Strindberg, Johann 917  
 Strong, Lydia 558, 1563  
 Struik, Dirk J. 856  
 Strunsky, Simeon 1542  
 Strutt, John William (Lord Rayleigh) 279, 397, 449,  
     577, 848, 1116, 1339  
 Struve, Otto 126  
 Stuart, A. 1536  
 Stuart, Copans A. 710  
 Student (William Sealy Gossett) 1188  
 Stuessy, Tod F. 1575  
 Stukeley, William 380  
 Stumpf, LaNore 1139  
 Sturluson, Snorri 1698  
 Sturtevant, A. H. 578  
 Sudarshan, E. C. 1174  
 Sudarshan, George 1612, 1621  
 Suess, Eduard 292, 1634  
 Sufi Creation Myth 1698  
 Suidas 341  
 Suits, C. G. 1363  
 Sukoff, Albert 1020  
 Sullivan, Arthur 439, 463, 527, 790, 824, 1065, 1180,  
     1268, 1553, 1603, 1638  
 Sullivan, John William Navin 3, 10, 177, 393, 733, 856,  
     1134, 1339, 1363, 1374, 1416  
 Sullivan, Louis Henry 99  
 Sullivan, Walter 1693  
 Süskind, Patrick 229  
 Sussmann, Hector 1614  
 Sutherland, Jr., Earl W. 1253  
 Sutton, Christine 977  
 Swann, Donald 631  
 Swann, William Francis Gray 580, 707, 856, 881, 999,  
     1339, 1693  
 Swartz, Norman 146  
 Swedenborg, Emanuel 1142  
 Swenson, Jr., Lloyd S. 501, 1340  
 Swift, Jonathan 70, 96, 114, 269, 688, 706, 733, 856,  
     881, 999, 1036, 1107, 1155, 1464, 1555, 1586,  
     1671  
 Swigert, Jack 108  
 Swimme, Brian 1694  
 Swinburne, Richard 1634  
 Swings, Pol 1472  
 Sydenham, Thomas 371, 904  
 Sylvester, James Joseph 21, 281, 293, 338, 449, 604,  
     699, 703, 706, 742, 857, 858, 859, 881, 961,  
     1036, 1067, 1173, 1202, 1204, 1224, 1459, 1468,  
     1481, 1578, 1594



- Syminges, John 544  
 Synge, John L. 650, 681, 733, 858, 881, 889, 941,  
 1020, 1494, 1614  
 Szasz, Thomas 311, 904  
 Szego, Gábör 858  
 Szent-Györgyi, Albert 211, 364, 407, 733, 772, 1054,  
 1197, 1224, 1253, 1447  
 Szilard, Leo 539, 1477
- T**
- Tabb, John Banister 39, 67, 290, 1458  
 Tagore, Rabindranath 785, 1011, 1142, 1407, 1517, 1698  
 Taine, Hippolyte 1151  
 Tait, Peter Guthrie 326, 887, 1448  
 Talbot, Michael 278, 1694  
 Tannery, Paul 1359  
 Tansley, A. G. 384, 539  
 Tarbell, Ida 547  
 Tasso, Torquato 269  
 Tate, Allen 1416  
 Tatishchev, Vasilii Nikitich 1340  
 Taton, René 364  
 Tatum, Edward 575, 1197  
 Taylor, A. W. 256  
 Taylor, Alfred Maurice 1448  
 Taylor, Angus E. 364, 444  
 Taylor, Ann 48  
 Taylor, Anne 1517  
 Taylor, Bayard 145, 552, 1044, 1517, 1646  
 Taylor, Calvin W. 707  
 Taylor, E. S. 278, 327, 428  
 Taylor, Edwin F. 1494  
 Taylor, Isaac 707  
 Taylor, Jeremy 1107  
 Taylor, John 1162  
 Taylor, Richard E. 1215  
 Taylor, Rod 18  
 Taylor, Walter W. 90, 94, 337, 1663  
 Tazieff, Haroun 1713, 1714  
 Tchekhov, Anton 1542  
 Teague, Jr., Freeman 1468  
 Teale, Edwin Way 56, 185, 325, 999, 1036  
 Teall, J. J. Harris 539, 678, 1340  
 Teall, Sir J. J. Harris 1614  
 Teasdale, Sara 288, 910, 1517  
 Teeple, John E. 229, 251  
 Teilhard de Chardin, Pierre 208, 275, 481, 887, 1055,  
 1134, 1142, 1151, 1394, 1660  
 Television Introduction 178  
 Teller, Edward 377, 407, 548, 858, 1256, 1340, 1468,  
 1671  
 Teller, Wendy 377, 548, 1340  
 Teller, Woolsey 618, 800, 1694  
 Temple, Frederick 618, 1340, 1394  
 Temple, G. 1340  
 Tenenbaum, G. 1173  
 Teng Mu 514  
 Tennant, F. R. 1416  
 Tennyson, Alfred (Lord) 37, 39, 43, 44, 67, 126, 141,  
 156, 221, 223, 259, 287, 289, 326, 481, 569, 572,  
 733, 910, 946, 999, 1044, 1057, 1143, 1151,  
 1157, 1266, 1340, 1401, 1457, 1461, 1481, 1517,  
 1555, 1646, 1694, 1713, 1729  
 Terborgh, John 166, 1498  
 Terence 221, 539, 1047, 1253  
 Teresi, Dick 190  
 Termier, Pierre 293, 758  
 Tertullian 1  
 Tesla, Nikola 141, 295, 887  
 Thackeray, William Makepeace 1646  
 Thagard, Paul 662, 695  
 Thaxter, Celia 43  
 Thayer, John H. 1156  
 The Arabian Nights 43  
 The Bible 25, 57, 221, 259, 284, 380, 382, 501, 544,  
 739, 777, 910, 925, 1021, 1036, 1107, 1186, 1245,  
 1253, 1456, 1472, 1517, 1647, 1698, 1724  
 The Editors 1543  
 The Federated American Engineering Society 428  
 The Hon. Mrs. Ward 1518  
 Theiler, Max 1734  
 Thesiger, Ernest 501  
 The X-Files 574, 772, 1134, 1481, 1634  
 Thiele, T. N. 1036  
 Thierry, Paul Henri, Baron d'Holbach 221, 800, 949, 999  
 Thom, René 604, 858, 882, 1340  
 Thomas, Dylan 777  
 Thomas, E. R. 1132  
 Thomas, Lewis 57, 65, 211, 325, 376, 443, 482, 506,  
 578, 679, 702, 742, 801, 859, 904, 1037, 1151,  
 1254, 1340, 1402, 1429, 1448, 1472, 1562, 1571,  
 1710  
 Thomas, R. S. 515  
 Thompson, A. R. 1341  
 Thompson, Dick 1714  
 Thompson, Elihu 539, 1254  
 Thompson, Francis 115, 208, 1060, 1518, 1694  
 Thompson, Hunter S. 141  
 Thompson, Jennifer 1672  
 Thompson, Jennifer Trainer 1568  
 Thompson, Silvanus P. 184, 199, 882, 1037  
 Thompson, Sir D'Arcy Wentworth 38, 235, 352, 490,  
 559, 859, 888, 926, 947, 1052, 1093, 1165  
 Thompson, W. R. 1571  
 Thompson, William Robin 1037  
 Thomson, J. Arthur 229, 251, 274, 402, 462, 482, 619,  
 636, 695, 696, 782, 888, 1000, 1053, 1341, 1394,  
 1409, 1419, 1481, 1564

- Thomson, James 44, 269, 287, 624, 630, 639, 641, 662, 1000, 1499, 1518, 1710
- Thomson, Sir George 501, 678, 733, 1342, 1368, 1416, 1660
- Thomson, Sir George Paget 10, 393, 1718
- Thomson, Sir Joseph John 364, 388, 446, 447, 888, 1116, 1243
- Thomson, Thomas 251, 949
- Thoreau, Henry David 21, 36, 51, 52, 74, 96, 115, 126, 184, 208, 221, 251, 274, 325, 326, 364, 386, 431, 434, 436, 443, 509, 539, 552, 619, 678, 733, 739, 859, 919, 952, 969, 1000, 1037, 1044, 1107, 1152, 1168, 1205, 1342, 1363, 1379, 1380, 1429, 1468, 1473, 1488, 1518, 1543, 1555, 1584, 1634, 1647, 1694, 1719, 1721, 1729
- Thorn, John 1543
- Thorne, Kip S. 159, 180, 346, 393, 636, 785, 905, 1038, 1167, 1241, 1254, 1342, 1448, 1481, 1494, 1518, 1631, 1695
- Thring, Meredith Wooldridge 420, 428
- Thucydides 221
- Thudichum, J. L. W. 1052
- Thurber, James 197, 322, 371, 388, 681, 946, 1343, 1525
- Thurlow, Lord Edward, 1st Baron Thurlow 1001
- Thurston, William Paul 859
- Thurstone, Louis Leon 1197, 1543
- Tibshirani, Robert J. 1532
- Tiffany, Lewis 177
- Till, Irene 704
- Tillich, Paul 141, 1394
- Tillotson, John 1187
- Tillyard, E. M. W. 1380, 1566
- Timiryazev, K. A. 650, 734
- Ting, Samuel C. C. 1448
- Tinker, John F. 105
- Tinkler, Keith J. 605
- Tipler, Frank 1045, 1175, 1489
- Tippett, L. C. 322, 1707
- Titchener, Edward Bradford 274, 501, 753
- Todhunter, Isaac 126, 860
- Toepffer, Rodolphe 590
- Toffler, Alvin 1162, 1187, 1584
- Tolkien, J. R. R. 1448
- Tolman, Edward Chance 503
- Tolman, R. C. 298
- Tolstoy, Alexei 946
- Tolstoy, Leo 199, 208, 222, 269, 311, 556, 688, 753, 860, 1343, 1660
- Tombaugh, Clyde 678, 1143
- Tomlinson, C. 300
- Tomlinson, Henry Major 882
- Tomonaga, Sin-Itiro 1001
- Toogood, Hector B. 1590
- Topsell, Edward 48, 58, 66
- Torrance, Thomas F. 1089
- Torrey, Ray Ethan 482
- Toulmin, Stephen 662, 1071, 1089, 1116, 1167, 1448, 1615, 1729
- Towne, Lisa 291
- Townes, Charles H. 1698
- Townsend, Joseph 590
- Townson, Robert 252, 281, 1205
- Toynbee, Arnold J. 1090, 1343, 1376, 1395, 1660, 1694
- Traube, Moritz 400
- Trautman, Andrzej 436
- Travers, Pamela Lyndon 1518
- Tredgold, Thomas 428
- Trefethen, Joseph M. 590
- Trefil, James 1213, 1220
- Trevelyan, George Macaulay 482, 1518
- Trevelyan, George Otto 860
- Trevor, J. E. 252
- Trilling, Lionel 669, 1229
- Trimble, George S. 1421
- Trimble, V. 1694
- Trivers, Robert 169
- Trollope, Anthony 1543, 1660
- Trotter, Wilfred 26, 662, 1419
- Trotter, William 734
- Trudeau, Edward 312
- Trudeau, Richard J. 860
- Truesdell, Clifford 1134, 1566, 1578, 1594, 1595, 1620
- Trumbull, John 17, 126
- Truzzi, Marcello 1203
- Tsiolkovsky, Konstantin Eduardovich 515, 1476, 1481, 1550, 1590
- Tucker, Abraham 662
- Tucker, Albert W. 860
- Tucker, Karen 734
- Tucker, Wallace 734
- Tucker, Wilson 1343
- Tudge, Colin 1343
- Tufte, Edward R. 621
- Tukey, John W. 22, 443, 860, 1012, 1164, 1526, 1543, 1579
- Tumin, Melvin 308
- Tupper, Kerr Boyce 1108
- Tupper, Martin Farquhar 443
- Turgenev, Ivan 235, 1001
- Turing, Alan 343
- Turnbull, Charles D. 961
- Turnbull, Herbert Westren 860
- Turner, H. H. 269, 449, 1359
- Turner, Michael S. 165, 1615, 1694
- Turner, William 1159
- Turney, John 1061
- Turok, Neil G. 298

- Tuttle, Hudson 1001, 1634, 1709  
 Twain, Mark (Clemens, Samuel Langhorne) 706, 707, 743  
 Twain, Mark (Samuel Langhorne Clemens) 29, 35, 36, 45, 48, 57, 62, 67, 69, 70, 71, 73, 77, 82, 86, 106, 115, 126, 151, 224, 269, 287, 290, 326, 331, 333, 348, 349, 350, 364, 371, 380, 401, 451, 482, 490, 501, 540, 548, 590, 593, 607, 619, 627, 630, 652, 662, 694, 777, 790, 860, 904, 927, 962, 1001, 1047, 1063, 1076, 1157, 1159, 1168, 1223, 1260, 1262, 1343, 1364, 1448, 1468, 1501, 1518, 1543, 1560, 1586, 1615, 1647, 1714, 1729  
 Tymoczko, Thomas 1203  
 Tyndall, John 141, 155, 407, 503, 540, 590, 678, 780, 949, 1395  
 Tyron, E. P. 1694
- U**  
 Ulam, Stanislaw 177, 861, 1134, 1452  
 Umbgrove, J. H. F. 590  
 Umov, N. A. 407  
 Union Carbide and Carbon 1343  
 United Nations Treaty on the Exploration and Use of Space 1058  
 University of California, Berkeley 1449  
 Unsold, Albrecht 1223  
 Updike, John 84, 165, 346, 348, 573, 619, 772, 888, 919, 1009, 1084, 1476, 1519, 1555, 1698, 1720  
 Upgren, Arthur 1472  
 Upton, Winslow 114  
 Ure, Andrew 1052  
 Urey, Harold Clayton 1343, 1501, 1635  
 US Army Corps of Engineers 420  
 Uspenskii, Petr Demianovich 346  
 Uzor 1660
- V**  
 Vaihinger, Hans 141, 1660  
 Valentine, Alan 365  
 Valentinus, Basilius 397  
 Valéry, Paul 540, 781, 1343, 1374, 1395, 1419, 1494, 1568  
 van't Hoff, Jacobus Henricus 252, 709, 1056  
 van Beneden, P. J. 1068  
 van Bergeijk, W. A. 166, 772  
 van de Hulst, H. C. 1501  
 van de Kamp, Peter 443  
 van der Gracht, W. A. 1063  
 van der Post, Laurens 1544  
 van der Riet Wooley, Sir Richard 1489  
 van Dine, S. S. 1592  
 van Fraassen, Bas C. 1090, 1615  
 van Gogh, Vincent Willem 548, 688, 742, 1519  
 van Belmont, Jean-Baptista 252, 1717  
 van Hise, Charles R. 590, 597  
 van Leeuwenhoek, Antony 80, 734, 917, 1661  
 van Noordwijk, A. J. 1255  
 van Sant, Gus 1135  
 Van Sloan, Edward 1556  
 Varese, Edgar 1449  
 vas Dias, Robert 1481  
 Vash 1344  
 Vaughan, Henry 445, 1519  
 Veblen, Oswald 604, 861, 882, 1594  
 Veblen, Thorstein 274, 322, 1254  
 Vehrenberg, Hans 1590  
 Velikovskiy, Immanuel 678  
 Venn, John 151, 861  
 Verhoeven, Cornelis 1725  
 Vernadskii, Vladimir Ivanovich 365, 1344, 1449  
 Verne, Jules 198, 365, 396, 420, 506, 591, 929, 946, 1344, 1456, 1489, 1719  
 Vernon, A. G. 1704  
 Verworn, M. 650  
 Vesalius, Andreas 1496  
 Vezzoli, Dante 1591  
 Victim, A. 430  
 Vidal, Gore 1056  
 Viereck, George S. 371, 861  
 Vincenti, Walter G. 336, 1664  
 Virchow, Rudolf Ludwig Karl 371, 540, 543, 578, 904, 1072, 1108, 1220, 1344, 1395, 1421  
 Virgil 126, 208, 269, 444, 910, 1021, 1635, 1714  
 Vitaliano, Dorothy 201  
 Vitousek, Peter Mooney 1152  
 Vitruvius 96  
 Vivilov, N. I. 1570  
 Vizinczey, Stephen 1152  
 Vogel, Steven 171  
 Vogt, Carl 191, 963  
 Volkov, Evgenii I. 934  
 Vollmer, James 420  
 Voltaire (François-Marie Arouet) 126, 330, 559, 604, 678, 754, 861, 1001, 1108, 1143, 1152, 1187, 1344  
 Volterra, Vito 1617  
 von Baer, Carl Ernst 1344  
 von Baeyer, Adolf 490, 501, 1001  
 von Baeyer, Hans Christian 141, 734, 940, 1001, 1135, 1214  
 von Bertalanffy, Ludwig 278, 1368  
 von Bitter Rucker, Rudy 1481  
 von Braun, Wernher 515, 619, 624, 679, 681, 1254, 1481, 1489, 1491, 1730  
 von Brücke, Ernst 1586  
 von Bubnoff, S. 662, 1264  
 von Buch, L. 734, 1063  
 von Clausewitz, Carl 1187

- von Ebner-Eschenbach, Marie 669, 1108  
 von Euler, Hans 252  
 von Frisch, Karl 552, 1344, 1449  
 von Goethe, Johann Wolfgang 99, 104, 181, 314, 326,  
 365, 443, 501, 637, 650, 698, 734, 759, 862, 882,  
 904, 914, 929, 1001, 1037, 1045, 1053, 1055,  
 1116, 1135, 1160, 1236, 1344, 1354, 1364, 1368,  
 1408, 1421, 1550, 1570, 1571, 1615, 1640, 1695  
 von Haller, Albrecht 688  
 von Helmholtz, Hermann 365, 388, 407, 443, 515, 540,  
 663, 735, 754, 777, 862, 888, 893, 1236, 1364,  
 1635  
 von Humboldt, Alexander 270, 541, 556, 742, 773, 924,  
 1037, 1063, 1160, 1187, 1345  
 von Karman, Theodore 420  
 von Lenard, Philipp E. A. 365  
 von Liebig, Justice 1051  
 von Liebig, Justus 6, 155, 235, 252, 365, 767, 1005,  
 1037, 1200, 1222, 1254, 1369  
 von Lindemann, Louis Ferdinand 141  
 von Lommel, Eugen 1410  
 von Meyer, Ernst 252  
 von Mises, Ludwig 1408  
 von Mises, Richard 908, 1187, 1544  
 von Neumann, John 153, 264, 432, 636, 862, 935, 1369  
 von Schelling, Friedrich Wilhelm Joseph 252, 1003  
 von Schlegel, Friedrich 504, 863, 1380  
 von Siemens, Werner 365, 1003  
 von Weizsäcker, Carl Friedrich (Baron) 142, 1135  
 von Zittel, Karl Alfred 591  
 Vooley, Hollis R. 863  
 Voorhees, Irving Wilson 684  
 Vyasa 1635
- W**
- Wächtershäuser, Günter 758, 1055  
 Waddell, John Alexander Low 428  
 Waddington, Conrad Hal 735, 924, 967, 1345, 1374,  
 1615, 1707  
 Wade, Nicholas 1145, 1239, 1275, 1426  
 Waismann, Friedrich 863, 1021  
 Waite, A. E. 399  
 Wakefield, Priscilla 187  
 Waksman, Selman A. 915, 1256, 1548  
 Walcott, Charles D. 593, 1003  
 Walcott, Derek 115, 1544  
 Wald, George 483, 501, 593, 773, 940, 1116, 1229,  
 1345, 1449, 1575  
 Walgate, Robert 1229  
 Walis, Claudia 209  
 Walker, Eric A. 420, 429  
 Walker, John 735, 1003  
 Walker, Kenneth 334, 667, 743, 914, 1200, 1220, 1671  
 Walker, Marshall 213, 1564  
 Walker, Marshall John 559, 935, 1187, 1544  
 Walker, Ruth A. 743  
 Wall, Hubert Stanley 863  
 Wallace, Alfred Russel 35, 82, 444, 504, 509, 591, 663,  
 735, 801, 967, 1055, 1155, 1262, 1498, 1661  
 Wallace, David Rains 483  
 Wallace, Henry A. 1377  
 Wallace, Lew 161  
 Wallace, Robert C. 142  
 Waller, William H. 506  
 Wallin, Ivan E. 155, 483, 967, 1564  
 Walsh, John E. 330  
 Walshe, Sir F. M. R. 1449  
 Walters, Marcia C. 950  
 Walther, Hans 882  
 Walther, Johannes 336  
 Walton, Izaak 51, 60, 63, 630, 864, 1718  
 Walz-Chojnacki, Grey 160  
 Wang, Chamont 156, 1526, 1544  
 Ward, Artemus (Charles Farrar Browne) 889  
 Ward, Barbara 384  
 Ward, Edward 420  
 Ward, Fred 108  
 Ward, Henshaw 888  
 Ward, Lester Frank 444, 1003  
 Ward, Peter D. 1160, 1203  
 Warner, Charles Dudley 1003  
 Warner, Sylvia Townsend 198, 605, 864, 1161, 1568  
 Warrain, Francis 605  
 Warren, Henry White 127, 450, 777  
 Warren, Robert Penn 790, 1708  
 Washburn, Mark 1155  
 Washington, Henry S. 259  
 Waterman, Alan T. 1345  
 Watson, Alfred N. 444  
 Watson, David Lindsay 1345  
 Watson, James D. 483, 575, 773, 1345  
 Watson, Janet 1264  
 Watson, Lyall 566  
 Watson, Sir William 1060, 1562  
 Watts, Alan Wilson 275, 282, 326, 483, 667, 773, 1004,  
 1460  
 Watts, Isaac 288  
 Waugh, Evelyn 333, 1544  
 Weaver, Jefferson Hane 1443  
 Weaver, Tom 1556  
 Weaver, Warren 177, 695, 743, 864, 1345, 1429  
 Webb, Charles Henry 1045  
 Webb, Jack 541  
 Webb, Jimmy 1058  
 Webb, Mary 57  
 Webber, Charles Wilkins 1004  
 Weber, Max 663, 1346, 1430  
 Weber, Robert L. 1254

- Webster, Arthur Gordon 344  
 Webster, John 19, 864, 1108  
 Wegener, Alfred 293, 606, 1661  
 Weidlein, Edward Ray 663, 924, 1419  
 Weierstrass, Karl 882  
 Weigall, Arthur Edward 90, 94, 1072  
 Weil, André 864, 882  
 Weil, Simone 17, 161, 557, 619, 864, 1197, 1346, 1419, 1449, 1519, 1635, 1661  
 Weinberg, Alvin Martin 781, 1449, 1579  
 Weinberg, Gerald M. 198  
 Weinberg, R. A. 940  
 Weinberg, Steven 165, 365, 502, 883, 924, 1070, 1135, 1229, 1346, 1402, 1615, 1661, 1695, 1698  
 Weiner, Jonathan 261, 1496  
 Weingarten, Violet 709, 1464  
 Weisburd, Stefi 308, 509  
 Weismann, August 651  
 Weiss, Paul A. 940, 1346, 1450  
 Weisskopf, Victor Frederick 314, 393, 663, 736, 935, 1090, 1116, 1220, 1254, 1346, 1359, 1402, 1419, 1426, 1450  
 Weisz, Paul B. 171, 1045, 1416  
 Welch, Lew 1671  
 Weldon, Fay 165  
 Weller, Stuart 801  
 Wellington, Arthur Mellen 429  
 Wells, Carolyn 71, 75, 79, 1254  
 Wells, H. G. (Herbert George) 3, 94, 142, 143, 200, 252, 270, 333, 346, 407, 483, 515, 541, 566, 570, 663, 678, 773, 788, 864, 911, 927, 950, 1004, 1006, 1037, 1072, 1135, 1152, 1236, 1255, 1264, 1347, 1359, 1364, 1411, 1416, 1421, 1429, 1450, 1489, 1519, 1526, 1544, 1555, 1579, 1616, 1635, 1637, 1701  
 Welsh, Joan I. 18  
 Welty, Eudora 669  
 Werner, Alfred 252  
 West, Jessamyn 541  
 West, Mae 7, 315  
 West, Philip 236  
 Westaway, Frederic William 865, 1037  
 Westbroek, Peter 21  
 Westfall, Richard S. 580  
 Weston-Smith, Miranda 665  
 Weyl, Hermann 127, 153, 297, 502, 605, 754, 756, 785, 865, 883, 888, 1004, 1173, 1229, 1243, 1347, 1379, 1450, 1481, 1568, 1593, 1661, 1729  
 Whaling, Thornton 1395  
 Wharton, Edith 1695  
 Wharton, William 605  
 Whatley, Richard 541  
 Wheeler, Edgar C. 1351  
 Wheeler, Hugh 1586  
 Wheeler, John Archibald 161, 165, 180, 278, 293, 326, 393, 486, 624, 663, 678, 754, 758, 785, 1004, 1037, 1038, 1116, 1135, 1167, 1214, 1230, 1255, 1347, 1481, 1494, 1635, 1695  
 Wheeler, Sir Mortimer 90, 94, 344, 485  
 Wheeler, William Morton 29, 169, 430, 1707, 1737  
 Wheelock, John 1165  
 Wheelock, John Hall 1380  
 Whetham, Sir William Cecil Dampier 866, 1347  
 Whewell, William 10, 252, 281, 328, 366, 444, 490, 541, 557, 591, 605, 624, 651, 663, 736, 754, 866, 917, 963, 1267, 1347, 1359, 1374, 1395, 1450, 1616, 1661, 1726  
 Whipple, E. P. 580  
 Whipple, Fred L. 1152, 1489  
 Whipple, George H. 25, 1661  
 Whitcomb, J. 619  
 White, Andrew Dickson 1395  
 White, Arthur 1203  
 White, Bailey 1264  
 White, Gilbert 32, 34, 187, 696, 1056, 1708  
 White, H. E. 1500  
 White, Henry Kirke 288, 1635  
 White, Henry S. 1616  
 White, J. F. 736  
 White, Leslie Alvin 1348  
 White, Stephen 1117  
 White, Terence Hanbury 48  
 White, Timothy 483  
 White, William Frank 866, 883, 1545  
 White, William Hale (Mark Rutherford) 127  
 Whitehead, Alfred North 3, 22, 68, 87, 104, 177, 274, 281, 298, 328, 344, 347, 366, 371, 386, 393, 444, 483, 502, 541, 651, 663, 683, 688, 695, 698, 700, 706, 736, 754, 773, 777, 779, 785, 801, 866, 888, 892, 962, 963, 1004, 1012, 1038, 1051, 1077, 1084, 1090, 1093, 1135, 1187, 1200, 1203, 1207, 1230, 1236, 1244, 1348, 1354, 1360, 1364, 1369, 1396, 1408, 1420, 1450, 1482, 1545, 1566, 1593, 1616, 1624, 1636, 1705  
 Whitehead, Hal 127  
 Whitehead, J. H. C. 861  
 Whitesides, George M. 390, 775, 937, 1049, 1227  
 Whitman, Walt 34, 115, 142, 227, 270, 288, 506, 557, 950, 1005, 1045, 1057, 1070, 1072, 1152, 1380, 1472, 1482, 1519, 1555, 1695  
 Whitney, Willis Rodney 231, 314, 1255, 1364, 1450, 1704  
 Whitrow, G. J. 678, 1636  
 Whittaker, R. H. 711  
 Whittaker, Sir Edmund 624  
 Whittier, John 420  
 Whyte, A. Gowans 570, 1136, 1501  
 Whyte, Lancelot Law 541, 801, 958, 1187, 1348

- Wickenden, W. E. 421  
 Wickham, Anna (Edith Alice Mary Harper) 1569  
 Wiechert, Emil 1695  
 Wieland, Heinrich O. 253  
 Wiener, Norbert 384, 432, 449, 543, 570, 868, 883,  
 1117, 1136, 1354, 1403, 1451  
 Wiesner, Jerome Bert 1197  
 Wiggins, Lynda 659  
 Wigglesworth, Sir Vincent B. 366  
 Wightwick, George 96  
 Wigner, Eugene Paul 127, 421, 432, 703, 756, 868,  
 1136, 1236, 1348, 1526, 1545  
 Wikström, J. E. 1451  
 Wilber, Ken 484  
 Wilcox, Ella Wheeler 60, 552, 928, 1520  
 Wilczek, Frank 1136  
 Wildavsky, A. 1288  
 Wilde, Oscar 94, 99, 145, 152, 161, 227, 333, 490, 542,  
 552, 664, 681, 709, 773, 1005, 1067, 1188, 1220,  
 1349, 1396, 1458, 1520, 1579, 1593, 1661  
 Wilder, Raymond L. 3, 868  
 Wilder, Thornton 341, 669, 1188, 1451  
 Wiles, Andrew 545, 868  
 Wiley, E. O. 581  
 Wiley, Harvey W. 253  
 Wiley, Jr., John P. 263  
 Wiley, R. B. 415  
 Wilf, Alexander 1451  
 Wilford, John Noble 105, 349  
 Wilford, Noble John 361  
 Wilkins, Bishop John 548  
 Wilkins, John 1489, 1662  
 Wilkins, Maurice 1585  
 Willerding, Margaret F. 868  
 Willey, Gordon R. 90, 94, 684  
 Williams, Carol 552  
 Williams, Charles 868, 1021  
 Williams, Dafydd (Dave) Rhys 946  
 Williams, G. H. 591  
 Williams, Horatio B. 868  
 Williams, L. Pearce 1360  
 Williams, Sarah 1520  
 Williams, Tennessee 1705  
 Williams, W. 1243  
 Williams, W. H. 347  
 Williams, William Carlos 904  
 Williamson, Marianne 711  
 Willis, Bailey 292  
 Willis, Connie 1407  
 Willis, John Christopher 484  
 Willis, Nathaniel Parker 42  
 Willm, Pierre 1454  
 Willstätter, Richard 366, 502, 1005, 1360  
 Wilmot, John (2nd Earl of Rochester) 1699  
 Wilson, David Scofield 434, 1005  
 Wilson, Edmund 679  
 Wilson, Edward O. 54, 57, 65, 73, 167, 171, 178, 384,  
 434, 449, 484, 619, 664, 736, 754, 954, 957, 969,  
 1068, 1081, 1349, 1402, 1451, 1616, 1662  
 Wilson, Edwin B. 914, 1545  
 Wilson, J. A. 91  
 Wilson, John 1266  
 Wilson, John Tuzo 293, 1161  
 Wilson, Jr., E. Bright 1038, 1197, 1255, 1257  
 Wilson, Logan 1424  
 Wilson, Paul A. 95, 97  
 Wilson, Robert Q. 308  
 Wilson, Sir Daniel 1168  
 Wiltshire, John 669  
 Winchell, Alexander 270, 591, 1005, 1152, 1482, 1616  
 Winkler, C. 230  
 Winne, Harry A. 421  
 Winsor, Dorothy A. 421, 429  
 Winsor, Frederick 557, 569, 868  
 Wintrobe, Maxwell M. 635  
 Wisconsin Society of Ornithology 41  
 Wisdom, John O. 1616  
 Wise, William 349, 351  
 Wissler, C. 91  
 Witt, Otto N. 739, 1476  
 Wittgenstein, Ludwig Josef Johann 97, 99, 184, 198,  
 230, 366, 517, 542, 580, 651, 664, 688, 785, 868,  
 883, 950, 1220, 1349, 1411, 1452, 1591, 1624,  
 1636, 1671  
 Wittig, Georg 1255  
 Wodehouse, P. G. 301, 344  
 Wöhler, Friedrich 1005, 1038, 1051, 1053, 1704  
 Wohlforth, Charles 261, 625  
 Wolcot, John 301  
 Wolf, Fred Alan 394, 573, 692, 1214  
 Wolfe, Humbert 915  
 Wolfe, Steven 1491  
 Wolfe, Thomas 1464  
 Wolfenden, John Frederick 1727  
 Wolfowitz, J. 1545  
 Woll, Matthew 1502  
 Wolpert, Lewis 274, 505, 574, 936, 1349, 1402, 1416,  
 1452  
 Wonnacott, Ronald J. 1545  
 Wood, John George 57, 917  
 Wood, Robert William 45, 77, 78, 431  
 Woodbridge, Frederick James Eugene 1005, 1616, 1671  
 Woodford, F. Peter 1501  
 Woodger, Joseph Henry 169, 178, 322, 1054, 1616  
 Woodson, Thomas T. 82, 192, 421  
 Woodward, Robert Burns 1570  
 Woodward, Robert Simpson 591, 1188  
 Woolf, Virginia 333, 669, 869

- Woolgar, S. 1407  
 Woolley, Richard 1264  
 Woolley, Sir Charles Leonard 345, 546, 1424, 1469  
 Woosley, Stan 1556  
 Wooten, Henry 194  
 Wordsworth, William 29, 40, 44, 46, 59, 115, 142, 181, 373, 381, 382, 552, 597, 605, 892, 1005, 1045, 1108, 1255, 1349, 1364, 1374, 1520, 1591, 1647, 1729  
 Wren, Sir Christopher 352, 1489  
 Wright, Charles R. A. 1579  
 Wright, Chauncey 542, 1090, 1349, 1662  
 Wright, Frances 736, 1236  
 Wright, Frank Lloyd 97, 100, 788, 869, 1349, 1468  
 Wright, Harold Bell 421  
 Wright, Helen 314  
 Wright, Jim 778  
 Wright, Orville 366  
 Wright, R. D. 1038  
 Wright, Robert 967  
 Wright, Thomas 115, 146, 303, 352, 366, 573, 664, 869, 919, 1006  
 Wright, Wilbur 444  
 Writer undetermined 193  
 Wu, Chien-Shiung 162  
 Wurtz, Charles Adolphe 253, 1617  
 Wyatt, Mrs. James 100  
 Wycherley, William 1207  
 Wyllie, Peter J. 1079  
 Wyndham, John 1617  
 Wynne, Annette 1737  
 Wynter, Dr. 1169  
 Wysong, R. L. 142
- X**
- Xenophanes 1555
- Y**
- Yalow, Rosalyn 802, 1197  
 Yang, Chen Ning 1051, 1214, 1255, 1569  
 Yates, Frances 1349, 1522, 1545  
 Ya Vilenkin, N. 692  
 Yavne, Moshe 1014  
 Yeats, William Butler 1230, 1255, 1520, 1636, 1702  
 Yentsch, Clarice M. 1406  
 Yeo, R. 1562
- Yogananda, Paramahansa 1006  
 Yorke, James 227  
 Young, Arthur 371, 1108  
 Young, Edward 115, 270, 288, 445, 889, 904, 1006, 1520  
 Young, John 108  
 Young, John Wesley 869  
 Young, John Zachary 3  
 Young, Joshua 777, 950  
 Young, Louise B. 773, 801, 1152, 1167, 1238, 1456, 1696  
 Young, Michael Dunlop 169  
 Young, Roland 38, 42, 62, 66, 68, 70, 75  
 Young, Thomas 1047  
 Young John Zachary 191, 957, 1007, 1452  
 Yourcenar, Marguerite 703, 801  
 Yudowitch, K. L. 12  
 Yukawa, Hideki 803  
 Yule, G. U. 1526
- Z**
- Zagier D. 1173  
 Zamyatin, Yevgeny 343, 952, 1735  
 Zebrowski, George 688, 1636, 1696  
 Zee, Anthony 624, 777, 1214, 1381, 1569  
 Zeeman, Pieter 1735  
 Zeilberger, Doron 869  
 Zelazny, Roger 869  
 Zeldovich, Yakov Borisovich 165, 297, 619  
 Zelinsky, Wilbur 1402  
 Zener, Clarence 421  
 Zevi, Bruno 91, 97, 100  
 Zihlman, Adrienne 1245  
 Ziliak, S. T. 1522  
 Ziman, John M. 372, 620, 736, 1136, 1349, 1354, 1408, 1424, 1617, 1664  
 Zimmerman, E. C. 372  
 Zimmerman, Michael 1417  
 Zinkernagel, Rolf M. 1221, 1349  
 Zinsser, Hans 371, 502, 1038, 1350  
 Zirin, Harold 1556  
 Zirker, Jack B. 383  
 Zolynas, Al 1117  
 Zoman, John M. 1239  
 Zubrin, Robert 1482  
 Zukav, Gary 1136  
 Zuni Creation Myth 1699  
 Zwicky, Fritz 1591

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**Volume II**



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Universe, and Zoology**

**Carl C. Gaither**

*BA (Psychology), MA (Psychology), MA (Criminal Justice), MS (Mathematical Statistics)*

and

**Alma E. Cavazos-Gaither**

*BA (Spanish)*

**Volume II**

**Medicine and Art – Zoology**



**Springer**

Carl C. Gaither  
502 Weiss Drive  
Killeen, Texas 76542

Alma E. Cavazos-Gaither  
502 Weiss Drive  
Killeen, Texas 76542

ISBN: 978-0-387-49575-0

e-ISBN: 978-0-387-49577-4

Library of Congress Control Number: 2007938494

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***This book is dedicated to***

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***And to the memory of***

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# Preface

In putting before you, the reader, this collection of 18,000 quotations it seems fitting to discuss how a book such as this came about. In 1995 I told a librarian friend that I was deeply frustrated in my attempts to find quotations on statistics. I told her that although there were a few books with some quotations available, it was quite clear that each author had very different opinions of how to approach the subject. For example, both Alan Mackay and Isaac Asimov wrote books of science quotations that were organized thematically, but in them the quotations were often misstated and the documentation sparse or nonexistent. The books were, however, the state of the art for that time. Another example, Maurice B. Strauss's book *Familiar Medical Quotations*, provided good documentation but, understandably, the quantity of quotations pertaining to science as compared to medicine was limited. As I explained the failings of the extant literature, my friend looked up from her desk and quietly asked, "Well, why don't you compile one?"

I took this idea to my wife, who agreed to work with me on this task. Over a ten-year period we wrote a series of books that contained quotations from several fields of science. These books came to be known as the Speaking Series (Institute of Physics Publishing, Bristol, UK) and were written, like the current revised and greatly expanded compendium, for a broad audience of scientists as well as lay people like ourselves who do not claim expertise in the many scientific fields.

Science is a dynamic force in virtually every sphere of life. At this the beginning of the twenty-first century, few readers will need to be convinced of the enormous impact of science on art, politics, literature, commerce, education, communications, entertainment, judiciary matters, and—often intensely—on religion, and ethics. It is our opinion that the average reader of this book—whether engineer or technician, architect or artist, doctor or nurse, physicist or astronomer, poet or novelist, mathematician or statistician, teacher or student, atheist or believer—should find a great number of quotations pertaining to his or her individual interest. Furthermore, the juxtaposition of the many views may be thought-provoking.

A dictionary normally consists of an alphabetical arrangement of words and their meanings. In this dictionary instead of words we give an alphabetical arrangement of over 2,000 *thematically* organized categories pertaining to science. Feedback from our previous books indicated that this format was preferred over an author-arranged selection of quotations. The presentation order of the quotations within each subject theme is alphabetical by author. Other quotations of a particular author can be found in the author index.

Our quotation choices were largely influenced by the availability of books, magazines, journals, and newspapers; in turn, to make it as simple as possible for the reader to obtain our sources, we provide our bibliographic references from what we hope are readily accessible sources. Also, for journal articles we strive to provide the actual page number where the quotation may be found, rather than

just the first page of the article in which the quotation appears. Brief biographical information (birth/death date and occupation) is given when at all possible. We were able to provide this contextual information because we were fortunate to have a publisher who did not deem the cost of including this information excessive.

The reader who needs to research a quotation in greater detail can use bibliographical information to find (1) other relevant data; (2) a fuller quote containing other interesting ideas; and (3) the context in which the quotation was used. Where we could not determine where a quotation was originally written we were obliged to use the quotation from a secondary source, and we list the reference where that has been done. Unfortunately, some very good quotations were bypassed and not included because we could not determine where they originated. As it is, about 100 of such quotations are included and have been credited, regrettably but by necessity, as “Author undetermined,” “Source undetermined,” or both. Despite unavoidable omissions, we hope that this book will provide a rich resource that allows you, the reader, to find relevant quotations or citations quickly, and will serve to inspire your search of the literature.

This dictionary, founded on the quotations from our nine previous books, contains over 7,000 additional quotations and provides by far the greatest number of scientific quotations that has appeared in any single published form to date. In addition, supporting information, such as source of the quotation and biographical information, are greatly expanded beyond any previously published effort.

Our three objectives in compiling this book were: First, to show the diversity and the richness of the various sciences from a variety of literary genres; second, to demonstrate that people from virtually every settled land and continent have given science a great deal of thought from 2000 BCE and earlier to the present time; and third, to provide a resource of thought-provoking ideas useful to anyone involved in just about any aspect of science or in any of the areas noted above, which are greatly influenced by the sciences.

In our attempt to fulfill these objectives we acted merely as collectors of quotations from many sources and from many areas of science. Here in this vast collection of quotations are the words of great philosophers and thought-influencers of science, past and present. Included are better known and lesser known thinkers of the classic Greek and Roman times, religious leaders, and philosophers from the Renaissance to the present. Many times an individual has spoken or written a statement pertaining to some aspect of science that was destined to live on and have meaning beyond the immediate context in which it was made. We hope you enjoy a pleasant and stimulating journey through the forest of ideas of scientists, laymen, politicians, novelists, playwrights, and poets about the human search for and attainment of scientific knowledge.

Max Delbrück, a physicist turned biologist, said in his Noble lecture “A Physicist’s Renewed Look at Biology: Twenty Years Later” that “the books of the great scientists are gathering dust on the shelves of learned libraries.” Somewhere else we read: “...often we rake in the litter of the printing press whilst a crown of gold and rubies is offered us in vain.” Unfortunately, these “gems”— these ideas — are often lost to us before they have time to become established in the collective memory of readers. It has been our concern that much of this wit and wisdom is read once and returned to the library shelf to be heard of no more. It seemed that these ideas, hidden within obscure chapters of books, both fiction and nonfiction, or on pages between covers of long forgotten articles in journals, should once again see the light of day. Apart from the practical day-to-day use of doing so, it is valuable that a new generation see lost or forgotten quotable maxims, proverbs, aphorisms, epigrams, jokes, poetry, songs, and quotations so the young may appreciate their charm and interest.

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We would especially like to thank David Packer of Springer for his editorial guidance, and Kathleen McKenzie for her copyediting and her many valuable comments and suggestions, and for her help with fact checking.

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No claim for completeness is made, for completeness is impossible in a book of this type; nor has any attempt been made to provide balance in the quotations between the needs of the general reader and the specialist. It would have been impossible for us to document each person's favorite scientific quotation, and thus we know that this book will suffer the fate of other literary, artistic, or musical works that attempt a broad overview: Stern critics will find fault with the omission of what they perceive as an important quotation from their respective fields. We must ask these critics to remember that our aim in compiling this book has been to save both great and not-so-great words pertaining to science and to add unmistakable value to that which can be retrieved from the Internet, regardless of the time and effort expended by any who searches there.

Within these works we found surprising and often incredible quotations pertaining to science. Just as certain views about science represented in quotes of years long past are not necessarily those of the authors, certain opinions that are stated therein concerning women, and persons of various nationalities, creeds, and races, are clearly not reasonable in an age when belief in the equality of all people—including a person's inherent capacity to contribute to scientific thought—is a shared ideal. Steven Skiena stated in his book, *The Algorithm Design Manual*, "It is traditional for the author to magnanimously accept the blame for whatever deficiencies remain. I don't. Any errors, deficiencies, or problems in this book are somebody else's fault, but I would appreciate knowing about them so as to determine who is to blame." While we are in sympathy with this, we still believe that any errors are our responsibility and we would appreciate having them called to our attention. For our critics we are sure you will be able to suggest improvements.

Carl C. Gaither  
Alma E. Cavazos-Gaither  
Killeen, Texas  
June 30, 2007

# Contents

MEDICINE AND ART .....	905	MINERAL: SALT .....	928
MEMORY .....	905	MINERAL: SANDSTONE .....	928
MENSTRUATION .....	905	MINERAL: SAPPHIRE .....	929
METAL .....	905	MINERALOGIST .....	929
METAPHOR .....	906	MINERALOGY .....	929
METAPHYSICS .....	908	MINING .....	929
METEOR .....	908	MIRACLE .....	930
METEORITE .....	911	MIRROR .....	930
METHOD .....	912	MISERY .....	930
METRICS .....	914	MISTAKE .....	930
MICROBE .....	915	MITOCHONDRION .....	931
MICROBIOLOGY .....	915	MIXTURE .....	931
MICROCOSM .....	915	MODEL .....	931
MICROPALEONTOLOGY .....	916	MOLAR SOLUTION .....	936
MICROSCOPE .....	916	MOLECULAR BIOLOGY .....	936
MIGRATION .....	917	MOLECULAR HYPOTHESIS .....	936
MILKY WAY .....	918	MOLECULE .....	937
MIND .....	920	MOMENTUM .....	940
MINERAL .....	924	MONKEYS AND TYPEWRITERS .....	940
MINERAL: ALABASTER .....	924	MONOGRAPH .....	941
MINERAL: AMBER .....	924	MONOPOLE .....	941
MINERAL: AMETHYST .....	925	MONSTER .....	942
MINERAL: CHALK .....	925	MOON .....	942
MINERAL: COAL .....	925	MOON LANDING .....	946
MINERAL: CRYSTAL .....	925	MORPHOLOGY .....	947
MINERAL: DIAMOND .....	926	MOTION .....	947
MINERAL: EMERALD .....	927	MOUNTAIN .....	950
MINERAL: FLINT .....	927	MUCOUS .....	952
MINERAL: GRANITE .....	927	MULTIPLICATION .....	952
MINERAL: JADE .....	927	MUON .....	953
MINERAL: LOADSTONE .....	927	MUSEUM .....	953
MINERAL: MARBLE .....	927	MUTATION .....	953
MINERAL: OPAL .....	928	MUTUALISM .....	954
MINERAL: PEARL .....	928	MYRMECOLOGIST .....	954

MYSTERY .....	954	ORGANISM .....	1053
MYSTICISM .....	957	ORGANIZATION .....	1054
MYTH .....	957	ORGANS .....	1055
NAME .....	959	ORIGIN OF LIFE .....	1055
NATURAL HISTORY .....	962	ORIGINALITY .....	1055
NATURAL LAW .....	963	ORNITHOLOGY .....	1056
NATURAL SCIENCE .....	963	OSMOTIC PRESSURE .....	1056
NATURAL SELECTION .....	963	OSTEOPATH .....	1056
NATURAL THEOLOGY .....	967	OTHER WORLDS .....	1056
NATURALISM .....	967	OUTER SPACE .....	1057
NATURALIST .....	968	OUTLIER .....	1058
NATURE .....	970	PAIN .....	1059
NEANDERTHAL .....	1006	PALEONTOLOGIST .....	1060
NEBULA .....	1006	PALEONTOLOGY .....	1061
NECESSITY .....	1007	PANSPERMIA .....	1063
NEURONS .....	1007	PARABOLA .....	1063
NEUROPHYSIOLOGY .....	1007	PARADIGM .....	1064
NEUROSCIENCE .....	1007	PARADISE .....	1064
NEUTRINO .....	1007	PARADOX .....	1065
NEUTRON .....	1009	PARASITE .....	1067
NEWTONIAN MECHANICS .....	1009	PARKINSON'S DISEASE .....	1068
NIGHT .....	1010	PARTICLE .....	1068
NOCTURNAL .....	1011	PAST .....	1070
NONSENSE .....	1011	PATENT .....	1072
NOTATION .....	1011	PATENT MEDICINE .....	1072
NOVAE .....	1012	PATHOLOGY .....	1072
NUCLEUS .....	1012	PATIENT .....	1073
NULL HYPOTHESIS .....	1012	PATTERN .....	1074
NUMBER .....	1013	PAULI PRINCIPLE .....	1075
NUMBER, FIBONACCI .....	1021	PENDULUM .....	1075
NUMBER THEORY .....	1021	PENICILLIN .....	1076
NURSING .....	1022	PERCENTAGE .....	1076
NUTRITION .....	1024	PERCEPTION .....	1076
OBJECTIVITY .....	1025	PERCUSSION .....	1077
OBSCURATIONISM .....	1025	PERIODIC TABLE .....	1077
OBSERVATION .....	1025	PERPETUAL MOTION .....	1078
OBSERVATORY .....	1038	PESSIMISM .....	1079
OBSERVER .....	1039	PEST CONTROL .....	1079
OBSTETRICS .....	1039	PESTILENCE .....	1079
OCCAM'S RAZOR .....	1039	PETRIFICATION .....	1079
OCEAN .....	1040	PETROLOGY .....	1079
OCEANOGRAPHY .....	1045	PH.D. ....	1079
ODDS .....	1045	PHARMACIST .....	1079
OMEGA POINT .....	1045	PHARMACY .....	1080
OPINION .....	1046	PHENOMENA .....	1080
OPIUM .....	1047	PHILOSOPHER .....	1081
OPTICS .....	1047	PHILOSOPHER'S STONE .....	1081
ORBIT .....	1048	PHILOSOPHY .....	1081
ORDER .....	1048	PHILOSOPHY OF SCIENCE .....	1084
ORGAN TRANSPLANT .....	1051	PHOSPHORUS .....	1090
ORGANIC CHEMISTRY .....	1052	PHOTOELECTRIC .....	1090



PHOTOGRAPHY .....	1091	PROBLEM .....	1188
PHOTON.....	1091	PROGRESS .....	1197
PHOTOSYNTHESIS .....	1091	PROOF.....	1200
PHYLOGENESIS.....	1091	PROPHECY.....	1203
PHYLOGENY .....	1091	PROPOSITION.....	1203
PHYSIC .....	1092	PROTON.....	1204
PHYSICAL LAW .....	1092	PROTOPLASM .....	1204
PHYSICAL SCIENCE .....	1093	PROVINCIAL REGION .....	1204
PHYSICIAN .....	1093	PSEUDOSCIENCE .....	1204
PHYSICIST .....	1108	PSYCHICAL CONSTITUTION.....	1204
PHYSICS .....	1117	PUBLIC SPEAKING .....	1204
PHYSIOGNOMY .....	1137	PURITY .....	1204
PHYSIOLOGIST .....	1137	PURPOSE.....	1204
PHYSIOLOGY .....	1137	PYRAMID .....	1205
PI.....	1138	PYTHAGORAS .....	1205
PILL .....	1139	QUACK.....	1206
PLANET .....	1139	QUALITIES.....	1207
PLANET: EARTH .....	1143	QUANTIFICATION .....	1207
PLANET: JUPITER.....	1153	QUANTUM MECHANICS.....	1208
PLANET: MARS.....	1153	QUARK.....	1214
PLANET: MERCURY.....	1155	QUASAR .....	1215
PLANET: NEPTUNE.....	1156	QUATERNION.....	1215
PLANET: SATURN.....	1156	QUESTION.....	1215
PLANET: URANUS.....	1156	QUESTIONNAIRE.....	1221
PLANET: VENUS.....	1156	QUOTATION .....	1221
PLANKTON .....	1157	RACISM .....	1222
PLANT.....	1157	RADIATION .....	1222
PLATE TECTONICS.....	1160	RADICAL.....	1222
PMS.....	1161	RADIO ASTRONOMY.....	1223
POINT.....	1161	RAIN FOREST .....	1223
POINT OF VIEW .....	1161	RAINBOW.....	1223
POLLUTION .....	1161	RAMIFICATION .....	1224
POPULATION .....	1163	RANDOMNESS .....	1224
POSITION .....	1163	RANDOM DIGITS.....	1224
POSITRON .....	1163	RANDOM NUMBER.....	1225
POSSIBILITY.....	1163	RATIOCINATION .....	1225
POSTULATE .....	1163	REACTION .....	1225
POWER.....	1163	READING.....	1225
PRAYER .....	1164	REAL (BEING) .....	1225
PRECISION.....	1165	REALITY .....	1226
PREDICTION.....	1165	REASONING .....	1230
PREHISTORIC MAN .....	1167	RECOGNITION .....	1237
PREHISTORY .....	1167	RECORD .....	1237
PRESCRIPTION.....	1168	RECOVERY .....	1237
PRESENT .....	1169	RECTANGLE .....	1237
PRESERVATION.....	1169	RECURSION .....	1237
PRIME NUMBER .....	1169	RED SHIFT .....	1238
PRIMORDIAL.....	1174	REDUCTIONISM .....	1238
PRINCIPLE .....	1174	REFEREE .....	1239
PROBABILITY .....	1174	REFORM .....	1239
PROBABLE ERROR.....	1188	REGRESSION .....	1239

RELATION .....	1240	SCIENCE AND PHILOSOPHY .....	1377
RELATIVITY .....	1240	SCIENCE AND POETRY .....	1379
RELIABILITY .....	1244	SCIENCE AND POLITICS .....	1381
RELIGION.....	1244	SCIENCE AND RELIGION .....	1382
RENORMALIZATION .....	1244	SCIENCE AND SOCIETY .....	1396
REPAIR.....	1244	SCIENCE AND STATE .....	1402
REPLICA .....	1244	SCIENCE AND SUPERSTITION .....	1403
REPORT .....	1245	SCIENCE AND WOMEN.....	1404
REPRODUCTION.....	1245	SCIENCE CREED.....	1406
RESEARCH.....	1246	SCIENCE FICTION .....	1406
RESEARCH PLAN .....	1255	SCIENCE GEEK .....	1407
RESIDUAL.....	1256	SCIENTIFIC COMMUNITY.....	1407
RESPIRATION .....	1256	SCIENTIFIC CRITICISM.....	1407
RESPONSIBILITY.....	1256	SCIENTIFIC DOUBT .....	1408
REST.....	1256	SCIENTIFIC INQUIRY .....	1408
RESULT.....	1256	SCIENTIFIC INVESTIGATION .....	1409
RETROGRADE MOTION .....	1257	SCIENTIFIC LITERACY .....	1411
REVOLUTION .....	1257	SCIENTIFIC METHOD.....	1411
RIDDLE.....	1258	SCIENTIFIC MIND .....	1417
RIEMANN HYPOTHESIS .....	1258	SCIENTIFIC PROGRESS.....	1420
RIGHTS OF ANIMALS.....	1260	SCIENTIFIC PUBLISHING .....	1421
RIGOR .....	1260	SCIENTIFIC SPIRIT.....	1425
RISK .....	1260	SCIENTIFIC TRENDS .....	1426
RIVER.....	1260	SCIENTIFIC TRUTH.....	1426
ROBOT .....	1262	SCIENTIFIC WORK.....	1429
ROCK.....	1262	SCIENTIST.....	1430
ROCKET.....	1264	SCRIBBLES .....	1452
ROCKFALL.....	1264	SEA .....	1452
ROTATION OF EARTH.....	1265	SEA SERPENT.....	1457
RUIN .....	1265	SEA SICKNESS .....	1457
RULE .....	1266	SEASIDE .....	1457
RUST .....	1266	SEDIMENT .....	1457
SAGACITY.....	1267	SEED.....	1457
SAMPLE.....	1267	SEISMOGRAPH .....	1458
SAND.....	1268	SEISMOGRAPHER .....	1458
SAVANT .....	1269	SEISMOGRAPHY .....	1458
SCATTERING .....	1269	SELF .....	1459
SCAVENGER .....	1269	SELF-AWARENESS .....	1459
SCENERY.....	1269	SELF-DELUSION.....	1459
SCIATICA.....	1269	SEMINAR.....	1459
SCIENCE.....	1269	SENSES .....	1459
SCIENCE, AGE OF.....	1350	SERIES .....	1459
SCIENCE, APPLIED .....	1350	SET THEORY .....	1459
SCIENCE, COMMUNICATION OF .....	1351	SEX .....	1460
SCIENCE, HISTORY OF.....	1354	SEXUALITY .....	1460
SCIENCE, MAN OF .....	1360	SHADOW .....	1461
SCIENCE, PROGRESS OF .....	1365	SHAPES.....	1461
SCIENCE AND ART .....	1369	SHELL .....	1461
SCIENCE AND CIVILIZATION.....	1374	SHORE .....	1461
SCIENCE AND MORALS .....	1375	SICKNESS.....	1462

SIGHT .....	1464	STREPTOMYCIN .....	1548
SIMPLICITY .....	1464	STRING THEORY .....	1549
SIMULTANEITY .....	1468	STRUCTURE .....	1549
SINGULARITY .....	1468	STUDENT .....	1549
SITE .....	1469	STUDY .....	1549
SIZE .....	1469	STUPIDITY .....	1550
SKELETON .....	1469	SUBSTANCE .....	1550
SKEPTICISM .....	1469	SUBTERRANEAN .....	1550
SKIN .....	1470	SUN .....	1551
SKY .....	1470	SUNSPOT .....	1555
SLEEP .....	1472	SUPERNOVA .....	1556
SNOW .....	1472	SUPERSTITION .....	1556
SOIL .....	1473	SUPERSTRING .....	1557
SOLAR SYSTEM .....	1474	SUPPOSITION .....	1557
SOLID STATE .....	1476	SURFACE TENSION .....	1557
SOLUBILITY .....	1476	SURGEON .....	1557
SOLUTION .....	1476	SURGERY .....	1560
SOUL .....	1477	SURPRISE .....	1562
SOUND .....	1477	SURVEY .....	1563
SPACE .....	1477	SURVIVAL .....	1564
SPACE AGE .....	1482	SYMBIOTICISM .....	1564
SPACE EXPLORATION .....	1482	SYMBIOSIS .....	1564
SPACE FLIGHT .....	1490	SYMBIOTE .....	1565
SPACE SETTLEMENT .....	1491	SYMBOL .....	1565
SPACE-TIME .....	1491	SYMBOLIC LOGIC .....	1566
SPECIALIZATION .....	1494	SYMMETRY .....	1567
SPECIES .....	1496	SYMPTOM .....	1569
SPECIFICATION .....	1498	SYNTHESIS .....	1569
SPECTROSCOPE .....	1499	SYSTEM .....	1570
SPECTRUM .....	1499	SYSTEMATICS .....	1571
SPECTRUM ANALYSIS .....	1500	TABLE .....	1573
SPECULATION .....	1500	TACHYON .....	1573
SPIN .....	1501	TAXONOMIST .....	1573
SPIRAL ARMS .....	1501	TAXONOMY .....	1574
SPONTANEOUS GENERATION .....	1501	TEACHER .....	1575
STAMP COLLECTING .....	1501	TEACHING .....	1575
STANDARD .....	1502	TECHNOLOGY .....	1579
STAR .....	1502	TEETH .....	1585
STARLIGHT .....	1520	TEKTITES .....	1586
STATISTICAL TEST .....	1521	TELEOLOGY .....	1586
STATISTICIAN .....	1522	TELESCOPE .....	1587
STATISTICS .....	1526	TEMPERATURE .....	1591
STATISTICS AND MEDICINE .....	1545	TEMPLE OF SCIENCE .....	1591
STATISTICS AND SOCIETY .....	1546	TENSOR .....	1592
STETHOSCOPE .....	1547	TESTING .....	1593
STOMACH .....	1547	THEOREM .....	1593
STONE .....	1547	THEORIST .....	1594
STORM .....	1548	THEORY .....	1595
STRATIGRAPHY .....	1548	THEORY OF FUNCTIONS .....	1617
STREAM .....	1548	THERMODYNAMICS .....	1617

THERMOMETER .....	1620	VECTOR ANALYSIS .....	1708
THINKING .....	1620	VEGETARIAN .....	1708
THOUGHT .....	1621	VEGETATION .....	1708
THUNDERBOLT .....	1624	VENUS, TRANSIT OF .....	1708
TIDAL BORE .....	1624	VERNAL EQUINOX .....	1709
TIDE .....	1624	VERNIER .....	1709
TIME .....	1624	VERTEBRATE .....	1709
TIME TRAVEL .....	1636	VIBRATION .....	1709
TOOL .....	1637	VIEW .....	1709
TOOTH .....	1637	VIRUS .....	1709
TOOTHACHE .....	1638	VITALITY .....	1710
TRACK .....	1639	VITAMIN .....	1710
TRACKING .....	1640	VOID .....	1710
TRADITION .....	1640	VOLATILITY .....	1710
TRANSISTOR .....	1640	VOLCANO .....	1710
TREE .....	1640	VOLCANOLOGIST .....	1714
TREE OF LIFE .....	1647	VOLUME .....	1714
TREE RINGS .....	1647	WARNING .....	1715
TRIAL AND ERROR .....	1647	WATER .....	1715
TRIANGLE .....	1647	WAVE .....	1718
TRIGONOMETRY .....	1648	WAVE MECHANICS .....	1718
TRILOBITE .....	1648	WAVE-PARTICLE DUALITY .....	1718
TRUTH .....	1649	WEAPON .....	1718
TUNNELING .....	1662	WEATHER .....	1718
TURBULENCE .....	1662	WEED .....	1719
TYPHUS .....	1662	WEIGHT .....	1719
TYPOLOGY .....	1663	WEIGHTLESSNESS .....	1719
UFO .....	1664	WETLANDS .....	1719
UNCERTAINTY .....	1664	WHIRLPOOL .....	1720
UNCERTAINTY PRINCIPLE .....	1665	WHITE DWARF .....	1720
UNDERSTANDING .....	1665	WILDERNESS .....	1720
UNEXPECTED .....	1671	WILDLIFE .....	1721
UNIFIED FIELD THEORY .....	1671	WIND .....	1722
UNIFORMITARIANISM .....	1672	WISDOM .....	1722
UNIQUENESS .....	1672	WONDER .....	1724
UNITS .....	1672	WORD .....	1726
UNIVERSE .....	1673	WORK .....	1727
UNIVERSE AND COSMOGENESIS .....	1696	WORLD .....	1727
UNIVERSE, DEATH OF .....	1699	WRITING .....	1729
UNKNOWN .....	1702	WRONG .....	1731
UREA .....	1704	X-RAY .....	1732
URIC ACID .....	1704	YELLOW FEVER .....	1734
URINANALYSIS .....	1704	ZEEMAN EFFECT .....	1735
VACCINATION .....	1705	ZERO .....	1735
VACUUM .....	1705	ZETA .....	1735
VALUE .....	1706	ZETA FUNCTION .....	1736
VARIANCE .....	1706	ZOO .....	1736
VARIATION .....	1706	ZOOLOGIST .....	1737
VARIETY .....	1708	ZOOLOGY .....	1737
VECTOR .....	1708	INDEX .....	II-1

# Contents (Volume I)

ABORTION .....	1	ANATOMIST.....	23
ABSORPTION LINE .....	1	ANATOMY .....	23
ABSTRACTNESS .....	1	ANEMIA .....	25
ABSTRACTION.....	2	ANESTHESIA .....	25
ABYSS.....	4	ANESTHETIST .....	26
ACADEMIC MIND.....	4	ANIMAL.....	26
ACCELERATOR .....	4	ANIMAL: AMPHIBIAN.....	30
ACCIDENT .....	4	ANIMAL: AMPHIBIAN: FROG.....	30
ACCOMPLISHMENT.....	4	ANIMAL: AMPHIBIAN: TADPOLE.....	30
ACCURACY.....	5	ANIMAL: AMPHIBIAN: TOAD.....	30
ACID.....	6	ANIMAL: ANNELID.....	30
ACTIVITY .....	6	ANIMAL: ANNELID: WORM.....	30
ACTUARY .....	6	ANIMAL: BIRD.....	32
ADAPTABILITY .....	6	ANIMAL: BIRD: ADJUTANT.....	34
ADDICTION .....	7	ANIMAL: BIRD: ALBATROSS.....	34
ADDITION.....	7	ANIMAL: BIRD: BALD EAGLE.....	34
ADENOID .....	8	ANIMAL: BIRD: BIRD OF PARADISE.....	34
ADHESIVE.....	8	ANIMAL: BIRD: BLACKBIRD.....	35
ADRENAL GLAND .....	8	ANIMAL: BIRD: BLUE JAY .....	35
ADSORPTION .....	8	ANIMAL: BIRD: BLUEBIRD.....	35
AESTHETIC.....	8	ANIMAL: BIRD: BOBOLINK.....	36
AFFINITY .....	10	ANIMAL: BIRD: CANARY .....	36
AGE OF EARTH.....	10	ANIMAL: BIRD: CONDOR.....	36
AGEING .....	11	ANIMAL: BIRD: CROW.....	36
AILMENT.....	12	ANIMAL: BIRD: CUCKOO.....	37
AIR.....	12	ANIMAL: BIRD: DODO.....	37
ALCHEMY.....	13	ANIMAL: BIRD: DOVE.....	37
ALGEBRA.....	14	ANIMAL: BIRD: DUCK .....	37
ALGORITHM.....	17	ANIMAL: BIRD: EAGLE.....	37
ALIENS .....	17	ANIMAL: BIRD: EMU.....	37
ALLERGY .....	18	ANIMAL: BIRD: FALCON.....	37
ALTERNATIVE LIFE .....	18	ANIMAL: BIRD: FLAMINGO .....	38
AMBITION.....	18	ANIMAL: BIRD: GOLDFINCH .....	38
AMINO ACID .....	18	ANIMAL: BIRD: GOOSE .....	38
AMNION .....	18	ANIMAL: BIRD: GRACKLE.....	38
AMPUTATION.....	19	ANIMAL: BIRD: HAWK .....	38
ANALOGY.....	19	ANIMAL: BIRD: HORNBILL .....	39
ANALYSIS .....	21	ANIMAL: BIRD: HUMMING BIRD.....	39
ANALYSIS OF VARIANCE.....	23	ANIMAL: BIRD: JAY.....	39
ANALYST .....	23	ANIMAL: BIRD: LARK.....	39
ANAPHYLAXIS .....	23	ANIMAL: BIRD: LINNET .....	40

ANIMAL: BIRD: LOON .....	40	ANIMAL: CNIDARIA: JELLYFISH.....	49
ANIMAL: BIRD: LOUISIANA WATER THRUSH.....	40	ANIMAL: CRUSTACEAN .....	49
ANIMAL: BIRD: MARTLET .....	40	ANIMAL: CRUSTACEAN: CRAB .....	49
ANIMAL: BIRD: MOCKING BIRD.....	40	ANIMAL: CRUSTACEAN: CRAWFISH.....	49
ANIMAL: BIRD: MOUNTAIN QUAIL.....	40	ANIMAL: CRUSTACEAN: LOBSTER .....	49
ANIMAL: BIRD: NIGHTINGALE .....	40	ANIMAL: CRUSTACEAN: WOODLOUSE.....	50
ANIMAL: BIRD: OSTRICH .....	41	ANIMAL: DUCK-BILLED PLATYPUS.....	50
ANIMAL: BIRD: OWL.....	41	ANIMAL: FISH.....	50
ANIMAL: BIRD: PARROT .....	41	ANIMAL: FISH: BARRACUDA.....	51
ANIMAL: BIRD: PARTRIDGE.....	41	ANIMAL: FISH: CODFISH .....	51
ANIMAL: BIRD: PASSENGER PIGEON .....	41	ANIMAL: FISH: COELACANTH.....	51
ANIMAL: BIRD: PEACOCK .....	41	ANIMAL: FISH: GUPPY .....	52
ANIMAL: BIRD: PELICAN.....	42	ANIMAL: FISH: HERRING.....	52
ANIMAL: BIRD: PENGUIN .....	42	ANIMAL: FISH: KIPPER.....	52
ANIMAL: BIRD: PHEASANT.....	42	ANIMAL: FISH: PICKEREL .....	52
ANIMAL: BIRD: PHOENIX .....	42	ANIMAL: FISH: SALMON.....	52
ANIMAL: BIRD: PIGEON .....	42	ANIMAL: FISH: SCULPIN.....	52
ANIMAL: BIRD: PURPLE FINCH.....	42	ANIMAL: FISH: SEA HORSE.....	52
ANIMAL: BIRD: QUAIL .....	42	ANIMAL: FISH: SEA SQUIRT.....	53
ANIMAL: BIRD: RAVEN .....	42	ANIMAL: FISH: SHARK .....	53
ANIMAL: BIRD: ROBIN .....	43	ANIMAL: FISH: SMELT.....	53
ANIMAL: BIRD: ROOK .....	43	ANIMAL: FISH: STURGEON .....	53
ANIMAL: BIRD: RUKH .....	43	ANIMAL: FISH: WHITING.....	54
ANIMAL: BIRD: SANDPIPER.....	43	ANIMAL: EUGLENA VIRDIS .....	54
ANIMAL: BIRD: SEA GULL .....	43	ANIMAL: INSECT .....	54
ANIMAL: BIRD: SEA-MEW .....	43	ANIMAL: INSECT: ANT .....	57
ANIMAL: BIRD: SEDGE-BIRD.....	43	ANIMAL: INSECT: BEDBUG.....	58
ANIMAL: BIRD: SPARROW .....	43	ANIMAL: INSECT: BEE.....	58
ANIMAL: BIRD: SWALLOW .....	44	ANIMAL: INSECT: BEETLE .....	59
ANIMAL: BIRD: SWAN .....	44	ANIMAL: INSECT: BUTTERFLY.....	59
ANIMAL: BIRD: THROSTLE .....	44	ANIMAL: INSECT: CATERPILLAR.....	60
ANIMAL: BIRD: THRUSH.....	44	ANIMAL: INSECT: CENTIPEDE.....	61
ANIMAL: BIRD: TOUCAN.....	45	ANIMAL: INSECT: CHIGGER.....	61
ANIMAL: BIRD: TURKEY .....	45	ANIMAL: INSECT: COCKROACH.....	61
ANIMAL: BIRD: VULTURE .....	45	ANIMAL: INSECT: CRICKET .....	61
ANIMAL: BIRD: WARBLER .....	46	ANIMAL: INSECT: DAMSEL FLY.....	61
ANIMAL: BIRD: WHITE-THROAT.....	46	ANIMAL: INSECT: DRAGON FLY .....	62
ANIMAL: BIRD: WHOOPING CRANE .....	46	ANIMAL: INSECT: FIREFLY.....	62
ANIMAL: BIRD: WOODPECKER.....	46	ANIMAL: INSECT: FLEA .....	62
ANIMAL: BIRD: WREN.....	46	ANIMAL: INSECT: FLY .....	62
ANIMAL: CHILERATA .....	46	ANIMAL: INSECT: GNAT.....	63
ANIMAL: CHILERATA: MITE.....	46	ANIMAL: INSECT: GRASSHOPPER .....	63
ANIMAL: CHILERATA: SCORPION .....	47	ANIMAL: INSECT: KATYDID.....	63
ANIMAL: CHILERATA: SPIDER .....	47	ANIMAL: INSECT: LADY BIRD.....	63
ANIMAL: CHILERATA: TARANTULA .....	48	ANIMAL: INSECT: LIGHTNING BUG.....	64
ANIMAL: CHILERATA: TICK.....	48	ANIMAL: INSECT: LOUSE .....	64
ANIMAL: CHORDATA .....	48	ANIMAL: INSECT: MAGGOT .....	64
ANIMAL: CHORDATA: OIKOPLEURA .....	48	ANIMAL: INSECT: MILLIPEDE .....	64
ANIMAL: CNIDARIA .....	48	ANIMAL: INSECT: MOSQUITO .....	64
ANIMAL: CNIDARIA: CORAL .....	48	ANIMAL: INSECT: MOTH.....	64
		ANIMAL: INSECT: PRAYING MANTIS.....	65

ANIMAL: INSECT: TERMITE.....	65	ANIMAL: MAMMAL: YAK.....	76
ANIMAL: INSECT: WALKING STICK.....	65	ANIMAL: MOLLUSK.....	76
ANIMAL: INSECT: WASP.....	65	ANIMAL: MOLLUSK: CLAM.....	76
ANIMAL: INSECT: WEEVIL.....	66	ANIMAL: MOLLUSK: GIANT SQUID.....	76
ANIMAL: MAMMAL.....	66	ANIMAL: MOLLUSK: NAUTILUS.....	77
ANIMAL: MAMMAL: AARDVARK.....	66	ANIMAL: MOLLUSK: OCTOPUS.....	77
ANIMAL: MAMMAL: APE.....	66	ANIMAL: MOLLUSK: OYSTER.....	77
ANIMAL: MAMMAL: ARMADILLO.....	66	ANIMAL: MOLLUSK: SLUG.....	77
ANIMAL: MAMMAL: BAT.....	66	ANIMAL: MOLLUSK: SNAIL.....	78
ANIMAL: MAMMAL: BEAR.....	67	ANIMAL: MOLLUSK: WHELK.....	78
ANIMAL: MAMMAL: BEAVER.....	68	ANIMAL: PROTOZOA.....	78
ANIMAL: MAMMAL: BIGHORN SHEEP.....	68	ANIMAL: PROTOZOA: AMOEBA.....	78
ANIMAL: MAMMAL: BUFFALO.....	68	ANIMAL: REPTILE.....	79
ANIMAL: MAMMAL: CAT.....	68	ANIMAL: REPTILE: ALLIGATOR.....	79
ANIMAL: MAMMAL: COW.....	68	ANIMAL: REPTILE: CROCODILE.....	79
ANIMAL: MAMMAL: COYOTE.....	68	ANIMAL: REPTILE: LIZARD.....	79
ANIMAL: MAMMAL: DEER.....	69	ANIMAL: REPTILE: LIZARD: CHAMELEON..	79
ANIMAL: MAMMAL: DOG.....	69	ANIMAL: REPTILE: SNAKE.....	79
ANIMAL: MAMMAL: DONKEY.....	69	ANIMAL: REPTILE: SNAKE: ASP.....	79
ANIMAL: MAMMAL: ELEPHANT.....	70	ANIMAL: REPTILE: SNAKE: COBRA.....	80
ANIMAL: MAMMAL: GIRAFFE.....	70	ANIMAL: REPTILE: SNAKE: PYTHON.....	80
ANIMAL: MAMMAL: GORILLA.....	70	ANIMAL: REPTILE: TURTLE.....	80
ANIMAL: MAMMAL: GUANACO.....	71	ANIMAL COMMUNITY.....	80
ANIMAL: MAMMAL: HIPPOPOTAMUS.....	71	ANIMALCULA.....	80
ANIMAL: MAMMAL: HORSE.....	71	ANSWER.....	80
ANIMAL: MAMMAL: JACKAL.....	71	ANTHROPOMORPHISM.....	82
ANIMAL: MAMMAL: LEOPARD.....	71	ANTHROPIC PRINCIPLE.....	82
ANIMAL: MAMMAL: LION.....	72	ANTHROPOLOGIST.....	82
ANIMAL: MAMMAL: LLAMA.....	72	ANTHROPOLOGY.....	83
ANIMAL: MAMMAL: MAMMOTH.....	72	ANTIBIOTIC.....	84
ANIMAL: MAMMAL: MANATEE.....	72	ANTI-MATTER.....	84
ANIMAL: MAMMAL: MOUSE.....	72	ANTIQUITY.....	85
ANIMAL: MAMMAL: OPOSSUM.....	72	ANTI-SCIENCE.....	86
ANIMAL: MAMMAL: OTTER.....	73	APOTHECARY.....	86
ANIMAL: MAMMAL: PANDA.....	73	APPEARANCE.....	87
ANIMAL: MAMMAL: PANTHER.....	73	APPLICATION.....	87
ANIMAL: MAMMAL: PECCARY.....	73	APPARATUS.....	87
ANIMAL: MAMMAL: PIG.....	73	APPROXIMATION.....	88
ANIMAL: MAMMAL: PIKAS.....	73	ARBITRARY.....	88
ANIMAL: MAMMAL: POLAR BEAR.....	73	ARCHAEOASTRONOMY.....	88
ANIMAL: MAMMAL: PORPOISE.....	73	ARCHAEOLOGICAL RECORD.....	88
ANIMAL: MAMMAL: PRAIRIE DOG.....	74	ARCHAEOLOGIST.....	88
ANIMAL: MAMMAL: RHINOCEROS.....	74	ARCHAEOLOGY.....	91
ANIMAL: MAMMAL: SHEEP.....	74	ARCHITECT.....	95
ANIMAL: MAMMAL: SHREW.....	74	ARCHITECTURE.....	97
ANIMAL: MAMMAL: SKUNK.....	74	ARGYRIA.....	101
ANIMAL: MAMMAL: SQUIRREL.....	75	ARITHMETIC.....	101
ANIMAL: MAMMAL: TIGER.....	75	ARROGANCE.....	104
ANIMAL: MAMMAL: WALRUS.....	75	ARTERY.....	104
ANIMAL: MAMMAL: WHALE.....	75	ARTIFACT.....	104
ANIMAL: MAMMAL: WOLF.....	76	ARTIFICIAL LIMBS.....	104

ASSERTION.....	104	BIODIVERSITY.....	166
ASSUMPTION.....	105	BIOGENESIS.....	167
ASTEROID.....	106	BIOGEOGRAPHY.....	167
ASTROGEOLOGY.....	106	BIOINFORMATICS.....	167
ASTROLOGER.....	107	BIOLOGICAL.....	167
ASTROLOGY.....	107	BIOLOGIST.....	169
ASTRONAUT.....	107	BIOLOGY.....	172
ASTRONOMER.....	108	BIONIC ORGANS.....	178
ASTRONOMICAL.....	115	BIOSTRATIGRAPHY.....	178
ASTRONOMICAL TIME.....	116	BIRTH CONTROL.....	178
ASTRONOMY.....	116	BLACK HOLE.....	179
ASTROPHYSICIST.....	127	BLINDNESS.....	181
ASTROPHYSICS.....	127	BLOOD.....	181
ASYMMETRY.....	127	BLOOD PRESSURE.....	181
ASYMPTOTE.....	128	BLUEPRINT.....	181
ATMOSPHERE.....	128	BODY.....	182
ATOM.....	128	BONE.....	182
ATOMIC.....	142	BOOK.....	183
ATOMIC BOMB.....	142	BOTANIST.....	184
ATOMIC ENERGY.....	142	BOTANY.....	186
ATOMIC LANDSCAPE.....	143	BOWEL MOVEMENT.....	187
ATOMIC WEIGHT.....	143	BRAIN.....	188
ATOMISM.....	143	BRIDGE.....	191
ATTRACTION.....	144	BRUTES.....	192
AURORA BOREALIS.....	144	BUBBLE.....	192
AUTHORITY.....	145	BUG.....	193
AUTONOMIC NERVOUS SYSTEM.....	146	BUILD.....	193
AUTONOMY.....	146	BUILDER.....	194
AUTOPSY.....	146	BUILDINGS.....	194
AVALANCHE.....	147	BUTTERFLY NET.....	194
AVERAGE.....	147	CALCULATION.....	195
AWARENESS.....	152	CALCULUS.....	198
AXIAL TILT.....	152	CALORIE.....	199
AXIOM.....	152	CANCER.....	199
AXIOMIZE.....	153	CANDLE.....	200
BACK.....	154	CATALOGUE.....	200
BACKBONELESSNESS.....	154	CATASTROPHE.....	200
BACTERIA.....	154	CAUSALITY.....	201
BACTERIOLOGIST.....	155	CAUSATION.....	201
BALANCE.....	155	CAUSE AND EFFECT.....	201
BAYESIAN.....	155	CAVE.....	208
BEACH.....	156	CAVERN.....	208
BEAUTY.....	156	CAVITY.....	208
BEGINNING.....	161	CELESTIAL.....	209
BELIEF.....	161	CELESTIAL MOTION.....	209
BESSEL FUNCTION.....	162	CELL.....	209
BETA DECAY.....	162	CENTRAL LIMIT THEOREM.....	211
BIBLIOGRAPHY.....	162	CERTAINTY.....	211
BIG BANG.....	162	CHANCE.....	213
BINOMIAL EXPANSION.....	165	CHANGE.....	222
BIOCHEMISTRY.....	165	CHAOS.....	224



CHEMICAL.....	227	CONDUCTOR.....	280
CHEMICAL AFFINITIES .....	230	CONFIDENCE .....	280
CHEMICAL BOND .....	231	CONFUSION.....	280
CHEMICAL CHANGE.....	231	CONIC SECTION .....	281
CHEMICAL ENGINEERING .....	231	CONJECTURE.....	281
CHEMIST .....	231	CONQUEST .....	282
CHEMISTRY.....	236	CONSCIOUSNESS .....	282
CHEMISTRY INSTRUMENTATION .....	253	CONSEQUENCE .....	282
CHEMOTHERAPY.....	253	CONSERVATION.....	282
CHEYNE–STOKES RESPIRATION.....	253	CONSERVATIONIST.....	284
CHILDBIRTH.....	253	CONSISTENCY .....	284
CHITIN .....	253	CONSTELLATION .....	284
CHOICE.....	254	CONSTELLATION: ANDROMEDA .....	288
CHOLERA.....	254	CONSTELLATION: ARCTURUS.....	288
CHROMOSOME.....	254	CONSTELLATION: ARIES .....	288
CHRONOLOGY.....	254	CONSTELLATION: CANCER.....	289
CIRCLE .....	255	CONSTELLATION: CANIS MAJOR .....	289
CIRCULATION.....	255	CONSTELLATION: CAPRICORNUS.....	289
CIRCUMCISION .....	255	CONSTELLATION: DRACO .....	289
CITY .....	256	CONSTELLATION: LIBRA.....	289
CIVILIZATION .....	256	CONSTELLATION: LOST PLEIAD.....	289
CLARITY .....	256	CONSTELLATION: ORION .....	289
CLASSIFICATION.....	257	CONSTELLATION: PISCES.....	290
CLIMATE CHANGE .....	259	CONSTELLATION: PLEIADES .....	290
CLINICIAN .....	261	CONSTELLATION: SAGITTARIUS .....	290
CLITORIS.....	261	CONSTELLATION: SCORPIO .....	290
CLONE .....	262	CONSTELLATION: SOUTHERN CROSS .....	290
COCAINE.....	262	CONSTELLATION: VIRGO .....	290
COD LIVER OIL .....	262	CONSTIPATION .....	291
COHERENCE.....	262	CONSTRUCT .....	291
COINCIDENCE .....	262	CONSTRUCTION.....	291
COLD.....	262	CONSULTANT.....	291
COLD FUSION .....	263	CONSULTATION.....	291
COLEOPTERIST .....	263	CONTAGION .....	292
COLLECTING .....	263	CONTINENT.....	292
COLONIZATION .....	263	CONTINENTAL DRIFT .....	292
COLOR.....	263	CONTINUITY .....	293
COMBINATORICS .....	264	CONTINUUM .....	293
COMET.....	264	CONTRACEPTIVE.....	294
COMMON SENSE.....	270	CONTROL.....	294
COMMUNITY .....	274	CONUNDRUM .....	294
COMPARISON .....	275	CONVALESCENCE.....	294
COMPLEXITY .....	275	CONVICTION.....	294
COMPOUND.....	275	COPERNICAN DOCTRINE.....	294
COMPREHENSION.....	276	CORRELATION .....	295
COMPUTER.....	276	COSMIC BALANCE .....	295
COMPUTING.....	277	COSMIC EVOLUTION .....	296
CONCEPT .....	277	COSMIC RAY .....	296
CONCEPTION .....	278	COSMOCHEMISTRY .....	296
CONCHOLOGY.....	278	COSMOGONIST.....	296
CONCLUSION .....	278	COSMOGONY.....	296

COSMOLOGICAL.....	297	DESTINY .....	337
COSMOLOGIST .....	297	DESTRUCTION .....	337
COSMOLOGY .....	297	DETAIL .....	337
COSMOS .....	299	DETECTION .....	338
COUGH .....	300	DETECTOR.....	338
COUNTING.....	301	DETERMINANT.....	338
COURAGE .....	301	DETERMINISM.....	338
CRAZY .....	301	DEVELOPMENT .....	338
CREATE .....	301	DIAGNOSIS .....	339
CREATION.....	302	DIAGNOSTICIAN .....	340
CREATIONISM.....	303	DICE .....	340
CREATIONIST .....	304	DISCOVERY .....	341
CREATIVITY .....	305	DIET .....	341
CREDIT .....	308	DIETY.....	342
CREED .....	308	DIFFERENCE .....	342
CRITICISM .....	308	DIFFERENTIAL .....	343
CRUST.....	309	DIFFERENTIAL EQUATION .....	343
CRYSTALLOGRAPHY .....	309	DIFFICULTY.....	344
CULTURE .....	309	DIFFUSION.....	344
CURE.....	310	DIG .....	344
CURIOSITY .....	312	DIGESTION .....	345
CURVE .....	315	DIGESTIVE CANAL.....	345
CYNIC .....	315	DIMENSION .....	345
DARK ENERGY .....	316	DINOSAUR .....	347
DARK MATTER .....	316	DINOSAUR: ALLOSAURUS.....	349
DARKNESS.....	316	DINOSAUR: ANKYLOSAURUS.....	349
DARWINISM .....	316	DINOSAUR: ARCHAEOPTERYX .....	349
DATA .....	318	DINOSAUR: BRACHIOSAURUS.....	349
DATING.....	322	DINOSAUR: BRONTOSAURUS .....	349
DAWN.....	322	DINOSAUR: ICHTHYOSAURUS.....	350
DEATH .....	322	DINOSAUR: IGUANODON.....	350
DECAY .....	326	DINOSAUR: LEPTOPTERYGIUS .....	350
DECIMAL .....	327	DINOSAUR: PTERODACTAL.....	350
DECISION.....	327	DINOSAUR: STEGOSAURUS.....	351
DEDUCTION .....	327	DINOSAUR: TYRANNOSSAURUS.....	351
DEEDS.....	328	DISCHARGE.....	351
DEFINITION .....	328	DISCONTINUITY .....	351
DELIRIUM .....	331	DISCOVER.....	351
DEMONSTRATION.....	331	DISCOVERY .....	352
DENSITY .....	331	DISCUSSION .....	367
DENTIST .....	331	DISEASE .....	367
DENTOPEDALOGY.....	333	DISINFECTANT .....	371
DENUATION .....	333	DISORDER.....	372
DEPLETION.....	334	DISPERSAL .....	372
DERIVATIVE .....	334	DISSECTION .....	372
DERMATOLOGIST .....	334	DISTANCE .....	373
DESCRIBE .....	334	DISTILL .....	373
DESCRIPTION.....	334	DISTRIBUTION.....	374
DESERT.....	334	DIVERGENCE .....	375
DESIGN.....	336	DIVERSITY .....	375
DESTINATION .....	337	DIVINE INTELLIGENCE.....	375

DIVISION .....	375	ENERGY STATE.....	407
DNA .....	375	ENGINEER.....	408
DWARF PLANET: PLUTO .....	376	ENGINEERING .....	421
EAR WAX .....	377	ENLIGHTENMENT.....	429
EARTH, DEATH OF .....	377	ENTOMOLOGIST .....	429
EARTHQUAKE.....	377	ENTOMOLOGY .....	430
ECHINODERMATA .....	381	ENTROPY .....	431
ECLIPSE.....	381	ENVIRONMENT .....	432
ECOLOGIST .....	383	ENZYME .....	434
ECOLOGY .....	383	EPILEPSY .....	434
ECONOMIST .....	385	EPILOGUE .....	434
ECOSYSTEM.....	385	EPITAPH .....	434
EDIFICE .....	385	EQUATION.....	434
EDUCATION.....	385	EQUILIBRIUM .....	436
EFFECT .....	387	EROSION .....	436
EFFICIENT.....	387	ERROR .....	436
EGG .....	387	ERUPTION .....	444
EL NIÑO.....	387	ESCHATOLOGY.....	444
ELECTRICITY .....	387	ESOTERIC.....	444
ELECTROCARDIOGRAM .....	389	ESTIMATE .....	445
ELECTRON.....	389	ETERNITY .....	445
ELEGANCE .....	394	ETHER.....	445
ELEMENT .....	394	ETHER SPACE.....	446
ELEMENT: ALUMINUM .....	396	ETHICS.....	447
ELEMENT: ANTIMONY .....	396	EUCLID.....	449
ELEMENT: ARGON.....	397	EUGENICS .....	450
ELEMENT: ARSENIC.....	397	EUREKA .....	450
ELEMENT: BISMUTH.....	397	EVAPORATION .....	450
ELEMENT: CARBON .....	397	EVENT .....	450
ELEMENT: CHLORINE.....	397	EVIDENCE.....	451
ELEMENT: COBALT .....	398	EVOLUTION.....	451
ELEMENT: GOLD.....	398	EXAMINATION.....	484
ELEMENT: HYDROGEN.....	398	EXAMPLE.....	484
ELEMENT: IODINE .....	398	EXCAVATION .....	485
ELEMENT: LEAD .....	399	EXCEPTION .....	485
ELEMENT: MERCURY .....	399	EXCLUDED MIDDLE .....	485
ELEMENT: NITROGEN.....	399	EXISTENCE.....	485
ELEMENT: OXYGEN .....	399	EXPAND.....	486
ELEMENT: PHOSPHORUS .....	400	EXPERIENCE .....	486
ELEMENT: RADIUM.....	400	EXPERIMENT .....	490
ELEMENT: SODIUM .....	400	EXPERIMENTAL METHOD .....	502
ELEMENT: SULPHUR.....	400	EXPERIMENTER .....	503
ELEMENT: TITANIUM .....	401	EXPERT.....	503
ELEMENT: URANIUM.....	401	EXPLANATION .....	504
ELEMENT: ZINC.....	401	EXPLICIT .....	505
ECLIPSE.....	401	EXPLORATION .....	505
ELLIPSE.....	402	EXPONENTIAL.....	506
ELLIPTIC FUNCTION .....	402	EXPOSITION .....	506
EMERGENCE .....	402	EXTERNAL WORLD.....	506
EMOTION .....	402	EXTINCTION .....	506
ENERGY .....	402	EXTRATERRESTRIAL LIFE .....	509

EYE.....	515	FUNGI .....	568
EYELID .....	516	FUSION .....	568
FACE.....	517	FUTURE.....	569
FACT.....	517	GAIA.....	571
FACTOR .....	542	GALAPAGOS.....	571
FAILURE.....	542	GALAXY.....	571
FAITH OF SCIENCE.....	542	GALL BLADDER.....	573
FALLACY.....	543	GAMBLING .....	573
FAME.....	543	GARDEN .....	573
FART.....	543	GAS.....	574
FAULT.....	544	GASTRULATION .....	574
FEE .....	544	GENE.....	575
FERMAT'S THEOREM.....	545	GENE POOL .....	576
FERMENTATION .....	545	GENERA .....	576
FETUS .....	545	GENERAL PRACTICE.....	576
FEVER.....	545	GENERAL PRACTITIONER .....	576
FIELD .....	546	GENERAL RELATIVITY .....	576
FIELD STUDY .....	546	GENERALITY .....	576
FIELD THEORY .....	546	GENERALIZATION .....	577
FIELD WORK.....	546	GENETIC .....	577
FIELDS.....	546	GENETIC THEORY .....	578
FIGURE.....	547	GENETICS .....	578
FILTER .....	547	GENIUS.....	578
FIRE.....	547	GENOME .....	580
FIRMAMENT.....	548	GENUS .....	581
FISSION .....	548	GEOLOGY .....	581
FLATULENCE .....	548	GEOLOGICAL TIME.....	591
FLIGHT .....	548	GEOLOGIST .....	593
FLOWER.....	549	GEOMETER.....	597
FLU.....	553	GEOMETRY.....	598
FLUID.....	553	GEOMORPHOLOGY .....	605
FLUORO-CHEMISTRY.....	553	GEOPHYSICS .....	606
FLUXION .....	553	GERM PLASM.....	606
FLYING SAUCERS .....	553	GEYSER.....	606
FOCUS.....	553	GLACIAL DEBRIS .....	606
FOOL.....	553	GLACIER .....	606
FOOTPRINT.....	554	GLAND.....	607
FORCE.....	554	GLASSWARE.....	608
FORECAST .....	557	GLUONS .....	608
FORESIGHT.....	559	GOAL.....	608
FORETHOUGHT .....	559	GOD.....	609
FORM .....	559	GOUT .....	620
FORMULA .....	559	GRAIN.....	620
FOSSIL .....	561	GRAPH.....	620
FOURTH DIMENSION .....	566	GRAVITATIONAL LENS .....	621
FRACTAL.....	566	GRAVITY .....	621
FRACTION.....	567	GREATNESS.....	624
FRACTURE.....	567	GREENHOUSE WARMING .....	625
FREEDOM .....	567	GROUP.....	625
FUNCTION .....	567	GROUP THEORY .....	625
FUNDING.....	568	GUESS.....	625

GYNECOLOGIST.....	626	ILLNESS.....	668
HAIR.....	627	ILLUSION.....	670
HAPPENING.....	627	ILLUSTRATION.....	670
HAPPINESS.....	627	IMAGINATION.....	670
HARMONIC LAW.....	627	IMMORTALITY.....	679
HEADACHE.....	627	IMMUNITY.....	679
HEALING.....	627	IMMUNOLOGICAL DEFENSE.....	679
HEALTH.....	628	IMPOSSIBILITY.....	679
HEART.....	630	IMPRESSION.....	681
HEAT.....	631	IMPROBABILITY.....	681
HEAVENS.....	633	INADEQUACY.....	682
HEILIGENSCHN.....	635	INCONCEIVABILITY.....	682
HEMATOCRIT.....	635	INDEPENDENCE.....	682
HEREDITY.....	635	INDEX FOSSIL.....	682
HERITAGE.....	635	INDIGESTION.....	682
HERNIA.....	635	INDIVIDUAL.....	682
HERPES.....	635	INDIVIDUALITY.....	682
HETEROCHRONIC CHANGE.....	636	INDUCTION.....	683
HETEROGENEITY.....	636	INERTIA.....	683
HEXAGON.....	636	INFECTION.....	684
HIEROGLYPHICS.....	636	INFERENCE.....	684
HILBERT.....	636	INFINITE.....	684
HILBERT SPACE.....	636	INFINITESIMAL.....	688
HISTORIAN.....	636	INFINITY.....	689
HISTORY.....	637	INFORMATION.....	692
HIVES.....	637	INGENUITY.....	694
HOLOTYPE.....	638	INHERITANCE.....	694
HOMEOPATHY.....	638	INNOVATION.....	694
HOMO SAPIEN.....	638	INORGANIC.....	695
HONORS.....	638	INSANITY.....	695
HORMONE.....	638	INSCRIPTION.....	695
HOSPITAL.....	638	INSIGHT.....	695
HUMAN BEINGS.....	639	INSOMNIAC.....	696
HUMAN BODY.....	640	INSPIRATION.....	696
HUMAN SPIRIT.....	640	INSTINCT.....	696
HURRICANE.....	640	INSTRUMENT.....	696
HYBRID.....	640	INSULIN.....	698
HYDROLOGY.....	640	INTEGER.....	698
HYPERBOLA.....	640	INTEGRAL.....	699
HYPERSPACE.....	641	INTEGRATION.....	699
HYPOCHONDRIAC.....	641	INTELLECT.....	699
HYPODERMIC NEEDLE.....	642	INTELLECTUAL.....	700
HYPOTHESIS.....	642	INTELLIGENCE.....	700
ICE.....	652	INTELLIGENT DESIGN.....	701
ICE STORMS.....	652	INTERACTION.....	701
ICEBERG.....	652	INTERDEPENDENCE.....	702
ICHOLOGY.....	653	INTERN.....	702
ICHTHYOLOGIST.....	653	INTERNIST.....	702
IDEA.....	653	INTERPRETATION.....	702
IDEOLOGY.....	664	INTERSTELLAR MESSAGE.....	702
IGNORANCE.....	664	INTESTINE.....	702

INTUITION .....	703	LIGHTNING.....	777
INVALID .....	703	LIKELIHOOD .....	778
INVARIANCE .....	703	LIMIT .....	778
INVARIANTS.....	703	LINE .....	779
INVENTION.....	704	LITERATURE .....	779
INVENTOR .....	706	LIVER.....	781
INVESTIGATION .....	707	LIVING FOSSILS .....	781
INVESTIGATOR.....	708	LIVING MATTER.....	782
ION .....	708	LIVING VERSUS DEAD .....	782
IRRATIONALITY .....	708	LOCATION.....	782
IRREVERSABLITY .....	709	LOGARITHM.....	782
ISOMERISM .....	709	LOGIC .....	782
ISOSTASY .....	709	LOGICIAN .....	785
IT.....	709	LONELINESS .....	786
JAW .....	710	LUCK.....	786
JEALOUSY .....	710	LUNG .....	786
JOURNAL .....	710	MACHINE.....	787
JOURNEY .....	710	MACHINERY .....	788
JUDGMENT .....	710	MACROEVOLUTION .....	788
JUSTIFICATION .....	710	MAGIC .....	788
KEY .....	711	MAGMA .....	790
KINGDOM .....	711	MAGNET.....	790
KNOT.....	711	MAGNETISM .....	790
KNOWING .....	711	MAGNITUDE .....	791
KNOWLEDGE .....	711	MAL DE MER .....	791
LABEL.....	737	MALADY .....	792
LABORATORY .....	737	MALARIA .....	792
LABYRINTH .....	739	MALARIOLOGIST.....	792
LAKE.....	739	MALPRACTICE .....	792
LAND .....	739	MAN .....	792
LANDSCAPE.....	740	MANDLEBROT SET.....	801
LANGUAGE.....	740	MANKIND .....	801
LATIN SQUARE.....	743	MAP.....	802
LAVA.....	743	MARINE BIOLOGY.....	803
LAVA BEDS .....	744	MARTIAN .....	803
LAW .....	744	MARTYRDOM .....	803
LAW OF GRAVITATION .....	754	MASS.....	803
LAW OF NATURE.....	754	MATHEMATICAL SCIENCE .....	803
LAW OF VARIATION .....	756	MATHEMATICIAN .....	869
LEARNING .....	756	MATTER.....	883
LECTURE.....	758	MAXWELL'S THEORY .....	889
LEMMA.....	759	MEANING.....	889
LEPROSY .....	759	MEASLES .....	889
LEVER.....	759	MEASUREMENT .....	889
LIBERALITY .....	759	MECHANICS .....	892
LIFE.....	759	MEDIAN.....	894
LIGHT.....	774	MEDICAL SCIENCE.....	894
LIGHT YEAR.....	777	INDEX .....	I-1

## MEDICINE AND ART

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Directly or indirectly, the various forms of art reflect the strivings, the struggles, and the sufferings of mankind. The state of health and the ills of a society are recorded not only in the writings of its physicians and scholars but also in the themes and moods of its artists and poets.

*Mirage of Health*

Chapter VII (p. 215)

Harper & Brothers Publishers. New York, New York, USA. 1959

## MEMORY

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Memory plays strange pranks with facts. The rocks and fissures and gullies of the mountain-side melt quickly into the smooth, blue outlines of the distant panorama. Viewed through the perspective of memory, an unrecorded observation, the vital details long since lost, easily changes its countenance and sinks obediently into the frame fashioned by the fancy of the moment.

*Sir William Osler, Bart.*

Osler, The Teacher (p. 51)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1920

**Thorne, Kip S.** 1940–

American theoretical physicist

Memories are fallible; different people, experiencing the same events, may interpret and remember them in very different ways.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 19)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

## MENSTRUATION

**Butler, Brett**

No biographical data available

I would like it if men had to partake in the same hormonal cycles to which we're subjected monthly. Maybe that's why men declare war — because they have a need to bleed on a regular basis.

In Roz Warren

*Glibquips* (p. 107)

Crossing Press, Freedom, California. USA. 1994

**Crimmins, Cathy**

Humorist

A period is just the beginning of a lifelong sentence.

In Roz Warren

*Glibquips* (p. 107)

Crossing Press, Freedom, California. USA. 1994

**Harrison, R. J.**

No biographical data available

**Montagna, William**

Dermatological researcher

The specific purpose of menstruation is obscure. Not least of its imponderables is why it should occur only in certain primates. It would seem to be a waste of tissue and essential substances such as iron. Several hundred milliliters of blood are lost each month and this is obviously a drain on a woman's reserves and a constant call on her blood-forming bone marrow. Apart from its social disadvantages and discomfort, it often leads to tiredness, bad temper and anemia. From a biological point of view, menstruation should not occur at all!

*Man* (p. 326)

Appleton-Century-Crofts. New York, New York, USA. 1973

**Paglia, Camille** 1947–

American social critic, intellect and writer

It is not menstrual blood per se which disturbs the imagination — unstaunchable as that red flood may be — but rather the albumen in the blood, the uterine sheds, placental jellyfish of the female sea. This is the chthonian matrix from which we rose. We have an evolutionary revulsion from slime, our site of biological origins. Every month, it is woman's fate to face the abyss of time and being, the abyss which is herself.

*Sexual Personae. Art and Decadence from Nefertiti to Emily Dickinson*

Yale University Press. New Haven, Connecticut, USA. 1990

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

But nothing could easily be found that is more remarkable than the monthly flux or women. Contact with it turns new wine sour, crops touched by it become barren, grafts die, seeds in gardens are dried up, the fruit of trees falls off, the bright surface of mirrors in which it is merely reflected is dimmed, the edge of steel and the gleam of ivory are dulled, hives of bees die, even bronze and iron are at once seized by rust...

*Natural History*

Volume II, Book VII, sec 64

Harvard University Press. Cambridge, Massachusetts, USA. 1947

## METAL

**Baker, Russell** 1925–

American writer and journalist

So there he is at last. Man on the moon. The poor magnificent bungler. He can't even get to the office without undergoing the agonies of the damned, but give him a little metal, a few chemicals, some wire and \$20 or \$30 billion dollars and, vroom!

Resource Recovery Act of 1969 (p. 1231)  
Hearings, Ninety-first Congress  
United States Congress. Senate. Committee on Public Works. Subcommittee on Air and Water Pollutions  
US Government Printing Office. Washington, D.C. 1969

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
English Romantic poet and satirist

I think it may be of Corinthian brass  
Which was a mixture of all metals, but  
The brazen uppermost.

The Complete Poetical Works of Byron  
Don Juan  
Canto VI, 56–58  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Flaubert, Gustave** 1821–90  
French novelist

Bronze. Metal of the classic centuries.  
*Dictionary of Accepted Ideas*  
M. Reinhardt. London, England. 1954

**Henry, William**  
No biographical data available

The metals are not presented immediately to the hand of man, like the objects of the animal and vegetable kingdoms, but, they are, for the most part, buried in darkness, in the bowels of the earth, where they are so much disguised, by a combination of mixture with other substances, that they often appear entirely unlike themselves.

*The Elements of Experimental Chemistry* (Volume 2)  
Notes (p. 389)  
Thomas & Andres. Boston, Massachusetts, USA. 1814

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

One will not deny me, I trust, all the theory of oxidation and combustion; the analysis and decomposition of air by metals and combustible bodies ...  
*Mémoires de Chimie* Volume 2, (p. 87)  
Dupont. Paris, France. 1803

**Rawlings, Majorie Kinnan** 1896–1953  
American writer

Cast iron is so superior for cooking utensils to our modern aluminum that I not only cannot grieve for the pioneer hardship of cooking in iron over the hearth, but shall retire if necessary to the back yard with my two Dutch ovens, turning over all my aluminum cookers for air-planes with a secret delight.

*Cross Creek*  
Charles Scribner's Sons. New York, New York, USA. 1942

## METAPHOR

**Calvin, William H.** 1939–  
Theoretical neurophysiologist

Kant said that our metaphors comprise the conceptual spectacles through which we view the world.... If we are to have meaningful, connected experiences; ones that we can comprehend and reason about; we must be able to discern patterns to our actions, perceptions, and conceptions. Underlying our vast network of interrelated literal meanings (all of those words about objects and actions) are those imaginative structures of understanding such as schema and metaphor, such as the mental imagery that allows us to extrapolate a path, or zoom in on one part of the whole, or zoom out until the trees merge into a forest.

*The Cerebral Code* (pp. 159–160)  
The MIT Press. 1996

**Capra, Fritjof** 1939–  
Austrian-born American physicist

Gradually, physicists began to realize that nature, at the atomic level, does not appear as a mechanical universe composed of fundamental building blocks, but rather as a network of relations, and that, ultimately, there are no parts at all in this interconnected web. Whatever we call a part is merely a pattern that has some stability and therefore captures our attention.

*The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism* (p. 329)  
Shambhala. Boston, Massachusetts, USA. 1991

**Cole, K. C.** 1942–  
American science writer

So much of science consists of things we can never see: light “waves” and charged “particles”; magnetic “fields” and gravitational “forces”; quantum “jumps” and electron “orbits.” In fact, none of these phenomena is literally what we say it is. Light waves do not undulate through empty space in the same way that water waves ripple over a still pond; a field is only a mathematical description of the strength and direction of a force; an atom does not literally jump from one quantum state to another, and electrons do not really travel around the atomic nucleus in orbits. The words we use are merely metaphors.

On Imagining the Unseeable  
*Discover Magazine*, December 1982 (p. 70)

**Davy, Sir Humphry** 1778–1829  
English chemist

...the tropes and metaphors of the speaker were like the brilliant wild flowers in a field of corn, very pretty, but which did very much hurt to the corn.

*Consolations in Travel, or the Last Days of a Philosopher*  
Dialogue V (p. 253)  
J. Murray. London, England. 1830

The works of scientific men are like the atoms of gold, of sapphire and diamonds, that exist in the mountain; they form no perceptible part of the mass of the mountain; they



are neglected and unknown when it is entire; they are covered with vegetable mould, and by forests. But when time has sapped its foundation — when its fragments are scattered abroad by the elements, and its decayed materials carried down the rivers, then they glitter, and are found; then their immortality is known, and they are employed to ornament the diadems of emperors and the scepters of kings.

*The Collected Works of Sir Humphry Davy* (Volume 1)  
Memories of the Life of Sir Humphry Davy  
Chapter IV (p. 218)  
London, England. 1839–1849

### Fulford, Robert

No biographical data available

Metaphor, the life of language, can be the death of meaning. It should be used in moderation, like vodka. Writers drunk on metaphor can forget they are conveying information and ideas.

*Globe & Mail (Toronto)*, December 4, 1996

### Goleman, Daniel 1946–

American writer and psychologist

The logic of the emotional mind is associative; it takes elements that symbolize a reality, or trigger a memory of it, to be the same as that reality. That is why similes, metaphors and images speak directly to the emotional mind.... If the emotional mind follows this logic and its rules, with one element standing for another, things need not necessarily be defined by their objective identity: what matters is how they are perceived; things are as they seem.... Indeed, in emotional life, identities can be like a hologram in the sense that a single part evokes the whole.

*Emotional Intelligence* (p. 294)  
Bloomsbury. London, England. 1996

### Goodwin, Brian Carey 1931–

Biologist

The point...is not to conclude that there is something wrong with Darwin's theory because it is clearly linked to some very powerful cultural myths and metaphors. All theories have metaphorical dimensions which I regard as not only inevitable but also extremely important. For it is these dimensions that give depth and meaning to scientific ideas, that add to their persuasiveness, and colour the way we see reality.

*How the Leopard Changed Its Spots: The Evolution of Complexity* (p. 32)  
Phoenix. London, England. 1994

### Gould, Stephen Jay 1941–2002

American paleontologist, evolutionary biologist, and historian of science

If we must deal in metaphors [when discussing evolution], I prefer a very broad, low and uniform slope. Water drops randomly at the top and usually dries before flowing anywhere. Occasionally, it works its way downslope

and carves a valley to channel future flows. The myriad valleys could have arisen anywhere on the landscape. The current positions are quite accidental. If we could repeat the experiment, we might obtain no valleys at all, or a completely different system. Yet we now stand at the shore line contemplating the fine spacing of valleys and their even contact with the sea. How easy it is to be misled and to assume that no other landscape could possibly have arisen.

*The Panda's Thumb: More Reflections in Natural History*  
Chapter 12 (p. 140)

W.W. Norton & Company, Inc. New York, New York, USA. 1980

### Harré, Rom

No biographical data available

Metaphor and simile are the characteristic tropes of scientific thought, not formal validity of argument.

*Varieties of Realism*

Part I (p. 7)

Basil Blackwell. Oxford, England. 1986

### Klarreich, E.

No biographical data available

Berry isn't speaking in metaphors. I've tried to play this music by putting a few thousand primes into my computer, he says but it's just a horrible cacophony. You'd actually need billions or trillions — someone with a more powerful machine should do it.

Prime Time

*New Scientist*, 11/11/00

### McLuhan, Marshall 1911–80

Canadian educator, philosopher, and scholar

### McLuhan, Eric

No biographical data available

...all words are metaphor...

*The Laws of Media: The New Science*

Chapter 3 (p. 120)

University of Toronto Press. Toronto, Ontario, Canada. 1988

### Moore, James R.

No biographical data available

Clever metaphors die hard. Their tenacity of life approaches that of the hardiest micro-organisms. Living relics litter our language, their *raison d'être* forever past, ignored if not forgotten, and their present fascination seldom impaired by the confusions they may create.

*The Post-Darwinian Controversies: A Study of the Protestant Struggle to Come to Terms with Darwin in Great Britain and America*

Chapter I (p. 19)

Cambridge University Press. Cambridge, England. 1979

### Poynting, John Henry 1852–1914

English physicist

To take an old but never-worn-out metaphor, the physicist is examining the garment of Nature, learning of how

many, or rather of how few different kinds of thread it is woven, finding how each separate thread enters into the pattern, and seeking from the pattern woven in the past to know the pattern yet to come.

*Collected Scientific Papers*

Presidential Address

The Mathematical and Physical Section

The British Association (Dover) 1899 (p. 603)

At The University Press. Cambridge, England. 1920

## METAPHYSICS

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

There is no drawing the line between physics and metaphysics. If you examine every day facts at all closely, you are a physicist; but if you press your physics at all home, you become a metaphysician; if you press your metaphysics at all home, you are in a fog.

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 259)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Darwin, Charles Robert** 1809–82

English naturalist

Origin of man now proved. — Metaphysics must flourish. — He who understands [the] baboon would do more towards metaphysics than Locke.

*M Notebook*

#84, 16 August 1838

**Douglas, James** 1753–1819

No biographical data available

Metaphysical truths can only be established by producing effects from corresponding causes; and though we may confront such demonstrative evidence with the immutable laws of mathematical decision, we must be sensible that there will still remain some pretense for doubt; thus the basis of that knowledge, which on these principles we have been long labouring to accomplish, will become an endless toil, an endless force for controversy: and having the passions and the prejudices of mankind to combat, which mathematical certainty can alone effectually suppress, we must content ourselves only with making converts of those who have minds sufficiently expansive without the shackles of Euclid, and the vanity of displaying their own learning and pedantry.

*A Dissertation on the Antiquity of the Earth*

Preface (pp. i–ii)

Printed at the Logographic Press. London, England. 1785

**von Mises, Richard** 1883–1953

Austrian-born American mathematician

There is no field that will always remain the special province of metaphysics and into which scientific research

can never carry any light; there are no “eternally unexplorable” areas.

*Positivism: A Study in Human Understanding*

Chapter 21 (p. 273)

Harvard University Press. Cambridge, Massachusetts, USA. 1951

## METEOR

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

This hairy meteor did denounce

The fall of Scepters and of Crowns.

*The Poetical Works of Samuel Butler* (Volume 1)

First Part, Canto I, l. 245–246

Bell & Daldy. London, England. 1835

**Caithness, James Balharrie**

No biographical data available

Wonderful, shimmering trail of light,

Falling from whence on high!

Flooding the world in thy moment’s flight

With the sense of a mystery!

Softly thy radiance works a spell,

Night is enhanced, as a note may swell

From a simple melody.

*Pastime Poems*

The Meteor

E. Macdonald. London, England. 1924

**Darwin, Erasmus** 1731–1802

English physician and poet

Ethereal Powers! you chase the shooting stars,

Or yoke the vollied lightnings to your cars.

*The Botanic Garden*

Part I, Canto I, II, l. 115

Jones & Company. London, England. 1825

**Devaney, James** 1890–1976

Australian poet, novelist, journalist and teacher

The coming of this lovely night

Lifted the world’s great roof of blue

And bared the awful Infinite —

So grand an hour, so vast a view,

Abashed I stand each night anew:

When out of unimagined deeps

Spectacular you burst upon

The dark, and down the starry steeps

A trail of whitest fire you shone

One breathless moment — and were gone.

*Where the Wind Goes*

To a Falling Star

Angus & Robertson. Sydney, Australia. 1939

**Dodd, Robert** 1936–

No biographical data available

It is much too early to tell whether the idea of periodic impacts by extraterrestrial objects will blossom into a still

grander view of the Earth's relation to the other members of the Sun's family or will wither before a fiery blast of new data, but it shows that the romance between geology and planetary astronomy that began with the manned space program is far from over.

*Thunderstones and Shooting Stars*

Chapter 11 (p. 186)

Harvard University Press. Cambridge, Massachusetts, USA. 1986

### Dorman, Imogen

No biographical data available

Down thru the cold blue depths you've gone

A wanderer lone

Bearing a message written on

Metallic stone.

Cast from the planet of your birth

Thru cold you've flown,

Cold such as mortals on the earth

Have never known.

Heat you have found in wintry skies

Earth's atmosphere

Set you aflame, to many eyes

An omen drear.

Lucky the ones who, searching, read

Your message true,

Wanderer of the lightning speed

Down from the blue.

The Meteor

*Popular Astronomy*, Volume 38, Number 3, March 1930 (p. 133)

### Dryden, John 1631–1700

English poet, dramatist, and literary critic

And oft, before tempestuous winds arise,

The seeming stars fall headlong from the skies,

And shooting through the darkness, gild the night

With sweeping flories and long trails of light.

*The Poetical Works of Dryden*

Virgil's Georgics, Book I, l. 501–504

The Riverside Press. Cambridge, Massachusetts, USA. 1949

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

I would rather believe in ghosts than in hyperbolic meteors.

In David H. Levy

*The Man Who Sold the Milky Way* (p. 8)

University of Arizona Press. Tucson, Arizona. 1993

### Frost, Robert 1874–1963

American poet

Have I not walked without an upward look

It was a risk I had to take — and took.

*Complete Poems of Robert Frost*

Bravado

Henry Holt & Company. New York, New York, USA. 1949

Did you stay up last night (the Magi did)

To see the star shower known as Leonid

That once a year by hand or apparatus

Is so mysteriously pelted at us?

*Complete Poems of Robert Frost*

A Loose Mountain (Telescopic)

Henry Holt & Company. New York, New York, USA. 1949

### Hoffman, Jeffrey 1944–

American astronaut

Suddenly I saw a meteor go by underneath me. A moment later I found myself thinking, That can't be a meteor. Meteors burn up in the atmosphere above us; this was below us. Then, of course, the realization hit me [I was in space].

In Kevin W. Kelley

*The Home Planet*

With Plate 10

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1988

### Holmes, Charles N.

No biographical data available

Across the darkened dome of night

Where sun-kings reign till break of dawn,

A shooting star darts fast and bright,

Then like a spectral light is gone;

It fades from sight, and leaves behind

No more a trace than passing wind.

*The Shooting Star*

Source undetermined

### Jeffers, Robinson 1887–1962

American poet

It was like the glittering night last October

When the earth swam through a comet's tail, and fiery

serpents

Filled half of heaven.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 283)

Stanford University Press. Stanford, California, USA. 1988

### Jefferson, Thomas 1743–1826

3<sup>rd</sup> president of the United States

We certainly are not to deny whatever we cannot account for. A thousand phenomena present themselves daily which we cannot explain, but where facts are suggested, bearing no analogy with the laws of nature as yet known to us, their verity needs proof proportioned to their difficulty. A cautious mind will weigh the opposition of the phenomenon to everything hitherto observed, the strength of the testimony by which it is supported, and the error and misconceptions to which even our senses are liable. It may be very difficult to explain how the stone you possess came into the position in which it was found. But is it easier to explain how it got into the clouds from whence it is supposed to have fallen? The actual fact however is the thing to be established.

In Andrew A. Lipscomb (ed.)

*The Writings of Thomas Jefferson*

Volume 11 (p. 440)  
Thomas Jefferson Memorial Association. Washington, D.C. 1905

I could more easily believe that two Yankee professors  
would lie than that stones would fall from the heaven.

In R.V. Jones  
The Natural Philosophy of Flying Saucers  
*Physics Bulletin*, Volume 19, 1968 (p. 225)

**London, Jack** 1876–16  
American author

I would rather be a meteor, every atom of me in magnifi-  
cent glow, than a sleepy and permanent planet.  
*StarDate*, May/June 1955 (p. 3)

**Martin, Florence Holcomb**  
No biographical data available

Slashed by the earth the comets orbit glares  
With tiny meteors; each fiery tail  
Now into incandescence sparks and flares  
In earth's rare upper atmosphere.  
The Riddle of the Skies  
*The Scientific Monthly*, Volume LXXV, Number 2, August 1952 (p. 119)

**Mitchell, Maria** 1818–89  
American astronomer and educator

...a meteor seems to come like a messenger from departed  
spirits.  
In Eve Merriam  
*Growing Up Female in America*  
Maria Mitchell (p. 81)  
Doubleday & Company, Inc. Garden City, New York, USA. 1971

**Mooch**  
Fictional character

You mean that this little pebble's been out there hot-rod-  
din' around the universe?  
*The Blob*  
Film (1958)

**Plum, David**  
No biographical data available

Then bear us, O Earth, with our eyes upward gazing,  
To the place where the Star-God his fireworks displays;  
When countless as snowflakes are meteors blazing  
With their red, green and orange and amber-like rays.  
Meteors  
*New York Evening Post*, November 20, 1866

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

And certain stars shot madly from their spheres.  
In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
A Midsummer-Night's Dream  
Act II, Scene i, l. 153  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Silliman, G. S.**  
No biographical data available

It seems not in accordance with ascertained science to  
ascribe mysterious appearances on the earth, or in its atmo-  
sphere, to causes preceding from the planets, or spheres,  
moving in space, independent of the earth and its system...  
Is it not more in harmony with the integrity and perfection  
of His work that this phenomenon [meteorites] should origi-  
nate in a meteorological process, than that the symmetry of  
the creation should be violated by a visit to the earth of a  
lone, foreign intruder from the depths of space?  
*On the Origin of Aerolites*  
W.C. Bryant. New York, New York, USA. 1859

**Smythe, Daniel** 1908–81  
American poet

A curve of fire traces the dark  
And warns us of a visitor.  
It makes an unfamiliar mark  
And then is seen no more.  
The Meteor  
*Nature Magazine*, Volume 50, Number 9, November 1957 (p. 493)

**Teasdale, Sara** 1884–1933  
American writer and poet

I saw a star slide down the sky,  
Blinding the north as it went by,  
Too burning and too quick to hold,  
Too lovely to be bought or sold,  
Good only to make wishes on  
And then forever to be gone.  
*The Collected Poems of Sara Teasdale*  
The Falling Star (p. 198)  
Collier Books. New York, New York, USA. 1966

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Now slides the silent meteor on, and leaves  
A shining furrow, as thy thoughts in me.  
*Alfred Tennyson's Poetical Works*  
The Princess, VII  
Oxford University Press, Inc. London, England. 1953

## The Bible

I saw a star that had fallen from heaven to the earth...  
*The Revised English Bible*  
Revelation 9:1–2  
Oxford University Press, Inc. Oxford, England. 1989

**Virgil** 70 BCE–19 BCE  
Roman epic, didactic, and idyllic poet

As oft, from heaven unfixed, shoot flying stars,  
And trail their locks behind them.  
In *Great Books of the Western World* (Volume 13)  
*The Aeneid*  
Book V, l. 528–529 (pp. 200–201)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

When it struck our earth there was to be a magnificent spectacle, no doubt, for those who were on the right side of our planet to see; but beyond that nothing. It was doubtful whether we were on the right side. The meteor would loom larger and larger in the sky, but with the umbra of our earth eating its heart of brightness out, and at last it would be the whole sky, a sky of luminous green clouds, with a white brightness about the horizon west and east. Then a pause — a pause of not very exactly definite duration — and then, no doubt, a great blaze of shooting stars. They might be of some unwonted colour because of the unknown element that line in the green revealed. For a little while the zenith would spout shooting stars. Some, it was hoped, would reach the earth and be available for analysis.

*Seven Famous Novels by H.G. Wells*

In the Days of the Comet

Book I, Chapter 5 (p. 774)

Alfred A. Knopf. New York, New York, USA. 1934

**METEORITE****Alexander, William**

No biographical data available

**Street, Arthur**

No biographical data available

Meteorites usually consist of an alloy of iron with about 8 per cent of nickel, with a small amount of cobalt. No doubt primitive man, whose local culture was thus by accident raised from the level of the stone age to that of the iron age, thought metallic meteorites were valuable gifts from the gods. Nowadays, however, meteorites are hardly regarded as a useful source of iron. For one thing the delivery service is erratic and the unheralded arrival of a meteorite in one's back garden would be more embarrassing than profitable.

*Metals In the Service of Man*

Penguin Books Ltd. Harmondsworth, England. 1945

**Chlandni, E. F. F.**

No biographical data available

If the planets had a beginning, then either they must have formed from pieces of matter in an unconsolidated and chaotic state, which had been dispersed throughout a vast space before gravitational attraction gathered them into large masses; or else new planetary bodies were formed from the fragments of much larger ones that were broken to pieces, either by some external impact or by an internal explosion.... [I]t seems likely that many of these original pieces would not have joined the larger accumulating planets, because they were too far from them or traveling

at excessive velocities, but would have remained independent...continuing their journeys in space until each entered the sphere of attraction of some planet, whereupon it would fall, giving rise to the meteoritic phenomenon.

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 5 (p. 77)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Frost, Robert** 1874–1963

American poet

Never tell me that not one star of all  
That slipped from heaven at night and softly fall  
Has been picked up with stones to build a wall.

*Complete Poems of Robert Frost*

A Star in a Stone-Boat

Henry Holt &amp; Company. New York, New York, USA. 1949

**Hamilton, W.**

No biographical data available

The outside of every stone that has been found [in the Siennese territory], and has been ascertained to have fallen from the cloud near Sienna, is evidently freshly vitrified, and is black, having every sign of having passed through an extreme heat; when broken, the inside is of a light-gray color mixed with black spots, and some shining particles, which the learned here have decided to be pyrites....

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 2 (p. 13)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Because we all confidently believe that there are at present, and have been from time immemorial, many worlds of life besides our own, we must regard it as probable in the highest degree that there are countless, seed-bearing meteoric stones moving about through space. If at the present instant no life existed upon this Earth, one such stone falling upon it might, by what we blindly call natural causes, lead to its becoming covered with vegetation.... The hypothesis that life originated on this Earth through moss-grown fragments from the ruins of another world may seem wild and visionary: all I maintain is that it is not unscientific.

*Address of Sir William Thomson, Knt., L.L.D., F.R.S., President*

Taylor &amp; Francis. London, England. 1871

**Meunier, M. S.**

No biographical data available

[I have concluded that] the meteorites are pieces of debris from a disrupted planet. Now just as one can, from exhumed remains of extinct animals, reconstruct the beings of past epochs, so it should be possible by examining

meteorites to reconstruct the celestial body that supplies these fossil vestiges....

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 3 (p. 29)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

### **Paneth, F. A.**

No biographical data available

As is well known, the most exact way of determining the ages of rocks depends on the regularity of radioactive decay processes. Obviously the same method can be applied to meteorites.... In our present state of ignorance of how they were formed, we must admit the possibility that there may be meteorites substantially older than the oldest strata of the earth.

In John A. Wood

*Meteorites and the Origin of Planets*

Chapter 4 (p. 55)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

### **Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

Of all the astronomical events, the fall of a meteorite is the most unnerving and yet the most reassuring. Reassuring because it proves to us that the depths of space are inhabited by bodies made of the same elements we have here on earth, that, at rock bottom, a man and a star are built of the same stuff.

*An Almanac for Moderns*

August Eleventh (p. 155)

G.P. Putnam's Sons. New York, New York, USA. 1935

## **METHOD**

### **Bernard, Claude** 1813–78

French physiologist

...good methods can teach us to develop and use to better purpose the faculties with which nature has endowed us, while poor methods may prevent us from turning them to good account. Thus the genius of inventiveness, so precious in the sciences, may be diminished or even smothered by a poor method, while a good method may increase and develop it.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter II, Section ii (p. 35)

Henry Schuman, Inc. New York, New York, USA. 1927

### **Billroth, Theodor** 1829–84

No biographical data available

The method of research, however, of positing the questions and solving the questions posited, is invariably the same, whether we have before us a blooming rose, a diseased grape-vine, a shining beetle, the spleen of a leopard, a

bird's feather, the intestines of a pig, the brain of a poet or philosopher, a sick poodle, or a hysterical princess.

*The Medical Sciences in the German Universities (Part II)*

The Descriptive Sciences (p. 53)

The Macmillan Company. New York, New York, USA. 1924

### **Camus, Albert** 1913–60

Algerian-French novelist, essayist, and playwright

When one has no character one has to apply a method.

*The Fall* (p. 11)

Alfred A. Knopf. New York, New York, USA. 1958

### **Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

The method employed I would gladly explain,

While I have it so clear in my head,

If I had but the time and you had but the brain —

But much yet remains to be said.

*The Complete Works of Lewis Carroll*

The Hunting of the Snark

Fit the Fifth (p. 771)

The Modern Library. New York, New York, USA. 1936

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

The availability of a large number of established methods serves in modern science often as a surrogate of thought.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part III

Science or an Obsession (p. 170)

Rockefeller University Press. New York, New York, USA. 1978

### **Cohen, Morris Raphael** 1880–1947

American philosopher

...the safety of science depends on there being men who care more for the justice of their methods than for any results obtained by their use.

*An Introduction to Logic and Scientific Method*

Chapter XX, Section 2 (p. 402)

Harcourt, Brace & Company. New York, New York, USA. 1934

### **Committee on the Conduct of Science**

The fallibility of methods means that there is no cookbook approach to doing science, no formula that can be applied or machine that can be built to generate scientific knowledge.... The skillful application of methods to a challenging problem is one of the great pleasures of science.

*On Being a Scientist*

The Nature of Scientific Research (p. 6)

National Academy Press. Washington, D.C. 1989

Some methods, such as those governing the design of experiments or the statistical treatment of data, can be written down and studied. But many methods are learned only through personal experience and interactions with other scientists. Some are even harder to describe or

teach. Many of the intangible influences on scientific discovery — curiosity, intuition, creativity — largely defy rational analysis, yet they are often the tools that scientists bring to their work.

*On Being a Scientist*

The Nature of Scientific Research (p. 6)

National Academy Press. Washington, D.C. 1989

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Method consists entirely in the order and disposition of the objects towards which our mental vision must be directed if we would find out any truth.

In *Great Books of the Western World* (Volume 31)

*Rules For the Direction of the Mind*

Rule V (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

You know my method. It is founded upon the observation of trifles.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Bascombe Valley Mystery (p. 148)

Wings Books. New York, New York, USA. 1967

Pon my word Watson, you are coming along wonderfully. We have really done very well indeed. It is true that you have missed everything of importance, but you have hit upon the method...

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Case of Identity (p. 411)

Wings Books. New York, New York, USA. 1967

**Egler, Frank E.** 1911–96

American botanist and ecologist

For all their value, the application of a method, alone, is not science, any more than a pile of bricks is architecture. I would sooner trust a good mind without a method than a good method without a mind.

*The Way of Science*

Methodology of Science (p. 36)

Hafner Publishing Company. New York, New York, USA. 1970

Concepts are games we play with our heads; methods are games we play with our hands, which at times are so handy they can be played without a head.

*The Way of Science*

Holism (p. 34)

Hafner Publishing Company. New York, New York, USA. 1970

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The method of nature: who could ever analyze it?

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

The Method of Nature (p. 119)

The Library of America. New York, New York, USA. 1983

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

We are convinced that exactitude in experiments is less the outcome of faithful observation of the divisions of an instrument than of exactitude of method.

In Maurice Crosland

*Gay-Lussac: Scientist and bourgeois*

Chapter 3 (p. 70)

Cambridge University Press. Cambridge, England. 1978

**Greenstein, George** 1940–

American astronomer

The scientist immersed in research is more bound up by the methods he employs than by the object of his study.

*Frozen Star*

Chapter 1 (p. 6)

Freundlich Books. New York, New York, USA. 1983

**Hertz, Heinrich** 1857–94

German physicist

For the moment I am blundering without precise method. I repeat old experiments in this field and demonstrate others which pass through my head...I hope that, among the hundred remarkable phenomena which I come across, some light will shine from one or another.

In René Taton

*Reason and Chance in Scientific Discovery*

Chapter III (p. 4)

Philosophical Library. New York, New York, USA. 1957

**Hilbert, David** 1862–1943

German mathematician

...for he who seeks for methods without having a definite problem in mind seeks for the most part in vain.

Hilbert: Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902

(p. 444)

**Hubble, Edwin Powell** 1889–1953

American astronomer

The methods of science may be described as the discovery of laws, the explanation of laws by theories, and the testing of theories by new observations. A good analogy is that of the jigsaw puzzle, for which the laws are the individual pieces, the theories local patterns suggested by a few pieces, and the tests the completion of these patterns with pieces previously unconsidered.

*The Nature of Science and Other Lectures*

Part I, The Nature of Science (p. 11)

The Huntington Library, San Marino, California, USA. 1954

**Lonergan, Bernard J. F.** 1904–84

Canadian philosopher, theologian, and educator

It is in the measure that special methods acknowledge their common core in transcendental method, that norms common to all the sciences will be acknowledged, that a secure basis will be attained for tackling interdisciplinary problems, and that the sciences will be mobilized within a higher unity of vocabulary, thought and orientation, in which they will be able to make their quite significant contribution to the solution of fundamental problems.

*Method in Theology*

Chapter 1 (p. 23)

Herder & Herder. New York, New York, USA. 1972

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

With a good method even a rather untalented person can accomplish much.

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*

Chapter 3 (p. 101)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

Everything is in the method, in the chances of attaining a steadfast, lasting truth...

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*

Chapter 3 (p. 83)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

**Pólya, George** 1887–1985

Hungarian mathematician

What is the difference between a method and device?

A method is a device which you use twice.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The Traditional Mathematics Professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

My method to overcome a difficulty is to go round it.

*How to Solve It: A New Aspect of Mathematical Method*

Part III, The traditional mathematics professor (p. 208)

Princeton University Press. Princeton, New Jersey, USA. 1973

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In science the man of real genius is the man who invents a new method. The notable discoveries are often made by his successors, who can apply the method with fresh vigor, unimpaired by the previous labour of perfecting it; but the mental caliber of the thought required for their work, however brilliant, is not so great as that required by the first inventor of the method.

*Mysticism and Logic and Other Essays*

Chapter II, Section II (p. 41)

Longmans, Green & Company. London, England. 1925

**Sagan, Carl** 1934–96

American astronomer and author

The method of science, as stodgy and grumpy as it may seem, is far more important than the findings of science.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 1 (p. 22)

Random House, Inc. New York, New York, USA. 1995

**Sir Joseph**

Fictional character

Method is everything in archaeology, my boy. Why, we always deal with our finds in order.

*The Mummy*

Film (1940)

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Content without method leads to fantasy; method without content to empty sophistry; matter without form to unwieldy crudition, form without matter to hollow speculation.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 306)

Suhrkamp. New York, New York, USA. 1988

**Walker, Kenneth** 1882–1966

Physician

To understand the true function of science and to be able to evaluate its theories it will first be necessary to have a very clear idea of the method by which it works.

*Meaning and Purpose*

Chapter II (p. 16)

Jonathan Cape. London, England. 1944

**Wilson, Edwin B.** 1879–1964

American statistician

A method is a dangerous thing unless its underlying philosophy is understood, and none [is] more dangerous than the statistical. Our aim should be, with care, to avoid in the main erroneous conclusions. In a mathematical and strictly logical discipline the care is one of technique; but in the natural science and in statistics the care must extend not only over the technique but to the matter of judgment, as is necessarily the case in coming to conclusions upon any problem of real life where the complications are great. Over-attention to technique may actually blind one to the dangers that lurk about on every side — like the gambler who ruins himself with his system carefully elaborated to beat the game. In the long run it is only clear thinking, experienced methods, that win the strongholds of science.

*The Statistical Significance of Experimental Data*

*Science*, Volume 58, Number 1493, 10 August 1923 (p. 94)

**METRICS**

**Lederman, Leon** 1922–

American high-energy physicist



In the 1990s the United States, not to be left too far behind, is inching toward the metric system.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 4 (p. 108)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

## MICROBE

### Donaldson, T. B.

No biographical data available

He, who fights Microbes Away  
Will be an Immune, some fine Day.

*An Apropos Alphabet with Immoral Conclusions by an Absent-Minded Beggar in Red & Blue*

Letter K

W.S. Sterling & Company. New York, New York, USA. 1900

### Dunne, Finley Peter 1867–1936

American journalist and humorist

...microbes is a vigitable, an' ivry man is like a conservatory full iv millyons iv these potted plants.

*Mr. Dooley's Opinions*

Christian Science (p. 5)

Harper. New York, New York, USA. 1906

### Gillilan, Strickland 1869–1954

American poet-humorist

Adam Had 'em.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#79 (p. 5)

Harper & Row, Publishers. New York, New York, USA. 1969

### Huxley, Aldous 1894–1963

English writer and critic

...think of the inexpugnable retreats for microbes prepared by Michelangelo in the curls of Moses' beard!

*Time Must Have a Stop*

Chapter III (p. 36)

The Sun Dial Press. Garden City, New York, USA. 1944

### Muir, John 1838–1914

American naturalist

And surely all God's people, however serious and savage, great or small, like to play. Whales and elephants, dancing, humming gnats, and invisibly small mischievous microbes — all are warm with divine radium and must have lots of fun in them.

*My Boyhood and Youth*

Chapter V (pp. 149–150)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1913

### Nobel, Alfred 1833–96

Swedish chemist, engineer, inventor, and industrialist

The advance in scientific research and its ever widening sphere stirs the hope in us that the microbes, those of the

soul as well as of the body, will gradually disappear, and that the only war humanity will wage in the future will be one against these microbes.

Quoted in Selman A. Waksman

*Les Prix Nobel. The Nobel Prizes in 1952*

Nobel banquet speech for award received in 1952

Nobel Foundation. Stockholm, Sweden. 1953

### Osler, Sir William 1849–1919

Canadian physician and professor of medicine

In war the microbe kills more than the bullet.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 2) (p. 427)

Clarendon Press. Oxford, England. 1925

### Waksman, Selman A. 1888–1973

Ukrainian-born American biochemist

With the removal of the danger lurking in infectious diseases and epidemics, society can face a better future, can prepare for a time when other diseases not now subject to therapy will be brought under control. Let us hope that in contributing the antibiotics, the microbes will have done their part to make the world a better place to live in.

*Les Prix Nobel. The Nobel Prizes in 1952*

Nobel banquet speech for award received in 1952

Nobel Foundation. Stockholm, Sweden. 1953

### Wolfe, Humbert 1885–1940

Poet and civil servant

The doctor lives by chicken pox,  
by measles, and by mumps.

He keeps a microbe in a box  
and cheers him when he jumps.

*Cursory Rhymes*

Poems Against Doctors II

E. Benn Limited. London, England. 1927

## MICROBIOLOGY

### Collard, Patrick

No biographical data available

Microbiology, like all the sciences, is founded upon the twin pillars of craft technique and philosophical speculation.

*The Development of Microbiology*

Chapter 1 (p. 1)

Cambridge University Press. London, England. 1976

## MICROCOSM

### Forbes, A.

No biographical data available

[A lake] is a little world within itself, a microcosm in which all the elemental forces are at work and the play of life goes on in full, but on a scale so small as to be easily grasped.

In F.E. Clements and V.E. Shelford  
*Bio-Ecology*  
 Chapter I (p. 14)  
 John Wiley & Sons, Inc. New York, New York, USA. 1939

## MICROPALEONTOLOGY

### Lipps, Jere

No biographical data available

Micropaleontology is a strange subject. It is not easily defined, its history is fairly dull, and it seems to focus only on geologic topics. Biologists by and large ignore those organisms that when fossilized become microfossils. Evolutionary biologists disdain them. Paleobiologists snub them, and “micropaleontologists” seem not to know what to do with them as once living animals or plants. Most “micropaleontologists” are not trained in biology, and the literature of micropaleontology is an enormous edifice testifying to that fact. Although not a mere flunky of geology, micropaleontology is nevertheless largely a servant of geology, albeit an extremely powerful one.

What, If Anything, Is Micropaleontology?  
*Paleobiology*, Volume 7, Number 2, 1981

## MICROSCOPE

### Bajer, Francis J.

No biographical data available

The curiosity of man remains undaunted since the dawn of civilization. It has manifested itself in many ways, not the least of which has been the burning desire to see but a little more or a little more clearly. Surely this is understandable when one realizes that almost all knowledge is first gleaned through visual inspection and observation. Scanning a Tiny World’s Wonders with the Magic of Electron Microscopy *Science Digest*, Volume 83, Number 3, March 1978 (p. 42)

### Baker, Henry 1698–1774

English naturalist

When you employ the Microscope, shake off all Prejudice, nor harbor any favorite Opinions; for, if you do, ‘tis not unlikely Fancy will betray you into Error, and make you see what you wish to see.

*The Microscope Made Easy*  
 Part I, Chapter XV, Cautions in Viewing Objects (p. 62)  
 Printed for R. Dodsley. London, England. 1743

### Dickens, Charles 1812–70

English novelist

Yes, I have a pair of eyes, replied Sam, and that’s just it. If they was a pair o’ patent double million magnifyin’ gas microscopes of hextra power, p’raps I might be able to see through a flight o’ stairs and a deal door; but bein’ only eyes, you see my wision’s limited.

*The Posthumous Papers of the Pickwick Club*

Chapter XXXIV (p. 415)  
 Dodd, Mead & Company. New York, New York, USA. 1944

### Dickinson, Emily 1830–86

American lyric poet

Faith is a fine invention  
 For gentlemen who see;  
 But microscopes are prudent  
 In an emergency.

*The Complete Poems of Emily Dickinson*  
 No. 185 (p. 87)  
 Little, Brown & Company. Boston, Massachusetts, USA. 1960

### Eliot, George (Mary Ann Evans Cross) 1819–80

English novelist

...very close and diligent looking at living creatures, even through the best microscope, will leave room for new and contradictory discoveries.

*Felix Holt, The Radical*  
 Chapter XXII (p. 226)  
 William L. Allison Company. New York, New York, USA. No date

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

I was sitting with my microscope,  
 upon my parlor rug,  
 With a very heavy quarto and a very lively bug;  
 The true bug had been organized  
 with only two antennae,  
 But the humbug in the copperplate would have them  
 twice as many.

*The Complete Poetical Works of Oliver Wendell Holmes*  
 Nux Postcoenatica, Stanza 1  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

### Hooke, Robert 1635–1703

English physicist

...me thinks it seems very probable, that nature has in these passages, as well as in those of Animal bodies, very many appropriated Instruments and contrivances, whereby to bring her designs and end to pass, which ‘tis not improbable, but that some diligent Observer, if help’d with better Microscopes, may in time detect.

*Micrographia*  
 Observation, XVIII (p. 116)  
 Printed by Jo. Martyn & Ja. Allestry. London, England. 1665

### Hugo, Victor 1802–85

French author, lyric poet, and dramatist

Where the telescope ends, the microscope begins, and which of the two has the grandest sight?

*Les Misérables*  
 Volume IV, Book III, Chapter 3 (p. 67)  
 The Heritage Press. New York, New York, USA. 1938

### Lambert, Johann Heinrich 1728–77

Swiss-German mathematician and astronomer

In a grain of sand, in a drop of water, we discover worlds and inhabitants; besides, our best microscopes only shew us the whales and elephants of those worlds; they are still far from reaching the insects.

Translated by James Jacque

*The System of the World*

Part I, Chapter III (p. 12)

Printed for Vernor & Hood. London, England. 1800

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

Microscopes should be invented for every kind of investigation and, where that is impossible, experiments should be conducted on a large scale. This is the only direct road to new discovery.

In J.P. Stern

*Lichtenberg: A Doctrine of Scattered Occasions*

Further Excerpts from Lichtenberg's Notebooks (p. 294)

Indiana University Press. Bloomington, Indiana, USA. 1959

**Mayo, William J.** 1861–1939

American physician

**Powers, Henry**

No biographical data available

Of all the Inventions none there is Surpasses  
the Noble Florentine's Dioptrick Glasses  
For what a better, fitter guift Could bee  
in this World's Aged Luciosity.  
To help our Blindnesse so as to devise  
a paire of new & Articial eyes  
By whose augmenting power wee now see more  
than all the world Has ever down Before.

In S. Bradbury

*The Microscope Past and Present*

In Commendation of ye Microscope (p. v)

Printed for R. Dodsley. London, England. 1743

**Selye, Hans** 1907–82

Austrian-American endocrinologist

The microscope can see things the naked eye cannot, but the reverse is equally true.

*From Dream to Discovery: On Being a Scientist*

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Strindberg, Johann** 1849–1912

Swedish dramatist and novelist

Then, is it reasonable to think that one can see, by looking in a microscope, what is going on in another planet?

*Chief Contemporary Dramatists; Twenty Plays from the Recent Drama of England, Ireland, America, Germany, France, Belgium, Norway, Sweden, and Russia*

Translated by N. Erichsen

The Father (p. 608)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**van Leeuwenhoek, Antony** 1632–1723

Dutch biology researcher and microscope developer

I have oft-times been besought, by divers gentlemen, to set down on paper what I have beheld through my newly invented Microscopia: but I have generally declined: first, because I have no style, or pen, wherewith to express my thoughts properly; secondly, because I have not been brought up to languages or arts, but only to business; and in the third place, because I do not gladly suffer contradiction or censure from others.

Observations Communicated to the Publisher in a Dutch Letter of the 9<sup>th</sup> of October 1676

*Philosophical Transactions of the Royal Society of London,*

Volume 12, 1677

**Whewell, William** 1794–1866

English philosopher and historian

...if the discoveries made by the Telescope should excite in any one's mind, difficulties respecting those doctrines of Natural Religion, — the adequacy of the Creator to the support and guardianship of all the animal life which may exist in the universe, — the discoveries of the Microscope may remove such difficulties: but...that train of thought which leads men to dwell upon such difficulties does not seem to be common.

*Of the Plurality of Worlds*

Chapter IV (p. 30)

John W. Parker & Son. London, England. 1853

**Wood, John George** 1827–1889

English writer on natural history

...even to those who aspire to no scientific eminence, the microscope is more than an amusing companion, revealing many of the hidden secrets of Nature, and unveiling endless beauties which were heretofore enveloped in the impenetrable obscurity of their own minuteness...a good observer will discover with a common pocket magnifier many a secret of nature which has escaped the notice of a whole array of dilettanti microscopists in spite of all their expensive and accurate instruments.

*Common Objects of the Microscope*

Chapter I (p. 2)

George Routledge & Sons. London, England. 1861

**MIGRATION**

**O'Neill, Gerard K.** 1927–92

American physicist

Every star around us is a favorable target for human migration. You don't have to wait for just those stars that happen to have earthlink planets; they may be very few and far between.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Cosmic Colonies (p. 297)

Ticknor & Fields. New York, New York, USA. 1984

**MILKY WAY**

**Alighieri, Dante** 1265–1321  
Italian poet and writer

...distinct with less and greater lights, the Galaxy so whitens between the poles of the world that it makes even the wise to question...

In *Great Books of the Western World* (Volume 21)  
*The Divine Comedy of Dante Alighieri*  
Paradise, Canto XIV, l. 97–100  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Chaucer, Geoffrey** 1343–1400  
English poet

See yonder, lo, the Galaxy  
Which men clepeth the Milky Way,  
For hit is whyt.

*The House of Fame*  
Book II  
Chatto & Windus. London, England. 1908

**de Fontenelle, Bernard le Bovier** 1657–1757  
French author

...you see that whiteness in the sky, which some call the milky-way; can you imagine what that is? Why, it is nothing but infinity of small stars, not to be seen by our eyes, because they are so very little; and they are sown so thick, one by another, that they seem to be one continued whiteness: I wish you had a glass to see this ant's nest of stars...

*Conversations on the Plurality of Worlds*  
The Fifth Evening (pp. 159–160)  
Printed for Peter Wilson. Dublin, Ireland. 1761

**de Morgan, Augustus** 1806–71  
English mathematician and logician

I have often had the notion that all the nebula we see, including our own, which we call the Milky Way, may be particles of snuff in the box of a giant of a proportionately larger universe. Of course the minimum time — a million of years or whatever the geologists make it — which our little affair has lasted, is but a very small fraction of a second to the great creature in whose nose we shall all be in a few tens of thousands of millions of millions of millions of years.

*A Budget of Paradoxes*  
Are Atoms Worlds (p. 377)  
Longmans, Green & Company. London, England. 1872

**Donne, John** 1572–1631  
English poet and divine

In that glistening circle in the firmament, which we call the Galaxie, the milkie way, there is not one starre of any of the six great magnitudes, which Astronomers proceed upon, belonging to that circle: it is a glorious circle, and

posseseth a great part of heaven, and yet is all of so little starres, as have no name, no knowledge taken of them...

*Donne's Sermons*  
Little Stars, Sermon 144 (p. 221)  
Clarendon Press. Oxford, England. 1942

**Hearn, Lafcadio** 1850–1904  
Greek-born American writer

In the silence of the transparent night, before the rising of the moon, the charm of the ancient tale sometimes descends upon me out of the scintillant sky, to make me forget the monstrous facts of science and the stupendous horror of space. Then I no longer behold the Milky Way, as that awful Ring of Cosmos, whose hundred million suns are powerless to lighten the abyss, but as the very Amanogwa itself — the river Celestial. I see the thrill of its shining stream, the mists that hover along the verge, and the watergrasses that bend in the winds of autumn. White Orihimé I see at her starry loom and the Ox that grazes on the farther shore — and I know that the falling dew is the spray of the Herdsman's oar.

*The Writings of Lafcadio Hearn*  
Volume VIII, The Romance of the Milky Way (p. 257)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1922

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

As we are used to call the appearance of the heavens, where it is surrounded with a bright zone, the Milky Way, it may not be amiss to point out some other very remarkable Nebulae which cannot well be less, but are probably much larger than our own system; and, being also extended, the inhabitants of the planets that attend the stars which compose them must likewise perceive the same phenomena. For which reason they may also be called milky ways by way of distinction.

In Laurence A. Marschall  
*The Supernova Story*  
Chapter 2 (p. 34)  
Plenum Press. New York, New York, USA. 1988

**Joyce, James** 1882–1941  
Irish-born author

Bloom was pointing out all the stars and the comets in the heavens to Chris Callinan and the jarvey: the great bear and Hercules and the dragon, and the whole jingbang lot. But, by God, I was lost, so to speak, in the milky way.

*Ulysses* (p. 231)  
Random House, Inc. New York, New York, USA. 1946

**Kilmer, Joyce** 1886–1918  
American poet

God be thanked for the Milky Way that runs across the sky.

That's the path that my feet would tread whenever I have to die.

Some folks call it a Silver Sword, and some a Pearly Crown.

But the only thing I think it is, is Main Street, Heaventown.  
*Main Street and Other Poems*  
Main Street  
George H. Doran Company. New York, New York, USA. 1917

**Lambert, Johann Heinrich** 1728–77  
Swiss-German mathematician and astronomer

I am undecided whether or not the visible Milky Way is but one of countless others all of which form an entire system. Perhaps the light from these infinitely distant galaxies is so faint that we cannot see them.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 217)  
Birkhäuser. Boston, Massachusetts, USA. 1987

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Showed the broad, white road in heaven,  
Pathway of the ghosts, the shadows,  
Running straight across the heavens,  
Crowded with the ghosts, the shadows.

*The Poetical Works of Henry Wadsworth Longfellow*  
The Song of Hiawatha, Hiawatha's Childhood  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Milton, John** 1608–74  
English poet

A broad and ample road, whose dust is Gold,  
And pavement Stars, as Stars to thee appear  
Seen in the galaxy, that Milkie way...

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book VII, l. 577–579  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ovid** 43 BCE–17 AD  
Roman poet

There is a high way, easily seen when the sky is clear. 'Tis called the Milky Way, famed for its shining whiteness.

Translated by Frank Justus Miller  
*Metamorphoses* (Volume 1)  
Book I, l. 168 (p. 15)  
William Heinemann. London, England. 1916

**Pasternak, Boris** 1890–1960  
Russian poet and novelist

With an awful, dreadful list  
Towards other galaxies unknown  
Ponderously turns the Milky Way...

*Poems*  
Night  
University of Michigan Press. Ann Arbor, Michigan, USA. 1959

And there, with frightful listing  
Through emptiness, away  
Through unknown solar systems

Revolves the Milky Way.

*Fifty Poems*  
Night  
George Allen & Unwin Ltd. London, England. 1963

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

Consider now the Milky Way; there also we see an innumerable dust; only the grains of this dust are not atoms, they are stars; these grains move also with high velocities; they act at a distance one upon another, but this action is so slight at great distance that their trajectories are straight; and yet, from time to time, two of them may approach near enough to be deviated from their path, like a comet which had passed too near Jupiter. In a world, to the eyes of a giant for whom our suns would be as for us our atoms, the Milky Way would seem only a bubble of gas.

*The Foundations of Science*  
Science and Method, Book IV  
Chapter I (p. 524)  
The Science Press. New York, New York, USA. 1913

**Rich, Adrienne** 1929–  
American poet

Driving at night I feel the Milky Way  
Streaming above me like the graph of a cry.

*Leaflets, Poems 1965–1968*  
Ghazals 7/24/68: ii  
W.W. Norton & Company, Inc. New York, New York, USA. 1969

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

This whole earth which we inhabit is but a point in space. How far apart, think you, dwell the two most distant inhabitants of yonder star, the breadth of whose disk cannot be appreciated by our instruments? Why should I feel lonely? is not our planet in the Milky Way?

*The Writings of Henry David Thoreau* (Volume 2)  
Walden  
Chapter V (p. 208)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Updike, John** 1932–  
American novelist, short story writer, and poet

The Milky Way, which used to be thought of as the path by which the souls of the dead traveled to Heaven, is an optical illusion; you could never reach it. Like fog, it would always thin out around you. It's a mist of stars we make by looking the long way through the galaxy...

*The Centaur*  
Chapter I (p. 37)  
Alfred A. Knopf. New York, New York, USA. 1995

**Wright, Thomas** 1711–86  
English cosmologist

This is the great Order of Nature which I shall now endeavor to prove, and thereby solve the Phenomena

of the Via Lactea; and in order thereto, I want nothing to be granted but what may easily be allowed, namely, that the Milky Way is formed of an infinite Number of small Stars.

*An Original Theory or New Hypothesis of the Universe*

Letter the Seventh (p. 62)

Printed for the Author. London, England. 1750

## MIND

**Adams, George** 1750–95

English instrument maker

The human mind, like a mirror, must be smoothed and polished, freed from false imaginations and perverted notions, before it is fit to receive and reflect the light of truth, and just information.

*Lectures on Natural and Experimental Philosophy* (Volume 2)

Lecture XIV (p. 101)

Printed by R. Hindmarsh. London, England. 1794

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

Elaborate apparatus plays an important part in the science of today, but I sometimes wonder if we are not inclined to forget that the most important instrument in research must always be the mind of man.

*The Art of Scientific Investigation*

Preface (p. ix)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

It is true that much time and effort is devoted to training and equipping the scientist's mind, but little attention is paid to the technique of making the best use of it.

*The Art of Scientific Investigation*

Preface (p. iv)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

## Blaise, Clarke

Our minds soar with instant connection, but our feet are stuck in temporal boots.

*Time Lord*

Chapter 1 (p. 19)

Weidenfeld & Nicolson. London, England. 2000

**Boas, George** 1891–1980

American philosopher

Though the solution of a problem may flash into the mind of the person without his knowing how it arose, nevertheless he has always done a good bit of thinking, puzzling, wondering about it before the flash occurs.

*The Inquiring Mind*

Chapter XV (p. 397)

Open Court Publishing Company. La Salle, Illinois, USA. 1959

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

**Chandrasekhar, Subrahmanyan** 1910–95

Indian-born American astrophysicist

When a supremely great creative mind is kindled, it leaves a blazing trail that remains a beacon for centuries.

Newton and Michelangelo

*Current Science*, Volume 67, Number 7, 10 October 1994 (p. 499)

**Darwin, Charles Robert** 1809–82

English naturalist

My mind seems to have become a kind of machine for grinding general laws out of large collections of facts...

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II, Autobiography (p. 81)

D. Appleton & Company. New York, New York, USA. 1896

But then arises the doubt, can the mind of man, which has, as I full believe, been developed from a mind as low as that possessed by the lowest animals, be trusted when it draws such grand conclusions?

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VIII (p. 282)

D. Appleton & Company. New York, New York, USA. 1896

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

To a great mind, nothing is little.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 6 (p. 187)

Wings Books. New York, New York, USA. 1967

**Dyson, Freeman J.** 1923–

American physicist and educator

I do not make any clear distinction between mind and God. God is what mind becomes when it is passed beyond the scale of our comprehension. God may be considered to be either a world-soul or a collection of world-souls. We are the chief inlets of God on this planet at the present stage of his development.

*Infinite in All Directions*

Part One, Chapter Six (p. 119)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

It appears to me that the tendency of mind to infiltrate and control matter is a law of nature. The infiltration of mind into the universe will not be permanently halted by any catastrophe or by any barrier that I can imagine. If our species does not choose to lead the way, others will do so, or may have already done so. If our species is extinguished, others will be wiser or luckier. Mind is patient. Mind has waited for 3 billion years on this planet before composing its first string quartet. It may have to wait for another 3 billion years before it spreads all over the galaxy. I do not expect that it will have to wait so long. But if necessary, it will wait. The universe is like a

fertile soil spread out all around us, ready for the seeds of mind to sprout and grow. Ultimately, late or soon, mind will come into its heritage.

*Infinite in All Directions*

Part One, Chapter Six (p. 118)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Scientific theories have blundered no doubt in the past; they blunder no doubt today; yet we cannot doubt that along with the error there come gleams of a truth for which the human mind is impelled to strive.

*Science and the Unseen World*

Chapter II (p. 22)

The Macmillan Company. New York, New York, USA. 1929

If we are to discern controlling laws of Nature not dictated by the mind it would seem necessary to escape as far as possible from the cut-and-dried framework into which the mind is so ready to force everything that it experiences.

*The Nature of the Physical World*

Chapter X (p. 210)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

The human mind is not capable of grasping the Universe. We are like a little child entering a huge library. The walls are covered to the ceiling with books in many different tongues. The child knows that something must have written these books. It does not know who or how. It does not understand the languages in which they are written. But the child notes a definite plan in the arrangement of the books — a mysterious order which it does not comprehend, but only dimly suspects.

In M. Taube

*Evolution of Matter and Energy*

Chapter 1 (p. 1)

Springer-Verlag. New York, New York, USA. 1985

**Feynman, Richard P.** 1918–88

American theoretical physicist

This law [the Law of Gravitation] has been called “the greatest generalization achieved by the human mind”, and you can guess already from my introduction that I am interested not so much in the human mind as in the marvel of a nature which can obey such an elegant and simple law as this law of gravitation. Therefore our main concentration will not be on how clever we are to have found it all out, but on how clever nature is to pay attention to it.

*The Character of Physical Law*

Chapter 1 (p. 14)

BBC. London, England. 1965

In this chapter we shall discuss one of the most far-reaching generalizations of the human mind. While we are admiring the human mind, we should take some time off to stand in awe of a nature that could follow with such completeness and generality such an elegantly simple principle as the law of gravitation.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

The Theory of Gravitation (p. 89)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Fletcher, Colin** 1922–2007

English backpacker and writer

In that first moment of shock, with my mind already exploding beyond old boundaries, I knew that something had happened to the way I looked at things.

*The Man Who Walked Through Time*

The Dream (p. 6)

Alfred A. Knopf. New York, New York, USA. 1967

**Frazer, Sir James George** 1854–1941

Scottish classicist and anthropologist

The mind of man refuses to acquiesce in the phenomena of sense. By an instinctive, an irresistible impulse it is driven to seek something beyond, something which it assumes to be more real and abiding than the shifting phantasmagoria of this sensible world.

*The Worship of Nature* (Volume 1)

Chapter I (p. 1)

Macmillan & Company Ltd. London, England. 1926

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

Astronomy and Pure Mathematics are the magnetic poles toward which the compass of my mind ever turns.

In Franz Schmidt and Paul Stäckel (eds.)

*Briefwechsel zwischen Carl Friedrich Gauss und Wolfgang Bolyai*

Letter XXIII, Letter to Bolyai, June 30, 1803 (p. 55)

B.G. Teubner. Leipzig, Germany. 1899

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

I shall not, either in this forum or anywhere, resolve the age-old riddle of epistemology: How can we “know” the “realities” of nature? I will, rather, simply end by restating a point well recognized by philosophers and self-critical scientists, but all too often disregarded at our peril. Science does progress toward more adequate understanding of the empirical world, but no pristine, objective reality lies “out there” for us to capture as our technologies improve and our concepts mature. The human mind is both an amazing instrument and a fierce impediment — and the mind must be interposed between observation and understanding.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Four, Chapter 16 (p. 214)  
Random House, Inc. New York, New York, USA. 1995

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

Many men have been laughed at...for gazing heavenward when their minds might have been occupied with affairs of earth. There will always be the mind that strives to reach to the skies, and the scoffer who regards all such aspirations as folly.

Two men stood looking through the bars,  
One saw mud, the other saw the stars.

*Discovery; or, The Spirit and Service of Science*  
Chapter I (pp. 21–22)  
Macmillan & Company Ltd. London, England. 1918

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

A mind which has once imbibed a taste for scientific inquiry, and has learnt the habit of applying its principles readily to the cases which occur, has within itself an inexhaustible source of pure and exciting contemplations...

*The Cabinet of Natural Philosophy*  
Part I, Chapter I, Section 11 (p. 14)  
Longman, Rees, Orme, Brown & Green. London, England. 1831

**Hey, Nigel S.** 1936–  
American science writer

Think of the myriad interconnected cells that we call a human being — living, dying and regenerating almost without our knowledge.... Think of the richness of their connectivity with the rest of creation. Think of their uncountable linkages with all the molecules — for example in air, in food, in water — that encounter us and enter into us almost without our knowledge, and leave us again, transformed, to visit some other resident, living or nonliving, of the world, the galaxy, the cosmos. This beautiful dance is what I see through the telescope of my mind.

*Why People Need Space*  
Lecture, National Space Centre, October 2002

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Every now and then a man's mind is stretched by a new idea or sensation, and never shrinks back to its former dimensions.

*The Autocrat of the Breakfast-Table*  
Chapter XI (p. 266)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

The mind, like Nature, abhors a vacuum.  
*The Novels and Poems of Victor Marie Hugo* (p. 262)  
Dumont, New York, New York, USA. 1896

**Huxley, Thomas Henry** 1825–95  
English biologist

The mind is so constituted that it does not willingly rest in facts and immediate causes, but seeks always after a knowledge of the remoter links in the chain of causation.

*Discourses Biological and Geological*  
On a Piece of Chalk  
D. Appleton & Company. New York, New York, USA. 1897

**Jevons, William Stanley** 1835–82  
English economist and logician

Summing up, then, it would seem as if the mind of the great discoverer must combine contradictory attributes. He must be fertile in theories and hypotheses, and yet full of facts and precise results of experience. He must entertain the feeblest analogies, and the merest guesses at truth, and yet he must hold them as worthless till they are verified in experiment. When there are any grounds of probability he must hold tenaciously to an old opinion, and yet he must be prepared at any moment to relinquish it when a clearly contradictory fact is encountered.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book IV, Chapter XXVI (p. 592)  
Macmillan & Company Ltd. London, England. 1887

**Kepler, Johannes** 1571–1630  
German astronomer

A mind accustomed to mathematical deduction, when confronted with the faulty foundations [of astrology] resists a long, long time, like an obstinate mule, until compelled by beating and curses to put its foot into that dirty puddle.

In Arthur Koestler  
*The Sleepwalkers*  
Part Four, Chapter I, Section 5 (p. 243)  
The Macmillan Company. New York, New York, USA. 1966

**Land, Edwin** 1909–91  
American scientist and inventor

Each stage of human civilization is defined by our mental structures: the concepts we create and then project upon the universe. They not only redescribe the universe but also in so doing modify it, both for our own time and for subsequent generations. This process — the revision of old cortical structures and the formulation of new cortical structures whereby the universe is defined — is carried on in science and art by the most creative and talented minds in each generation...

Remarks at Opening of New American Academy of Arts and Sciences  
Cambridge, Massachusetts April 2, 1979

**Lorentz, Hendrik Antoon** 1853–1928  
Dutch physicist

We wish to obtain a representation of phenomena and form an image of them in our minds. Till now, we have



always attempted to form these images by means of the ordinary notions of time and space. These notions are perhaps innate; in any case they have been developed by our daily observations. For me, these notions are clear, and I confess that I am unable to gain any idea of physics without them.... For me, an electron is a corpuscle which at any given instant is situated at a determinate point of space, and if I believe that at the following instant this corpuscle is situated elsewhere, I attempt to imagine its path, which is a line in space. And if this electron meets an atom and penetrates into its interior and, after several adventures, leaves the atom, I attempt to construct a theory in which this electron has retained its individuality...I would like to retain this ideal of other days and describe everything that occurs in this world in terms of clear pictures.

In A. d'Abro

*The Rise of the New Physics* (Volume One)

Chapter XIII (p. 108)

Dover Publications, Inc. New York, New York, USA. 1951

**Lovecraft, H. P. (Howard Phillips)** 1890–1937

American writer of fantasy, horror, and science fiction

The most merciful thing in the world, I think, is the inability of the human mind to correlate all its contents. We live on a placid island of ignorance in the midst of black seas of infinity, and it was not meant that we should voyage far. The sciences, each straining in its own direction, have hitherto harmed us little; but some day the piecing together of dissociated knowledge will open such terrifying vistas of reality, and of our own frightful position therein, that we shall either go mad from the revelation or flee from the deadly light into the peace and safety of a new dark age.

*The Call of Cthulhu*

The Horror in Clay (p. 139)

Penguin Books. New York, New York, USA. 1999

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

Give your mind now to the true reasoning I have to unfold. A new fact is battling strenuously for access to your ears. A new aspect of the Universe is striving to reveal itself. But no fact is so simple that it is not harder to believe than to doubt at the first presentation.

*On the Nature of the Universe*

Book II, l. 1023

Penguin Books. New York, New York, USA. 1994

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

When the human mind, with its limited powers, attempts to mirror in itself the rich life of the world, of which it is itself only a small part, and which it can never hope to exhaust, it has every reason for proceeding economically.

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 186)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

But to reason and to arrange are very different occupations of the mind; and a man may deserve praise as a mineralogist, who is but ill qualified for the researches of geology.

*Illustrations of the Huttonian Theory of the Earth*

Section 422 (p. 482)

Dover Publications, Inc. New York, New York, USA. 1964

**Puiseux, P.**

No biographical data available

It is an illogical peculiarity of the human mind that while it can not comprehend an infinite universe it readily refuses to limit it.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1912*

The Year's Progress in Astronomy (p. 135)

Government Printing Office. Washington, D.C. 1913

**Rosseland, Svein** 1894–1985

Norwegian astronomer

Who has not experienced the mysterious thrill of spring-time in a forest, with sunbeams flickering through the foliage, and the low humming of insect life? It is the feeling of unity with nature, which is the counterpart of the attitude of the scientist, analysing the sunbeams into light quanta and the soft rustling of the dragon-fly into condensations and rarefactions of the air. But what is lost in fleeting sentiment is more than regained in the feeling of intellectual security afforded by the scientific attitude, which may grow into a trusting devotion, challenging the peace of the religious mystic. For in the majestic growth of science, analytical in its experimental groping for detail, synthetic in its sweeping generalizations, we are watching at least one aspect of the human mind, which may be believed to have a future of dizzy heights and nearly unlimited perfectibility.

*Theoretical Astrophysics: Atomic Theory and the Analysis of Stellar Atmospheres and Envelopes*

Introduction (p. xi)

At The Clarendon Press. Oxford, England. 1936

**Rowland, Henry Augustus** 1848–1901

American physicist

I value in a scientific mind, most of all, that love of truth, that care in its pursuit, and that humility of mind which makes the possibility of error always present more than any other quality. This is the mind which has built up modern science to its present perfection, which has laid one stone upon the other with such care that it today offers to the world the most complete monument to human reason.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
 Chapter II (pp. 26–27)  
 Macmillan & Company Ltd. London, England. 1918

**Smollett, Tobias George** 1721–71  
 Scottish novelist

I find my spirits and my health affect each other reciprocally — that is to say, everything that decomposes my mind produces a correspondent disorder in my body; and my bodily complaints are remarkably mitigated by those considerations that dissipate the clouds of mental chagrin.

*The Works of Tobias Smollett* (Volume 6)  
 The Expedition of Humphry Clinker (p. 2340)  
 John D. Morris & Company. Philadelphia, Pennsylvania, USA. 1902

**von Humboldt, Alexander** 1769–1859  
 German naturalist and explorer

When the human mind first attempts to subject to its control the world of physical phenomena, and strives by meditative contemplation to penetrate the rich luxuriance of living nature, and the mingled web of free and restricted natural forces, man feels himself raised to a height from whence, as he embraces the vast horizon, individual things blend together in varied groups, and appear as if shrouded in a vapory veil.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
 Delineation of Nature. General Review of Natural Phenomena (p. 79)  
 Harper & Brothers. New York, New York, USA. 1869

That which, in the vagueness of our impressions, loses all distinctness of form, like some distant mountain shrouded from view by a veil of mist, is clearly revealed by the light of mind, which, by its scrutiny into the causes of phenomena, learns to resolve and analyze their different elements, assigning to each its individual character.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
 Introduction (pp. 33–34)  
 Harper & Brothers, Publishers. New York, New York, USA. 1869

...besides the pleasure derived from acquired knowledge, there lurks in the mind of man, and tinged with a shade of sadness, an unsatisfied longing for something beyond the present — a striving towards regions yet unknown and unopened.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
 Delineation of Nature. General Review of Natural Phenomena (p. 80)  
 Harper & Brothers, Publishers. New York, New York, USA. 1869

**Waddington, Conrad Hal** 1905–75  
 British biologist and paleontologist

We are part of nature, and our mind is the only instrument we have, or can conceive of, for learning about nature or about ourselves.

*The Nature of Life*  
 Chapter 5 (p. 124)  
 Harper & Row, Publishers. New York, New York, USA. 1960

**Weidlein, Edward Ray**  
 Chemical engineer

The endless frontiers of science now stretching to the stars can provide rich opportunities for the best creative minds.

Cooperation — A Responsibility of the Scientist  
*American Scientist*, March 1962 (p. 35)

**Weinberg, Steven** 1933–  
 American nuclear physicist

...I do not believe that scientific progress is always best advanced by keeping an altogether open mind. It is often necessary to forget one's doubts and to follow the consequences of one's assumptions wherever they may lead — the great thing is not to be free of theoretical prejudices, but to have the right theoretical prejudices. And always, the test of any theoretical preconception is where it leads.

*The First Three Minutes*  
 Chapter V (p. 119)  
 Basic Books, Inc., Publishers. New York, New York, USA. 1988

## MINERAL

**Smith, Godfrey**

Human life would certainly have enjoyed more innocence and satisfaction, were it not for the riches and lustre which nature dazzles their eyes with, and makes them indefatigable searchers into the innermost recesses of the earth, to her hidden treasures.

*The Laboratory; or, School of Arts*  
 Appendix  
 Of Mines and How to Discover Them  
 Printed by C. Whittingham. London, England. 1799

## MINERAL: ALABASTER

**Flaubert, Gustave** 1821–90  
 French novelist

Alabaster. Its use is to describe the most beautiful parts of a woman's body.

*Dictionary of Accepted Ideas*  
 M. Reinhardt. London, England. 1954

## MINERAL: AMBER

**Herrick, Robert** 1591–1674  
 English poet

I saw a flie within a beade  
 Of amber cleanly buried.

In J. Max Patrick (ed.)  
*The Complete Poetry of Robert Herrick*  
 The Amber Bead  
 W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Pope, Alexander** 1688–1744  
English poet

Pretty! in amber to observe the forms  
Of hairs, or straws, or dirt, or grubs, or worms!  
The things, we know, are neither rich nor rare,  
But wonder how the devil they got there.

*The Complete Poetical Works*

Epistle to Arbuthnot, l. 169

Houghton Mifflin Company. New York, New York, USA. 1903

## MINERAL: AMETHYST

### The Bible

The foundations of the city were adorned with precious stones...the twelfth, an amethyst.

*The Revised English Bible*

Revelation 21:21

Oxford University Press, Inc. Oxford, England. 1989

## MINERAL: CHALK

**Huxley, Thomas Henry** 1825–95  
English biologist

A great chapter of the history of the world is written in the chalk. Few passages in the history of man can be supported by such an overwhelming mass of direct and indirect evidence as that which testifies to the truth of the fragment of the history of the globe.... Let me add, that few chapters of human history have a more profound significance for ourselves. I weigh my words well when I assert, that the man who should know the true history of the bit of chalk which every carpenter carries about in his breeches-pocket, though ignorant of all other history, is likely, if he will think his knowledge out to its ultimate results, to have a truer, and therefore a better, conception of this wonderful universe, and of man's relation to it, than the most learned student who is deep-read in the records of humanity and ignorant of those of Nature.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On a Piece of Chalk (p. 4)

Macmillan & Company Ltd. London, England. 1904

The earth, from the time of the chalk to the present day, has been the theater of a series of changes as vast in their amount as they were slow in their progress. The area on which we stand has been first sea and then land for at least four alterations and has remained in each of these conditions for a period of great length.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On a Piece of Chalk (p. 29)

Macmillan & Company Ltd. London, England. 1904

A small beginning has led us to a great ending. If I were to put the bit of chalk with which we started into the hot but

obscure flame of burning hydrogen, it would presently shine like the sun. It seems to me that this physical metamorphosis is no false image of what has been the result of our subjecting it to a jet of fervent, though nowise brilliant, thought to-night. It has become luminous, and its clear rays, penetrating the abyss of the remote past, have brought within our ken some stages of the evolution of the earth. And in the shifting "without haste, but without rest" of the land and sea, as in the endless variation of the forms assumed by living beings, we have observed nothing but the natural product of the forces originally possessed by the substance of the universe.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On a Piece of Chalk (p. 36)

Macmillan & Company Ltd. London, England. 1904

## MINERAL: COAL

**Huxley, Thomas Henry** 1825–95  
English biologist

The position of the beds which constitute the coal-measures is infinitely diverse. Sometimes they are tilted up vertically, sometimes they are horizontal, sometimes curved into great basins; sometimes they come to the surface, sometimes they are covered up by thousands of feet of rock. But, whatever their present position, there is abundant and conclusive evidence that every under-clay was once a surface soil. Not only do carbonized root-fibers frequently abound in these under-clays; but the stools of trees, the trunks of which are broken off and confounded with the bed of coal, have been repeatedly found passing into radiating roots, still embedded in the under-clay. On many parts of the coast of England, what are commonly known as "submarine forests" are...seen at low water. They consist, for the most part, of short stools of oak, beech, and fir-trees, still fixed by their long roots in the bed of blue clay in which they originally grew. If one of these submarine forest beds should be gradually depressed and covered up by new deposits, it would present just the same characters as an under-clay of the coal, if the *Sigillaria* and *Lepidodendron* of the ancient world were substituted for the oak, or the beech, of our own times.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On the Formation of Coal (p. 147)

Macmillan & Company Ltd. London, England. 1904

## MINERAL: CRYSTAL

**Davidson, John** 1857–1909  
Scottish poet

"Who affirms that crystals are alive?"

I affirm it, let who will deny:

Crystals are engendered, wax and thrive,  
Wane and wither; I have seen them die.

*Fleet Street: And Other Poems*

Snow

Grant Richards. London, England. 1909

**Hauy, Abbé René Just** 1743–1822

French mineralogist

A casual glance at crystals may lead to the idea that they were sports of nature, but this is simply an eloquent way of declaring our ignorance. With a thoughtful examination of them, we discover laws of arrangement.... How variable, and at the same time how precise and regular are these laws! How simple they are ordinarily, without losing anything of their significance.

*Traité de Mineralogie* (p. xiii)

Chez Louis. Paris, France. 1801

**Hearn, Lafcadio** 1850–1904

Writer, translator, and teacher

I feel like a white granular mass of amorphous crystals — my formula appears to be isomeric with Spasmotoxin. My aurochloride precipitates into beautiful prismatic needles. My Platinochloride develops octohedron crystals, with fine blue florescence. My physiological action is not indifferent. One millionth of a grain injected under the skin of a frog produced instantaneous death accompanied by an orange blossom odor.

In Elizabeth Bisland

*The Life and Letters of Lafcadio Hearn* (Volume 1)

Letter to George M. Gould, 1889 (p. 462)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Mann, Thomas** 1875–1955

German-born American novelist

I shall never forget the sight. The vessel of crystallization was three-quarters full of slightly muddy water — that is, dilute waterglass — and from the sandy bottom there strove upwards a grotesque little landscape of variously colored growths: a confused vegetation of blue, green, and brown shoots which reminded one of algae, mushrooms, attached polyps, also moss, then mussels, fruit pods, little trees or twigs from trees, here, and there of limbs. It was the most remarkable sight I ever saw, and remarkable not so much for its profoundly melancholy nature.”

*Doktor Faustus*

Chapter III (p. 19)

Alfred A. Knopf. New York, New York, USA. 1948

**Marx, Carl M.**

No biographical data available

In these crystalline structures, the formative forces of the earth seem to manifest themselves most directly, as if they were merely slumbering lightly beneath the rigid surface, resting from the first day of creation.

Norman E. Emerton

*The Scientific Reinterpretation of Form*

Chapter One (p. 19)

Cornell University Press. Ithaca, New York, USA. 1984

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Tyndall declared that he saw in Matter the promise and potency of all forms of life, and with his Irish graphic lucidity made a picture of a world of magnetic atoms, each atom with a positive and a negative pole, arranging itself by attraction and repulsion in orderly crystalline structure. Such a picture is dangerously fascinating to thinkers oppressed by the bloody disorders of the living world. Craving for purer subjects of thought, they find in the contemplation of crystals and magnets a happiness more dramatic and less childish than the happiness found by mathematicians in abstract numbers, because they see in the crystals beauty and movement without the corrupting appetites of fleshly vitality.

*Back to Methuselah*

Preface (pp. lxii–lxiii)

Constable & Company Ltd. London, England. 1921

**Thompson, Sir D’Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

Crystals lie outside the province of this book; yet snow-crystals, and all the rest besides, have much to teach us about the variety, the beauty and the very nature of form.

*On Growth and Form* (Volume 2)

Chapter IX (p. 696)

At The University Press. Cambridge, England. 1951

## MINERAL: DIAMOND

**Fleming, Ian** 1935–

English novelist

It was domination by a beauty so pure that it held a kind of truth, a divine authority before which all other material things turned, like the bit of quartz, to clay. In these few minutes Bond understood the myth of diamonds, and he knew that he would never forget what he had suddenly seen inside the heart of this stone.

*Diamonds Are Forever*

Film (1971)

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

Perhaps time’s definition of coal is the diamond.

*Sand and Foam: A Book of Aphorisms* (p. 55)

Alfred A. Knopf. New York, New York, USA. 1959

**Meydendauer, A.**

German mineralogist

The diamond can only be of cosmic origin, having fallen as a meteorite at later periods of the earth’s formation.

The available localities of the diamond contain the residues of not very compact meteoric masses, which may, perhaps, have fallen in the prehistoric ages, and which have penetrated more or less deeply, according to the more or less resistant character of the surface where they fell. Their remains are crumbling away on exposure to the air and sun, and the rain has long ago washed away all prominent masses. The enclosed diamonds have remained scattered in the river-beds, while the fine, light matrix has been swept away.

In Frederick Houk Law

*Science in Literature*

The Romance of the Diamonds (p. 109)

Harper & Brothers. New York, New York, USA. 1929

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Now, a year or so ago, I had occupied my leisure in taking a London science degree, so that I have a smattering of physics and mineralogy. The thing was not unlike an uncut diamond of the darker sort, though far too large, being almost as big as the top of my thumb. I took it, and saw it had the form of a regular octahedron, with the curved faces peculiar to the most precious of minerals. I took out my penknife and tried to scratch it — vainly. Leaning forward towards the gas-lamp, I tried the thing on my watch-glass, and scored a white line across that with the greatest ease.

*Best Science Fiction Stories of H.G. Wells*

The Diamond Maker

Dover Publications, Inc. New York, New York, USA. 1966

**MINERAL: EMERALD**

**Salzberg, Hugh W.**

Take white lead, one part, and of any glass you choose, two parts, fuse together in a crucible and then pour the mixture. To this crystal, add the urine of an ass and after forty days you will find emeralds.

*From Caveman to Chemist*

Chapter III (p. 36)

American Chemical Society, Washington, D.C. 1991

**MINERAL: FLINT**

**Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

FLINT, n. A substance much in use as a material for hearts. Its composition is silica, 98.00; oxide of iron, 0.25; alumina, 0.25; water, 1.50. When an editor's heart is made, the water is commonly left out; in a lawyer's more water is added — and frozen.

*The Enlarged Devil's Dictionary* (p. 96)

Doubleday & Company, Inc. Garden City, New York, USA. 1967

**MINERAL: GRANITE**

**Cloos, Hans** 1885–1951

German geologist

However silent, these large, simple shapes have a wordless language. They say that the granite has grown in secure and secluded depths, guided wholly by its own laws; and that no disturbing outside influence has intervened in the slow tranquil growth of the crystals.

*Conversation with the Earth* (p. 105)

Alfred A. Knopf. New York, New York, USA. 1953

**MINERAL: JADE**

**Author undetermined**

When I think of a wise man, he seems like jade. Wise men have seen in jade all different virtues. It is soft, smooth and shining like kindness. It is hard, fine and strong like intelligence. Its edges seem sharp but do not cut, like justice. It hangs down to the ground like humility. When struck, it gives a clear, ringing sound, like music. The stains in it, which are not hidden and which add to its beauty, are like thoughtfulness. Its brightness is like heaven while its firm substance, born of the mountain and the waters, is like the earth. That is why wise men love jade.

In Joan M. Hartman

*Chinese Jade of Five Centuries*

C.E. Tuttle Company. Rutland, Vermont, USA. 1969

**MINERAL: LOADSTONE**

**Gilbert, William** 1544–1603

English scientist and physician

...the more advanced one is in the science of the loadstone, the more trust he has in the hypotheses, and the greater the progress he makes; nor will one reach anything like certitude in the magnetic philosophy, unless all, or at all events most, of its principles are known to him.

In *Great Books of the Western World* (Volume 28)

*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*

Preface (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**MINERAL: MARBLE**

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Verily it is one thing to have cash and another to know how to spend it. The man ought to die a violent death that put it into people's heads to try to make cherished,

beloved, sacred homes out of such cold, ghostly, unfeeling stuff as marble — a material which God intended for only gravestones. You can build a house out of it, and put a door-plate on it, and call it a dwelling, but it isn't any use — it is bound to look like a mausoleum, after all. Stewart's house looks like a stately tomb, now, and after it is finished it will never look entirely natural without a hearse in front of it.

Letter to San Francisco *Alta California*  
July 28, 1867

## MINERAL: OPAL

**Wilcox, Ella Wheeler** 1850–1919

American poet and journalist

And lo! The beautiful Opal,  
That rare and wondrous gem,  
Where the moon and sun blend into one,  
Is the child that was born to them.

*How Salvator Won & Other Recitations*

The Birth of the Opal

Edgar S. Werner. New York, New York, USA. 1891

## MINERAL: PEARL

**Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

Perhaps the sea's definition of a shell is the pearl.

*Sand and Foam: A Book of Aphorisms* (p. 55)

Alfred A. Knopf. New York, New York, USA. 1959

A pearl is a temple built by pain around a grain of sand.

*Sand and Foam: A Book of Aphorisms* (p. 4)

Alfred A. Knopf. New York, New York, USA. 1959

## MINERAL: SALT

### Author undetermined

A Salt is a substance which has been naturalized.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

**Boerhaave, Herman** 1668–1738

Dutch chemist, physician, and botanist

Whomsoever is not acquainted with the taste of Salts will never arrive at the knowledge of our Arcana.

*Elements of Chemistry* (Volume 1)

Part III (p. 438)

Printed for J. & J. Pemberton. London, England. 1735

**Darwin, Erasmus** 1731–1802

English physician and poet

Hence with diffusive salt old Ocean steeps  
His emerald shallows, and his sapphire deeps.  
Oft in wide lakes, around their warmer brim

In hollow pyramids the crystals swim;  
Or, fused by earth-born fires, in cubic blocks  
Shoot their white forms, and harden into rocks.

*The Botanic Garden*

Part I, Canto II, V

Canto II, l. 120–125 (p. 29–30)

Jones & Company. London, England. 1825

**Sagan, Carl** 1934–96

American astronomer and author

But let us look a little more deeply at our microgram of salt. Salt happens to be a crystal in which, except for defects in the structure of the crystal lattice, the position of every sodium and chlorine atom is predetermined. If we could shrink ourselves into this crystalline world, we would see rank upon rank of atoms in an ordered array, a regularly alternating structure — sodium, chlorine, sodium, chlorine, specifying the sheet of atoms we are standing on and all the sheets above us and below us. An absolutely pure crystal of salt could have the position of every atom specified by something like 10 bits of information. (Chlorine is a deadly poison gas employed in European battlefields in World War I. Sodium is a corrosive metal which burns upon contact with water. Together they make a placid and unpoisonous material, table salt. Why each of these substances has the properties it does is a subject called chemistry, which requires more than 10 bits of information to understand.) This would not strain the information-carrying capacity of the brain.

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 2 (p. 15)

Random House, Inc. New York, New York, USA. 1979

If the universe had natural laws that governed its behavior to the same degree of regularity that determines a crystal of salt, then, of course, the universe would be knowable. Even if there were many such laws, each of considerable complexity, human beings might have the capability to understand them all. Even if such knowledge exceeded the information-carrying capacity of the brain, we might store the additional information outside our bodies — in books, for example, or in computer memories — and still, in some sense, know the universe.

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 2 (p. 15)

Random House, Inc. New York, New York, USA. 1979

## MINERAL: SANDSTONE

**Abbey, Edward** 1927–89

American environmentalist and nature writer

The sandstone walls rise higher than ever before, a thousand, two thousand feet above the water, rounding off on top as half-domes and capitols, golden and glowing in the sunlight, a deep radiant red in the shade.

*Desert Solitaire*

Down the River (p. 205)  
Ballantine Books. New York, New York, USA. 1968

## MINERAL: SAPPHIRE

### Gübelin, Eduard

No biographical data available

In the close mesh of fiction and truth sapphire is more closely ensnared than any of its noble peers. Out of mankind's long acquaintance with it, towers of Babylonian dimensions have pressed heavily on its brazen back, built out of the tough ashlar of pagan and Christian magic, which sought to make use of supernatural powers through the stone of heavenly blue.

*The Color Treasury of Gemstones*

Sapphire: Lord Keeper of the Seals in the Gem Kingdom (p. 46)  
Crowell. New York, New York, USA. 1975

## MINERALOGIST

### Landes, K. K.

No biographical data available

Let there be more geological mineralogists! The only requirements, outside of educational background, are a prodigious curiosity, a vivid imagination, and a thick skin.

Geological Mineralogy

*American Mineralogist*, Volume 31, Number 3 & 4, March–April 1946 (p. 134)

### Russell, Bertrand Arthur William 1872–1970

English philosopher, logician, and social reformer

If you ask a mathematician, a mineralogist, a historian, or any other man of learning, what definite body of truths has been ascertained by his science, his answer will last as long as you are willing to listen.

*The Problems of Philosophy*

Chapter XV (p. 154)

Oxford University Press, Inc. London, England. 1959

## MINERALOGY

### Author undetermined

Mineralogy is the Alphabet of Geology.

In William Knight

*Facts and Observations Towards Forming a New Theory of the Earth*  
Introduction (p. 3)

### Verne, Jules 1828–1905

French novelist

I loved mineralogy, I loved geology. To me there was nothing like pebbles — and if my uncle had been in a little less of a fury, we should have been the happiest of families.

*A Journey to the Center of the Earth*

Chapter 1 (p. 6)

The Limited Editions Club. New York, New York, USA. 1966

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

...mineralogy is a science for the Understanding, for practical life; for its subjects are something dead which cannot rise again, and there is no room for synthesis.

In Johann Peter Eckermann

*Conversations with Goethe*

Friday, February 13, 1829 (p. 294)

J.M. Dent & Sons Ltd. London, England. 1970

## MINING

### Agricola, Georgius 1494–1555

German mineralogist

[I]f mining is a shameful and discreditable employment for a gentleman because slaves once worked mines, then agriculture also will not be a very creditable employment, because slaves once cultivated the fields, and even today do so among the Turks; nor will architecture be considered honest, because some slaves have been found skilful in that profession; nor medicine, because not a few doctors have been slaves; nor will any other worthy craft, because men captured by force of arms have practised it.

*De Re Metallica*

Book I (p. 23)

Dover Publications, Inc. New York, New York, USA. 1950

[I]nasmuch as the chief callings are those of the moneylender, the soldier, the merchant, the farmer, and the miner, I say, inasmuch as usury is odious, while the spoil cruelly captured from the possessions of the people innocent of wrong is wicked in the sight of God and man, and inasmuch as the calling of the miner excels in honour and dignity that of the merchant trading for lucre, while it is not less noble though far more profitable than agriculture, who can fail to realize that mining is a calling of peculiar dignity?

*De Re Metallica*

Book I (p. 24)

Dover Publications, Inc. New York, New York, USA. 1950

### Muir, John 1838–1914

American naturalist

The drifts and tunnels in the rocks may perhaps be regarded as the prayers of the prospector, offered for the wealth he so earnestly craves; but like the prayers of any kind not in harmony with nature, they are unanswered.

*Steep Trails*

Chapter XVI (p. 203)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

Mining discoveries and progress, retrogression and decay, seem to have been crowded more closely against each other here than on any other portion of the globe.

*Steep Trails*

Chapter XVI (p. 198)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**MIRACLE****Bradbury, Ray** 1920–

American writer

We live in miracles which cannot be explained. The scientist, the theologian, the artist — each attempts impossible explanations.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Ray Bradbury (p. 139)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

Evolution is very possibly not, in actual fact, always gradual. But it must be gradual when it is being used to explain the coming into existence of complicated, apparently designed objects, like eyes. For if it is not gradual in these cases, it ceases to have any explanatory power at all. Without gradualness in these cases, we are back to miracle, which is simply a synonym for the total absence of explanation.

*River Out of Eden: A Darwinian View of Life*

Chapter 3 (p. 83)

Basic Books. New York, New York, USA. 1995

**Dürrenmatt, Friedrich** 1921–90

Swiss playwright and novelist

...in the realm of science there is nothing more repugnant than a miracle.

Translated by James Kirkup

*The Physicists*

Act One (p. 48)

Grove Press, Inc. New York, New York, USA. 1964

**Einstein, Albert** 1879–1955

German-born physicist

That this [analogy of the atom with the solar system] insecure and contradictory foundation was sufficient to enable a man of Bohr's unique instinct and tact to discover the major laws of the spectral lines and of the electron shells of the atoms together with their significance to chemistry appeared to me like a miracle — and appears to me as a miracle even today. This is the highest form of musicality in the sphere of thought.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Autobiographical Notes (p. 45, 47)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Haldane, John Scott** 1860–1936

Scottish physiologist

The more we discover as to physiological activity and inheritance, the more difficult does it become to imagine any physical or chemical description or explanation which could in any way cover the facts as to the persistent co-ordination. From the standpoint of the physical sciences the maintenance and reproduction of a living organism is nothing less than a standing miracle, and for that reason the co-ordinated maintenance of structure and activity is inconsistent with the physical conception of self-existent matter and energy.

*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*

Lecture I, Mechanistic Biology (p. 11)

Doubleday, Doran &amp; Company, Inc. Garden City, New York, USA. 1931

**MIRROR****Durell, Clement V.** 1882–1968

English mathematician

...a reception was held and the science departments were on view. A young lady, entering the physical laboratory and seeing an inverted image of herself in a large concave mirror, naively remarked to her companion: "They have hung that looking glass upside down."

*Readable Relativity*

Chapter II (p. 12)

Harper &amp; Brothers. New York, New York, USA. 1960

**MISERY****Darwin, Charles Robert** 1809–82

English naturalist

...if the misery of our poor be caused not by the laws of nature, but by our institutions, great is our sin...

*The Voyage of the Beagle*

Chapter XXI (p. 500)

Heron Books. 1968

I am the most miserable, bemuddled, stupid dog in all England, and am ready to cry with vexation at my blindness and presumption.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to J.D. Hooker, July 14, 1857? (p. 461)

D. Appleton &amp; Company. New York, New York, USA. 1896

**MISTAKE****Braddon, Mary Elizabeth** 1837–1915

English novelist

We spend the best part of our lives in making mistakes, and the poor remainder in reflecting how very easily we might have avoided them.

*Aurora Floyd* (p. 241)

Ward, Lock &amp; Tyler. London, England. 1875



**Gombrich, Ernst Hans** 1909–2001  
English art historian and scholar

In order to learn, we must make mistakes, and the most fruitful mistakes which nature could have implanted in us would be the assumption of even greater simplicities than we are likely to meet in this bewildering world of ours.... To probe a hole we first use a straight stick to see how far it takes us. To probe the visible world we use the assumption that things are simple until they prove to be otherwise.

In John Pottage

*Geometrical Investigations* (p. 15)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1983

**Mayr, Ernst** 1904–2005  
German-born American biologist

In science one learns not only by one's own mistakes but by the history of the mistakes of others.

*The Growth of Biological Thought: Diversity, Evolution and Inheritance*  
Chapter 1 (p. 20)

Harvard University Press, Cambridge, Massachusetts, USA. 1982

**Miller, Henry George**  
No biographical data available

The more distinguished the doctor the more terrible the mistakes he has made — or will admit to.

Henry Millerisms

*World Neurology*, 9 April 1968 (p. 8)

**Obruchev, Vladimir** 1863–1956  
Russian geologist and geographer

Be persistent and persevering, but never stubborn. Do not cling to your judgments. Remember that there are many clever people in the world liable to spot your mistakes. If they are right, be not reluctant to agree with them.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers, Moscow, Russia. 1979

**Siegel, Eli** 1902–78  
American philosopher, poet, critic, and founder of Aesthetic Realism

If a mistake is not a stepping stone, it is a mistake.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #139 (p. 39)

Definition Press, New York, New York, USA. 1972

## MITOCHONDRION

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Surely, the mitochondrion that first entered another cell was not thinking about the future benefits of cooperation and integration; it was merely trying to make its own living in a tough Darwinian world.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter V (p. 310)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

## MIXTURE

**Huxley, Thomas Henry** 1825–95  
English biologist

Mix salt and sand, and it shall puzzle the wisest of men, with his mere natural appliances, to separate all the grains of sand from all the grains of salt; but a shower of rain will effect the same object in ten minutes.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 76)

Macmillan & Company Ltd. London, England. 1904

## MODEL

**Ball, John**

No biographical data available

To make progress in understanding all this, we probably need to begin with simplified (oversimplified?) models and ignore the critics' tirade that the real world is more complex. The real world is always more complex, which has the advantage that we shan't run out of work.

Memes as Replicators

*Ethology and Sociobiology*, Volume 5, Number 3, 1984 (p. 159)

**Bianco, Margery Williams** 1880–1944  
English-American author

The Rabbit could not claim to be a model of anything, for he didn't know that real rabbits existed; he thought they were all stuffed with sawdust like himself, and he understood that sawdust was quite out-of-date and should never be mentioned in modern circles.

*The Velveteen Rabbit: Or How Toys Become Real*

Athenaeum Books for Young Readers, New York, New York, USA. 2002

**Born, Max** 1882–1970  
German-born English physicist

All great discoveries in experimental physics have been due to the intuition of men who made free use of models, which were for them not products of the imagination, but representatives of real things.

Physical Reality

*Philosophical Quarterly*, Volume 3, Number 11, April 1953 (p. 140)

**Box, George E. P.** 1919–  
English statistician

All models are wrong but some are useful.  
Apocryphal

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

The pre-eminence of astronomy rests on the peculiarity that it can be treated mathematically; and the progress of physics, and most recently biology, has hinged equally on finding formulations of their laws that can be displayed as mathematical models.

*The Ascent of Man*

Chapter 5 (p. 165)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

Models — in contrast to those who sat for Renoir — improve with age.

*Heraclitean Fire: Sketches from a Life before Nature*

Part III

Science as a Profession (p. 171)

Rockefeller University Press. New York, New York, USA. 1978

### **Cheeseman, Peter**

Australian computer scientist

The apparent simplicity of a model is due to a failure of imagination and limited data, unless the domain really is simple. If the world were really random, chemistry, cooking, and credit would not be possible, so our models cannot be figments of our imagination.

In J. Shrager and P. Langley (eds)

Computational Models of Scientific Discovery and Theory Formation  
On Finding the Most Probable Model (p. 91)

Morgan Kaufmann Publishers. San Mateo, California, USA. 1990

### **Crick, Francis Harry Compton** 1916–2004

English biochemist

...no good model ever accounted for all the facts, since some data was bound to be misleading if not plain wrong. A theory that did fit all the data would have been “carpentered” to do this and would thus be open to suspicion.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 5 (p. 60)

Basic Books, Inc. New York, New York, USA. 1988

### **Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

When it comes to very highly organized systems, such as a living cell, the task of modeling by approximation to simple, continuous and smoothly varying quantities is hopeless. It is for this reason that attempts by sociologists and economists to imitate physicists and describe their subject matter by simple mathematical equations is rarely convincing.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*

Chapter 3 (p. 22)

Simon & Schuster. New York, New York, USA. 1988

The incorporation of imaginary elements into physical theories is one of the most difficult practices for a professional physicist to justify to the layman. Of course,

if a particular feature, such as isotopic spin symmetry, renders the model a brilliant success, then the physicist can simply reply, “I put it in because it works!”

*Superforce: The Search for a Grand Unified Theory of Nature*

Chapter 4 (pp. 66–67)

Simon & Schuster. New York, New York, USA. 1984

A model of the universe does not require faith, but a telescope. If it is wrong, it is wrong.

*Space and Time in the Modern Universe*

Chapter 7 (p. 201)

Cambridge University Press. Cambridge, England. 1977

### **Deutsch, Karl W.** 1912–92

Czech-born American international political scientist

Men think in terms of models.

Mechanism, Organism and Society

*Philosophy of Science*, Volume 18, Number 3, July 1951 (p. 230)

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Our model of Nature...should be like an engine with movable parts. We need not fix the position of any one lever; that is to be adjusted from time to time as the latest observations indicate. The aim of the theorist is to know the train of wheels which the lever sets in motion — that binding of the parts which is the soul of the engine.

The Internal Constitution of Stars

*Nature*, Volume 106, Number 2603, 2 September 1920 (p. 20)

### **Eigen, Manfred** 1927–

German biophysicist

A theory has only the alternative of being right or wrong. A model has a third possibility: it may be right, but irrelevant.

In J. Mehra (ed.)

*The Physicist's Conception of Nature: Symposium on the Development of the Physicist's Conception of Nature in the Twentieth Century*

Chapter 30 (p. 618)

Reidel. Boston, Massachusetts, USA. 1973

### **Ferris, Timothy** 1944–

American science writer

The model of the natural world we build in our minds by such a process will forever be inadequate, just a little cathedral in the mountains. Still it is better than no model at all.

*The Red Limit: The Search for the Edge of the Universe*

Preface (p. 8)

William Morrow & Company, Inc. New York, New York, USA. 1977

### **Feynman, Richard P.** 1918–88

American theoretical physicist

...the more you see how strangely Nature behaves, the harder it is to make a model that explains how even the simplest phenomena actually work. So theoretical physics has given up on that.

*QED: The Strange Theory of Light and Matter*

Chapter 3 (p. 82)  
Princeton University Press. Princeton, New Jersey, USA. 1985

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

I do not know that my view is more correct; I do not even think that “right” and “wrong” are good categories for assessing complex mental models of external reality — for models in science are judged [as] useful or detrimental, not as true or false.

*Dinosaur in a Haystack: Reflections in Natural History*  
Part Three, Chapter 8 (p. 96)  
Random House, Inc. New York, New York, USA. 1995

**Greedman, D. A.**  
No biographical data available

**Navidi, W. C.**  
No biographical data available

Models are often used to decide issues in situations marked by uncertainty. However statistical differences from data depend on assumptions about the process which generated these data. If the assumptions do not hold, the inferences may not be reliable either. This limitation is often ignored by applied workers who fail to identify crucial assumptions or subject them to any kind of empirical testing. In such circumstances, using statistical procedures may only compound the uncertainty.... Statistical modeling seems likely to increase the stock of things you think you know that ain't so.  
Regression Models for Adjusting the 1980 Census  
*Statistical Science*, Volume 1, Number 1, 1986 (p. 3)

**Greenwood, H. J.**  
No biographical data available

Let us not grace loose thinking with the word “model.”  
On Models and Modeling  
*Canadian Mineralogist*, Volume 27, 1989

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The making of models or pictures to explain mathematical formulae and the phenomena they describe is not a step towards, but a step away from reality; it is like making graven images of a spirit.... All the same, the mathematical physicist is still busily at work making graven images of the concepts of the wave-mechanics.

*The Mysterious Universe*  
Chapter V (p. 176, 177)  
The Macmillan Company. New York, New York, USA. 1932

**Kaplan, Abraham** 1918–93  
American philosopher of science, author, and educator

The words “model” and “mode” have, indeed, the same root; today, model building is science a la mode.  
*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter VII, Section 30 (p. 258)  
Chandler Publishing Company. San Francisco, California, USA. 1964

**Karlin, Samuel**  
No biographical data available

The purpose of models is not to fit the data but to sharpen the questions.

*11<sup>th</sup> R. A. Fisher Memorial Lecture*  
Royal Society 20 April 1983

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

I never satisfy myself until I can make a mechanical model of a thing. If I can make a mechanical model, I understand it.

*Baltimore Lectures on Molecular Dynamics, and the Wave Theory of Light* (p. 270)  
C.J. Clay & Sons. London, England. 1904

**Kolb, Edward W. (Rocky)** 1951–  
American cosmologist

To try to ferret out the important and interesting objects from the multitude of things in the sky, every cosmologist looks at the universe through a filter of a model, for without the conceptual framework of a model the staggering number of things in the universe would overwhelm anyone.

*Blind Watchers of the Sky*  
Chapter Eleven (p. 285)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

If you want to know whether you should take a model seriously or just regard it as a calculational tool, you can imagine that you are building a wall out of stones. For instance, if the stones represent models for various phenomena seen in the sky, and the wall represents all of astronomy, then choosing a model to explain a phenomenon is like choosing a stone to be incorporated into the wall. Sometimes the stone seems to fit naturally into a space in the wall; more often it has to be trimmed a bit to fit in. But it is impossible to judge whether it is a “beautiful” stone or the “correct” stone for that place in the wall when it is first inserted, because the true beauty or utility of the stone can't be judged in isolation from the rest of the wall. The two real criteria to judge the stone are whether it is one on which other stones can be placed and whether it exists harmoniously with the surrounding stones. If the stone not only fulfills the function of taking up spaces in the wall but also provides a platform on which to place other stones, it a beautiful stone.

*Blind Watchers of the Sky*  
Chapter Ten (pp. 287–288)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Lewis, C. S. (Clive Staples)** 1898–1963  
British author, scholar, and popular theologian

It is not impossible that our own Model will die a violent death, ruthlessly smashed by an unprovoked assault of new facts.... But I think it is more likely to change when, and because, far-reaching changes in the mental temper of our descendants demand that it should. The new Model will not be set up without evidence, but the evidence will turn up when the inner need for it becomes sufficiently great. It will be true evidence. But nature gives most of her evidence in answer to the questions we ask her. Here, as in the courts, the character of the evidence depends on the shape of the examination, and a good cross-examiner can do wonders.

*The Discarded Image: An Introduction to Medieval and Renaissance Literature*

Epilogue (pp. 222–223)

University Press. Cambridge, England. 1964

### **Lewis, Gilbert Newton** 1875–1946

American chemist

As we continue the great adventure of scientific exploration our models must often be recast. New laws and postulates will be required, while those that we already have must be broadened, extended and generalized in ways that we are now hardly able to surmise.

*The Anatomy of Science*

Chapter VIII (p. 219)

Yale University Press. New Haven, Connecticut, USA. 1926

### **Lindley, David** 1956–

English astrophysicist and author

There is no guarantee that any simple model will be able to explain everything.

*The End of Physics: The Myth of a Unified Theory*

Part I, Chapter 4 (p. 131)

Basic Books. New York, New York, USA. 1993

### **Lloyd, David**

No biographical data available

### **Volkov, Evgenii I.**

No biographical data available

One good experiment is worth a thousand models...; but one good model can make a thousand experiments unnecessary.

In C. Mosekilde and L. Mosekilde (eds.)

*Complexity, Chaos, and Biological Evolution*

The Ultradian Clock: Timekeeping for Intracellular Dynamics

(p. 51)

Plenum Press. New York, New York, USA. 1991

### **Maxwell, James Clerk** 1831–79

Scottish physicist

As long as the training of a naturalist enables him to trace the action only of a particular material system, without giving him the power of dealing with the general properties of all such systems, he must proceed by the method so often described in histories of science

— he must imagine model after model of hypothetical apparatus, till he finds one which will do the required work. If this apparatus should afterwards be found capable of accounting for many of the known phenomena, and not demonstrably inconsistent with any of them, he is strongly tempted to conclude that his hypothesis is a fact, at least until an equally good rival hypothesis has been invented.

Tait's Thermodynamics

*Nature*, Volume XVII, Number 431, January 31, 1878 (p. 258)

### **Miall, Andrew**

No biographical data available

There are those who try to generalize, synthesize, and build models, and there are those who believe nothing and constantly call for more data. The tension between these two groups is a healthy one; science develops mainly because of the model builders, yet they need the second group to keep them honest.

*Principles of Sedimentary Basin Analysis*

Chapter 8 (p. 363)

Springer-Verlag. New York, New York, USA. 1984

### **Milton, John** 1608–74

English poet

Hereafter, when they come to model Heav'n  
And calculate the Stars, how they will wield  
The mightier frame, how build, unbind, contrive  
To save appearances, how gird the Shear  
With Centric and Eccentric scribbled ore,  
Cycle and Epicycle, Orb in Orb.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VIII, l. 79–84

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Morrison, Foster**

No biographical data available

Much of the technical literature is difficult to read, even for scientists and engineers. Even the best books tend to dwell on the mathematical models and don't give the slightest hint what to do if one is lucky enough to have some data.

*The Art of Modeling Dynamic Systems: Forecasting for Chaos, Randomness & Determinism*

Preface (p. vii)

John Wiley & Sons, Inc. New York, New York, USA. 1991

### **Oreskes, Naomi**

No biographical data available

### **Belitz, K.**

No biographical data available

A model, like a novel, may resonate with nature, but it is not a "real" thing. Like a novel, a model may be convincing — it may "ring true" if it is consistent with our experience of the natural world. But just as we may

wonder how much the characters in a novel are drawn from real life and how much is artifice, we might ask the same of a model: How much is based on observation and measurement of accessible phenomena, how much is convenience? Fundamentally, the reason for modeling is a lack of full access, either in time or space, to the phenomena of interest.

*Science*, Volume 263, 1944

### **Paulos, John Allen** 1945–

American mathematician

The once-surprising existence of non-Euclidean models of Euclid's first four axioms can be seen as a sort of mathematical joke.

*Once Upon a Number: The Hidden Mathematical Logic of Stories*

Appendix: Humor and Computation (p. 132)

Basic Books. New York, New York, USA. 1998

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

We should always aim toward the economy of thought. It is not enough to give models for imitation. It must be possible to pass beyond these models and, in place of repeating their reasoning at length each time, to sum this in a few words.

Annual Report of the Board of Regents of the Smithsonian Institution, 1909

The Future of Mathematics (p. 128)

Government Printing Office. Washington, D.C. 1910

### **Poynting, John Henry** 1852–1914

English physicist

...while the building of Nature is growing spontaneously from within, the model of it, which we seek to construct in our descriptive science, can only be constructed by means of scaffolding from without, a scaffolding of hypotheses. While in the real building all is continuous, in our model there are detached parts which must be connected with the rest by temporary ladders and passages, or which must be supported till we can see how to fill in the understructure. To give the hypotheses equal validity with facts is to confuse the temporary scaffolding with the building itself.

*Collected Scientific Papers*

Part VII, Article 52 (p. 607)

At The University Press. Cambridge. 1920

### **Sciama, Dennis** 1926–99

English physicist

Since we find it difficult to make a suitable model of a certain type, Nature must find it difficult too. This argument neglects the possibility that Nature may be cleverer than we are. It even neglects the possibility that we may be cleverer tomorrow than we are today.

In Neil de Grasse Tyson

Galactic Engines

*Natural History*, Volume 106, Number 4, May 1997 (p. 71)

### **Sophocles** 496 BCE–406 BCE

Greek playwright

Nay, Knowledge must come through action; thou canst have no test which is not fanciful, save by trial.

In *Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

Trachiniai, I. 589

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Stewart, Ian** 1945–

English mathematician and science writer

Construction of models, I said, was an art. On this occasion the art is conjuring: I can do no better than wave the magic wand and extract the rabbit from the hat.

*Concepts of Modern Mathematics*

Chapter 8 (p. 120)

Dover Publications, Inc. New York, New York, USA. 1995

### **Stocking, Martha**

No biographical data available

Building statistical models is just like this. You take a real situation with real data, messy as this is, and build a model that works to explain the behavior of real data.

*New York Times*, February 10, 2000

### **von Neumann, John** 1903–57

Hungarian-American mathematician

To begin, we must emphasize a statement which I am sure you have heard before, but which must be repeated again and again. It is that the sciences do not try to explain, they hardly even try to interpret, they mainly make models. By a model is meant a mathematical construct which, with the addition of certain verbal interpretations, describes observed phenomena. The justification of such a mathematical construct is solely and precisely that it is expected to work — that is, correctly to describe phenomena from a reasonably wide area. Furthermore, it must satisfy certain aesthetic criteria — that is, in relation to how much it describes, it must be rather simple.

*The Neumann Compendium*

Method in the Physical Sciences (p. 628)

World Scientific. Singapore. 1995

### **Walker, Marshall John**

American physicist

Scientists have learned by humiliating experience that their model is not reality.

*The Nature of Scientific Thought*

Chapter XIV (p. 158)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

### **Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

What is a model? A model is like an Austrian timetable. Austrian trains are always late. A Prussian visitor asks

the Austrian conductor why they bother to print time-tables. The conductor replies "If we did not, how would we know how late the trains are?"

In H. Frauenfelder and E.M. Henley

*Subatomic Physics*

Part V (p. 351)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1974

## MOLAR SOLUTION

### Author undetermined

A molar solution is one which contains one g.m.w. [gram molecular weight] per liter.

Classroom Emanations

*Journal of Chemical Education*, Volume 2, Number 7, July 1925 (p. 611)

## MOLECULAR BIOLOGY

**Chargaff, Erwin** 1905–2002

Austrian biochemist

...molecular biology [is] the practice of biochemistry without a license.

*Essays on Nucleic Acids*

Amphisbaena

Elsevier Publishing Company. Amsterdam, Netherlands. 1963

**Crick, Francis Harry Compton** 1916–2004

English biochemist

...molecular biology can be defined as anything that interests molecular biologists.

Molecular Biology in the Year 2000

*Nature*, Volume 228, Number 5272, November 14, 1970 (p. 613 n)

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Molecular biology is Cartesian in its inspiration.

*The Biology of Ultimate Concern*

Chapter 2 (p. 20)

The New American Library, Inc. New York, New York, USA. 1967

**Kornberg, Arthur** 1918–

American biochemist

Molecular biology falters when it ignores the chemistry of the DNA blueprint — the enzymes and proteins, and their products — the integrated machinery and framework of the cell.

The Two Cultures: Chemistry and Biology

*Biochemistry*, Volume 26, Number 22, November 3, 1987 (p. 6890)

**Ludwig, Carl Friedrich Wilhelm** 1816–95

German physiologist

Whenever the body of an animal is subdivided to its ultimate parts, one always finally arrives at a limited number of chemical atoms.... One draws the conclusion in harmony with this observation, that all forms of activity

arising in the animal body must be a result of the simple attractions and repulsions which would be observed in the coming together of those elementary objects.

*Quarterly Review*, 2<sup>nd</sup> ed.

Winter, 1858

**Luria, Salvador Edward** 1912–91

Italian-American microbiologist

Molecular biology deals with questions of molecular structure, and therefore is biochemistry; but it is not the classical biochemistry that emerged earlier in the twentieth century out of the concerns of medical, agricultural, and industrial researchers. Molecular biology is genetics because it deals with genes, their functions, and their products; but, in contrast with classical genetics, it has dealt mainly with organisms such as bacteria and viruses rather than peas, maize or fruit flies, whose study had established the classical rules of genetics.

*A Slot Machine, a Broken Test Tube: An Autobiography*

The Science Path: II. The High Reaches (pp. 83–84)

Harper & Row, Publishers. New York, New York, USA. 1984

**Maddox, John Royden** 1925–

Welsh chemist and physicist

...coffee-breaks in molecular laboratories are as marked by speculation as in any other field, but the published literature gives the impression that its authors are more concerned with the correctness of their observations than with their significance. Those with the good fortune to have the time to think about the data accumulated in the literature would probably reap a rich harvest of understanding. The explanation of the unreflective state of molecular biology is easily accounted for: competitiveness.

The Dark Side of Molecular Biology

*Nature*, Volume 363, Number 6424, 6 May 1993 (p. 13)

**Wolpert, Lewis** 1929–

British embryologist

...the revolution in molecular biology changed the paradigm from metabolism to information.

*The Unnatural Nature of Science*

Chapter 5 (p. 93)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

## MOLECULAR HYPOTHESIS

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

There must be something in this molecular hypothesis and that as a mechanical symbol it is certainly not a mere hypothesis, but a reality.

*Baltimore Lectures on Molecular Dynamics and the Wave Theory of Light*

Lecture I (p. 15)

At The University Press. Cambridge, England. 1905

## MOLECULE

**Aldersey-Williams, Hugh** 1959–

English author and journalist

A molecule is a messy thing. It has a gangling skeleton whose bones are chemical bonds and whose joints are its component atoms.

*The Most Beautiful Molecule*

Chapter 1 (p. 11)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1995

**Ball, Philip** 1962–

English science writer

Once upon a time molecular scientists had to deduce all they knew about molecules from measurements made on many billions of them simultaneously. This can be a risky business, since we cannot always be sure how such measurements are related to the properties of individual molecules, just as the noise that emanates from a football stadium or theatre hall reveals nothing of the individual conversations people are having. But advances in experimental techniques that enable studies of single molecules...what they look like, how they interact, how they move...have over the past two decades opened up an entirely new realm of molecular studies. We are starting to get to know molecules in person.

*Stories of the Invisible*

Chapter 5 (p. 127)

Oxford University Press, Inc. Oxford, England. 2001

...molecules are the smallest units of meaning in chemistry. It is through molecules, not atoms, that one can tell stories in the sub-microscopic world. They are the words: atoms are just the letters.... And in molecules, as in words, the order in which the component parts are put together matters: “save” and “vase” do not mean the same thing.

*Stories of the Invisible*

Chapter 1 (p. 13)

Oxford University Press, Inc. Oxford, England. 2001

**Barrow, Gordon M.**

Chemist

The chemist must learn to live in, and to feel at home in, the world of molecules. It is not enough that he knows the chemical constitution and chemical reactions of the materials around him. To be really effective and successful, he must also develop an intimacy with the molecular world. He must fit himself into the molecular scale of things. He must put that first drummed-in chemical fact that molecules are small in the very back of his mind and replace it by a consciousness that molecules are real, intricate, structural arrangements of atoms in space.

*The Structure of Molecules*

Introduction (p. 1)

W.A. Benjamin, Inc. New York, New York, USA. 1964

**Clifford, William Kingdon** 1845–79

English philosopher and mathematician

...we look forward to the time when the structure and motions in the inside of a molecule will be so well known that some future Kant or Laplace will be able to make an hypothesis about the history and formation of matter.

In Leslie Stephen and Frederick Pollock (eds.)

*Lectures and Essays* (Volume 1)

Atoms (p. 190)

Macmillan &amp; Company Ltd. London, England. 1879

**Crick, Francis Harry Compton** 1916–2004

English biochemist

Almost all aspects of life are engineered at the molecular level, and without understanding molecules we can only have a very sketchy understanding of life itself.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 5 (p. 61)

Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

[Molecules of living things] are put together in much more complicated patterns than the molecules of nonliving things, and this putting together is done following programs, sets of instructions for how to develop, which the organisms carry around inside themselves. Maybe they do vibrate and throb and pulsate with “irritability,” and glow with “living” warmth, but these properties all emerge incidentally. What lies at the heart of every living thing is not a fire, not warm breath, not a “spark of life.” It is information, words, instructions. If you want a metaphor, don’t think of fire and sparks and breath. Think instead of a billion discrete, digital characters carved in tablets of crystal. If you want to understand life, don’t think about vibrant, throbbing gels and oozes, think about information technology.

*The Blind Watchmaker*

Chapter 5 (p. 112)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1986

**Dennett, Daniel Clement** 1942–

American philosopher

Any assortment of objects, especially “sticky” objects like molecules, randomly stirred for long enough will give rise to every conceivable possible combination.

*Consciousness Explained* (p. 11)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1991

**Frankel, Felice** 1945–

Science photographer

**Whitesides, George M.**

American chemist

Molecules — like ants, lemmings, herring, people — are happiest when surrounded by their own kind.

*On the Surface of Things: Images of the Extraordinary in Science*  
Introduction (p. 7)  
Chronicle Books. San Francisco, California, USA. 1997

### Harrison, George R.

No biographical data available

A farm is a factory where the energy of light is used to make cheap simple molecules into valuable complex molecules.

When Physics Goes Farming  
*The Atlantic Monthly*, July 1937

### Hoffmann, Roald 1937–

Polish-born American chemist

It's a wild dance floor there at the molecular level.

In Philip Ball  
*Designing the Molecular World: Chemistry at the Frontier* (p. 83)  
Princeton University Press. Princeton, New Jersey, USA. 1994

Men (and women) are not as different from molecules as they think.

*The Metamict State*  
Men and Molecules (p. 43)  
University of Central Florida Press. Orlando, Florida, USA. 1987

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

If we assume that the last breath of, say, Julius Caesar has by now become thoroughly scattered through the atmosphere, then the chances are that each of us inhales one molecule of it with every breath we take.

*An Introduction to the Kinetic Theory of Gases*  
Chapter II (p. 32)  
At The University Press. Cambridge, England. 1940

### Kropotkin, Peter Alekseyevich 1842–1921

Russian revolutionary and geographer

The molecule becomes a particle of the universe on a microscopic scale — a microcosmos which lives the same life.

Recent Science  
*Nineteenth Century*, Volume 34, 1893 (p. 252)

### Latham, Peter Mere 1789–1875

English physician

The very existence of ultimate molecules, or atoms, with the qualities which we so confidently assign to them, is a matter of the purest conjecture; it is entirely a fiction of the mind.

*An Essay on the Philosophy of Medical Science*  
Part I, Chapter 4  
Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1844

### Macfie, Ronald Campbell 1867–1931

Poet and physician

Life in living tissue is like nothing perhaps so much as a candle-flame. In the candle-flame the molecules are

composed and decomposed, yet the candle-flame keeps always the same shape; but let us change the environment of these dancing, partner-changing molecules — let us conduct away their heat by means of some copper wire, or let us deprive the flame of oxygen — and out goes the candle.

Protoplasm is only a slow flame, easily extinguished. It is easy to understand how a little thing — a needle, a few grains of poison — may destroy a large organism when we remember how intricately correlated it is in its minutest parts. Break but a single thread in the warp and woof of life and the whole wonderful web, with its pictures and patterns, all comes asunder. Take but a single brick out of the great house of life and it falls into ruin. The construction of the wonderful organisms of vegetables and animals is a miracle and mystery, but their death is merely a chemical or mechanical commonplace.

*Science, Matter and Immortality*  
Chapter 21 (p. 268)  
William & Norgate. London, England. 1909

...molecules of different elements throb in different ways, and thus produce different light waves, which, when analysed by a spectroscope...give definite characteristic colours...we can discover what any substance is by heating it so as to agitate its molecules, and then analysing, by a spectroscope, the ripples of light caused by the throbbing molecules. In this way we may be said to be able to tell any substance by feeling its pulse, or by listening to its heart, and the spectroscope may be compared to a stethoscope.

*Science, Matter and Immortality*  
Chapter 4 (p. 55)  
William & Norgate. London, England. 1909

### Mann, Thomas 1875–1955

German-born American novelist

For the molecule was composed of atoms, and the atom was nowhere near large enough even to be spoken of as extraordinarily small. It was so small, such a tiny, early, transitional mass, a coagulation of the unsubstantial, of the not-yet-substantial and yet substance-like, of energy, that it was scarcely possible yet — or, if it had been, was now no longer possible — to think of it as material, but rather as mean and border-line between the material and immaterial.

Translated by H.T. Lowe-Poeter  
*The Magic Mountain*  
Chapter V (p. 283)  
Alfred A. Knopf. New York, New York, USA. 1966

### Maxwell, James Clerk 1831–79

Scottish physicist

As long as we have to deal with only two molecules, and have all the data given us, we can calculate the result of their encounter; but when we have to deal with millions



of molecules, each of which has millions of encounters in a second, the complexity of the problem seems to shut out all hope of a legitimate solution.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 373)

At The University Press. Cambridge, England. 1890

I come from empyrean fires  
From microscopic spaces,  
Where molecules with fierce desires,  
Shiver in hot embraces  
The atoms clash, the spectra flash,  
Projected on the screen,  
The double D, magnesium b,  
And Thallium's living green.

*The Life of James Clerk Maxwell*

To the Chief Musician upon Nabla: A Tyndallic Ode (p. 634)

Macmillan & Company Ltd. London, England. 1882

...though in the course of ages catastrophes have occurred and may yet occur in the heavens, though ancient systems may be dissolved and new systems evolved out of their ruins, the molecules out of which these systems are built — the foundation-stones of the material universe — remain unbroken and unworn.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 377)

At The University Press. Cambridge, England. 1890

...in the heavens we discover by their light, and by their light alone, stars so distant from each other that no material thing can ever have passed from one to another; and yet this light, which is to us the sole evidence of the existence of these distant worlds, tells us also that each of them is built up of molecules of the same kinds as those which we find on earth. A molecule of hydrogen, for example, whether in Sirius or in Arcturus, executes its vibrations in precisely the same time.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (pp. 375–376)

At The University Press. Cambridge, England. 1890

[Molecular science is] one of those branches of study which deal with things invisible and imperceptible by our senses, and which cannot be subjected to direct experiment.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Molecules (p. 361)

At The University Press. Cambridge, England. 1890

### Montague, James J.

No biographical data available

Though men may boast of brain or brawn  
And maids of soft attractions,  
Such qualities depend upon  
Their chemical reactions.  
When Daniel, placid and serene,

Defied a den of lions,  
He owed his calm, unflinching mien  
To molecules and ions.

What's the Use of Worrying?

*Industrial and Engineering Chemistry: News Edition*, Volume 10, Number 20, 20 October 1932 (p. 257)

### Morrison, Jim 1943–71

American singer, song writer and poet

Love hides in molecular structures.

*Absolutely Live*

Love Hides

Sung by The Doors

July 1969

### Newman, Joseph S. 1892–1960

American poet

There's none to say how carbon first  
Conceived it ocy-hydric thirst —  
How nitrogen, in right proportion,  
And sulphur joined the strange consortion —  
But close upon the tenuous verge  
Where shadows end, does life emerge,  
And from these elemental five  
Sprang proteid molecules alive!

*Poems for Penguins and Other Lyrical Lapses*

Biochemistry

Greenburg. New York, New York, USA. 1941

Quite recently to be exact,  
Within a billion years, in fact.  
Some time before the glacial drift  
Had given the planet's face a lift,  
A group of shameless molecules  
Broke all the inorganic rules  
And (C.I.O. epitomized!)  
Spontaneously organized.

*Poems for Penguins and Other Lyrical Lapses*

Biology

Greenburg. New York, New York, USA. 1941

### O'Brien, Flann 1911–66

Irish novelist and political commentator

Did you ever study the Mollycule Theory when you were a lad? he asked. Mick said not, not in any detail.

That is a very serious defalcation and an abstruse exacerbation, he said severely, but I'll tell you the size of it. Everything is composed of small Mollycules of itself, and they are flying around in concentric circles and arcs and segments and innumerable various other routes too numerous to mention collectively, never standing still or resting but spinning away and darting hither and thither and back again, all the time on the go.

...

Mollycules is a very intricate theorem and can be worked out with algebra but you would want to take it by degrees

with rulers and cosines and familiar other instruments and then at the wind-up not believe what you had proved at all.

*The Dalkey Archive*

Chapter 9 (pp. 87–88)

Hart-Davis, MacGibbon. London, England. 1968

**von Baeyer, Hans Christian** 1938–

Physicist and author

Coiled serpents capture the essence of the molecule that is missing from mechanical models — the element of mystery. They remind us that just beneath the surface of the dazzling atomic landscape recorded by modern technology, the paradoxes of quantum mechanics lurk like venomous snakes.

*Taming the Atom*

Chapter 5 (p. 88)

Random House, Inc. New York, New York, USA. 1992

**Wald, George** 1906–97

American biologist and biochemist

I have lived much of my life among molecules. They are good company. I tell my students to try to know molecules, so well that when they have some question involving molecules, they can ask themselves, What would I do if I were that molecule? I tell them, Try to feel like a molecule; and if you work hard, who knows? Some day you may get to feel like a big molecule!

*Les Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

**Weinberg, R. A.**

No biographical data available

Can — and should — life be described in terms of molecules? For many, such description seems to diminish the beauty of Nature. For others of us, the wonder and beauty of nature are nowhere more manifest than in the submicroscopic plan of life.

*The Molecules of Life*

*Scientific American*, Volume 253, Number 4, October 1985 (p. 57)

**Weiss, Paul A.** 1898–1985

Chemist

...there is no phenomenon in a living system that is not molecular, but there is none that is only molecular, either.

*Within the Gates of Science and Beyond*

The Living System: Determinism Stratified (p. 270)

Hafner Publishing Company. New York, New York, USA. 1971

## MOMENTUM

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

We must consider motion in its two causes, the primary and universal cause, to which is due all the motion that

is in the world, and the particular cause to which it is due that various portions of matter acquire the movements which before they had not. As to the former, it is evident to me that it must be attributed to God Himself, who in the beginning created matter along with motion and rest, and ever since has preserved these in the same quantity. For, though motion is nothing but a mode in the thing which is moved, yet it is of a definite amount that remains constant for the whole universe, though it varies in regard to the several parts.

*Principles of Philosophy*

Part II, 36, 42

E. Mellen Press. Lewistown, New York, USA. 1988

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

If one wishes to draw a line of separation between the realm of ancient and modern science, it must be drawn at the instant when Jean Buridan conceived his theory of momentum, when he ceased to think of stars as kept in motion by certain divine beings and proclaimed that motions, celestial and terrestrial, are each controlled by the same mechanical laws.

*Études, sur Leonardo da Vinci*

A. Hermann. Paris, France. 1906–09

## MONKEYS AND TYPEWRITERS

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...If I let my fingers wander idly over the keys of a typewriter it might happen that my screed made an intelligible sentence. If an army of monkeys were strumming on typewriters they might write all the books in the British Museum. The chance of their doing so is decidedly more favourable than the chance of the molecules returning to one half of the vessel.

*The Nature of the Physical World*

Chapter IV (p. 72)

The Macmillan Company. New York, New York, USA. 1930

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

It was, I think, Huxley, who said that six monkeys, set to strum unintelligently on typewriters for millions of millions of years, would be bound in time to write all the books in the British Museum. If we examined the last page which a particular monkey had typed, and found that it had chanced, in its blind strumming, to type a Shakespeare sonnet, we should rightly regard the occurrence as a remarkable accident, but if we looked through all the millions of pages the monkeys had turned off in untold millions of years, we might be sure of finding a Shakespeare sonnet somewhere amongst them, the

product of the blind play of chance. In the same way, millions of millions of stars wandering blindly through space for millions of millions of years are bound to meet with every sort of accident, and so are bound to produce a certain limited number of planetary systems in time. Yet the number of these must be very small in comparison with the total number of stars in the sky.

*The Mysterious Universe*

Chapter I (p. 4)

The Macmillan Company. New York, New York, USA. 1932

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Neo-Darwinism does indeed carry the nineteenth-century brand of materialism to its extreme limits — to the proverbial monkey at the typewriter, hitting by pure chance on the proper keys to produce a Shakespeare sonnet.

*The Case of the Midwife Toad* (p. 30)

New York, New York, USA. 1972

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

There is a special department of hell for students of probability. In this department there are many typewriters and many monkeys. Every time that a monkey walks on a typewriter, it types by chance one of Shakespeare's sonnets.

*Nightmares of Eminent Persons*

The Metaphysician's Nightmare (p. 29)

The Bodley Head. London, England. 1954

**Russo, Richard** 1949–

American novelist

In a novel, two characters discuss the glitch in a computer which causes it to scroll an endless series of meaningless symbols: He sighs. "It casts serious doubt on the old theory that an infinite number of monkeys at an infinite number of typewriters would eventually write the Great American Novel, doesn't it?"

*Straight Man* (p. 129)

Random House, Inc. New York, New York, USA. 1996

**Synge, John L.** 1897–1995

Irish mathematician and physicist

"But not the sonnets?" asked the Orc, quizzically. "Yes, of course," retorted the Plumber, "The sonnets too. And the Bible. And the Koran. And that poem of mine which you have just recited...."

"But suppose," said the Orc, "that our monkey became very fond of some particular word, perhaps some naughty little four-letter word, and went on typing that word over and over again and never any other. I cannot see, in that case, how he would type even one play." "That would be quite an exceptional case," answered the Plumber. "Eddington had in mind a haphazard performance. The

monkey types the keys at random, and the outcome is governed by pure chance. And by pure chance the plays of Shakespeare emerge, after a long time of course." "Doubtless, doubtless," muttered the Orc, reflectively. "Poor monkey! How bored he would get! For he would reproduce the plays of Shakespeare not once but many times, in fact an infinite number of times."

*Kandelman's Krim*

Chapter Eleven (p. 145)

Jonathan Cape. London, England. 1957

## MONOGRAPH

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

"Oh, didn't you know?" he cried, laughing. "Yes, I have been guilty of several monographs. They are all upon technical subjects. Here, for example, is one 'Upon the Distinction between the Ashes of the Various Tobaccos.' In it I enumerate a hundred and forty forms of cigar, cigarette, and pipe tobacco, with coloured plates illustrating the difference in the ash. It is a point which is continually turning up in criminal trials, and which is sometimes of supreme importance as a clue. If you can say definitely, for example, that some murder has been done by a man who was smoking an Indian lunkah, it obviously narrows your field of search. To the trained eye there is as much difference between the black ash of a Trichinopoly and the white fluff of bird's-eye as there is between a cabbage and a potato."

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Sign of the Four, Chapter 1 (p. 612)

Wings Books. New York, New York, USA. 1967

## MONOPOLE

**Dirac, Paul Adrian Maurice** 1902–84

English theoretical physicist

From the theoretical point of view one would think that monopoles [magnets with one pole] should exist, because of the prettiness of the mathematics. Many attempts to find them have been made, but all have been unsuccessful. One should conclude that pretty mathematics by itself is not an adequate reason for nature to have made use of a theory. We still have much to learn in seeking for the basic principles of nature.

In Heinz R. Pagels

*Perfect Symmetry: The Search for the Beginning of Time*

Part Three, Chapter 1 (p. 284)

Simon & Schuster. New York, New York, USA. 1985

**Gamow, George** 1904–68

Russian-born American physicist

Two Monopoles worshipped each other,  
And all of their sentiments clicked.

Still, neither could get to his brother,  
Dirac was so fearfully strict!  
*Thirty Years That Shook Physics*  
Second Part (p. 202)  
Doubleday & Company, Inc. Garden City, New York, USA. 1966

## MONSTER

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

...the night comes on, and the shadows of the woods and  
rocks deepen: there are uncouth sounds along the beach  
and in the forest; and new monsters of yet stranger shape  
are dimly discovered moving amid the uncertain gloom.  
*Sketch-Book of Popular Geology*  
Lecture Forth (p. 151)  
William P. Nimmo & Company. Edinburgh, Scotland. 1880

## MOON

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

The old moon, like a worn and ancient coin, is still hanging  
in the west when I awake.  
*Desert Solitaire*  
Terra Incognita: Into the Maze (p. 289)  
Ballantine Books. New York, New York, USA. 1968

**Addison, Joseph** 1672–1719  
English essayist, poet, and statesman

Soon as the evening shades prevail,  
The moon takes up the wondrous tale,  
And nightly to the listening earth  
Repeats the story of her birth.  
In John Matthews Manley (ed)  
*English Poetry*  
Hymn (p. 220)  
Ginn & Company. Boston, Massachusetts, USA. 1907

**Alger, William R.** 1822–1905  
Unitarian minister and author

The moon is a silver pin-head vast,  
That holds the heaven's tent-hangings fast.  
*Poetry of the Orient*  
The Use of the Moon  
Roberts Brothers. Boston, Massachusetts, USA. 1866

**Blake, William** 1757–1827  
English poet, painter, and engraver

The moon like a flower  
In heaven's high bower,  
With silent delight  
Sits and smiles on the night.  
*The Complete Poetry and Prose of William Blake*  
The Moon  
University of California Press. Berkeley, California, USA. 1982

**Borman, Frank** 1928–  
American astronaut

The moon is a different thing to each of us.  
From Apollo VIII  
December 24, 1968

**Bronte, Charlotte** 1816–55  
English author

Where, indeed, does the moon not look well? What is  
the scene, confined or expansive, which her orb does not  
follow? Rosy or fiery, she mounted now above a not dis-  
tant bank; even while we watched her flushed ascent, she  
cleared to gold, and in a very brief space, floated up stain-  
less into a now calm sky.  
*Life and Works of the Sisters Brontë* (Volume 3)  
Villette La Terrasse (p. 214)  
AMS Press Inc. New York, New York, USA. 1973

**Burton, Robert** 1577–1640  
English clergyman and scholar

Doth the moon care for the barking of a dog?  
*The Anatomy of Melancholy* (Volume 2)  
Part II, Sect. III, Memb. VII (p. 231)  
AMS Press, Inc. New York, New York, USA. 1973

**Burton, Sir Richard Francis** 1821–90  
English explorer

That gentle Moon, the lesser light, the Lover's lamp, the  
Swain's delight,

A ruined world, a globe burnt out, a corpse upon the road  
of night.  
*The Kasidah of Haji Abdu El-Yezdi* (p. 10)  
McBride. New York, New York, USA. 1929

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

The moon pull'd off her veil of light,  
That hides her face by day from sight  
(Mysterious veil, of brightness made,) That's both her lustre and her shade),  
And in the lantern of the night,  
With shining horns hung out her light.  
*The Poetical Works of Samuel Butler* (Volume 1)  
Part II, Canto I, l. 905  
Bell & Daldy. London, England. 1835

He made an instrument to know  
If the moon shine at full or no;  
That would, as soon as e'er she shone straight,  
Whether 'twere day or night demonstrate;  
Tell what her d'iameter to an inch is,  
And prove that she's not made of green cheese.  
*The Poetical Works of Samuel Butler* (Volume 1)  
Part II, Canto III, l. 261  
Bell & Daldy. London, England. 1835

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

The moon was shining sulkily,  
Because she thought the sun  
Had got no business to be there  
After the day was done —

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter IV (p. 183)

The Modern Library. New York, New York, USA. 1936

**Cawein, Madison Julius** 1865–14  
American poet

Into the sunset's turquoise marge  
The moon dips, like a pearly barge;  
Enchantment sails through magic seas,  
To fairland Hesperides,  
Over the hills and away.

*Poems*

At Sunset, Stanza 1

The Macmillan Company. New York, New York, USA. 1911

**Collins, Michael** 1880–1922  
Irish soldier and politician

It was a totally different moon than I had ever seen before.  
The moon that I knew from old was a yellow flat disk, and  
this was a huge three-dimensional sphere, almost a ghostly  
blue-tinged sort of pale white. It didn't seem like a very  
friendly place or welcoming place. It made one wonder  
whether we should be invading its domain or not.

In Kevin W. Kelley

*The Home Planet*

With Plate 39

Addison-Wesley Publishing, Inc. Reading, Massachusetts, USA. 1988

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

There is something haunting in the light of the moon; it  
has all the dispassionateness of a disembodied soul, and  
something of its inconceivable mystery.

*Lord Jim*

Chapter XXIV (p. 213)

Rinehart & Company, Inc. New York, New York, USA. 1957

**Croly, George** 1780–1860  
German chemist and physician

How like a queen comes forth the lonely Moon  
From the slow opening curtains of the clouds  
Walking in beauty to her midnight throne!

*Gems, Principally from the Antique*

Diana

Printed for Hurst, Robinson & Company. London, England. 1822

**Darwin, Erasmus** 1731–1802  
English physician and poet

And hail their queen, fair regent of the night.

*The Botanic Garden*

Part I, Canto II, III, I. 90

Jones & Company. London, England. 1825

**Empedocles of Acragas** ca. 490 BCE–430 BCE  
Greek pre-Socratic philosopher

A borrowed light, circular in form, it revolves about the  
earth, as if following the track of a chariot.

In Arthur Fairbanks

*The First Philosophers of Greece*

Book I

Fragment 154 (p. 177)

Charles Scribner's Sons. New York, New York,

USA. 1898

**Flammarion, Camille** 1842–1925  
French astronomer and author

Orb of dream and mystery, pale sun of the night, solitary  
globe wandering in the silent firmament, the moon has in  
all times and among all nations peculiarly attracted atten-  
tion and thought.

*Popular Astronomy: A General Description of the Heavens*

Book II, Chapter VI (p. 145)

Chatto & Windus. London, England. 1894

**Frost, Robert** 1874–1963  
American poet

The Moon for all her light and grace  
Has never learned to know her place.

The notedest astronomers

Have set the dark aside for hers.

*Complete Poems of Robert Frost*

Two Leading Lights

Henry Holt & Company. New York, New York, USA. 1949

**Fry, Christopher** 1907–2005  
English playwright

...the moon is nothing

But a circumambulating aphrodisiac

Divinely subsidized to provoke the world

Into a rising birth-rate.

*The Lady's Not for Burning*

Act Three (p. 66)

Oxford University Press, Inc. New York, New York, USA. 1950

**Haggard, H. Rider** 1856–1925  
English novelist

The sky aft was dark as pitch, but the moon still shone  
brightly ahead of us and lit up the blackness. Beneath its  
sheen a huge white-topped breaker, twenty feet high or  
more, was rushing on to us. It was on the break — the  
moon shone on its crest and tipped its foam with light.  
On it rushed beneath the inky sky, driven by the awful  
squall behind it.

*The Favorite Novels of H. Rider Haggard*

She (p. 195)

Blue Ribbon Books, Inc. New York, New York, USA. 1928

**Homer (Smyrns of Chios)** fl. 750 BCE  
Greek poet

As when the stars shine clear, and the moon is bright —  
there is not a breath of air, not a peak nor glade nor jutting  
headland, but it stands out in the ineffable radiance that  
breaks from the serene of heaven...

In *Great Books of the Western World* (Volume 4)

*The Iliad of Homer*

Book VIII, l. 555 (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hood, Thomas** 1582–98  
English poet and editor

Mother of light! how fairly dost thou go  
Over those hoary crests, divinely led!  
Art thou that huntress of the silver bow  
Fabled of old? Or rather dost thou tread  
Those cloudy summits thence to gaze below,  
Like the wild chamois from her Alpine snow,  
Where hunters never climbed — secure from dread?

*The Complete Poetical Works of Thomas Hood*

Ode to the Moon

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

By death the moon was gathered in  
Long ago, ah long ago;  
Yet still the silver corpse must spin  
And with another's light must glow.  
Her frozen mountains must forget  
Their primal hot volcanic breath,  
Doomed to revolve for ages yet,  
Void amphitheatres of death.

*The Captive Shrew and Other Poems of a Biologist*

Cosmic Death

Harper & Brothers. New York, New York, USA. 1933

**Ingelow, Jean** 1820–97  
English poet and novelist

Such a slender moon, going up and up,  
Waxing so fast from night to night,  
And swelling like an orange flower-bud, bright,  
Fated, methought, to round as to a golden cup,  
And hold to my two lips life's best of wine.

*The Poetical Works of Jean Ingelow*

Songs of the Night Watches

The First Watch, pt. II

John B. Alden. New York, New York, USA. 1883

**Jastrow, Robert** 1925–  
American space scientist

**Newell, Homer E.**

No biographical data available

The moon is the Rosetta stone of the solar system, and  
to the student of the origin of the earth and planets, this

lifeless body is even more important than Mars and  
Venus.

Why Land on the Moon?

*The Atlantic Monthly*, Volume 211, Number 2; August, 1963 (p. 43)

**Jonson, Ben** 1573?–1637  
English dramatist and poet

Queen and huntress, chaste and fair,  
Now the sun is laid to sleep,  
Seated in thy silver car,  
State in wonted manner keep.  
Hesperus entreats thy light  
Goddess, excellently bright!

*Hymn*

To Cynthia

**Keats, John** 1795–1821  
English Romantic lyric poet

The moon put forth a little diamond peak  
No bigger than an unobserved star,  
Or tiny point of fairy scimitar.

*The Complete Poetical Works and Letters of John Keats*

Endymion

Book IV, l. 499

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Lear, Edward** 1812–88  
English humorist and artist

They dined on mince, and slices of quince,  
Which they ate with a runcible spoon;  
And hand in hand, on the edge of the sand,  
They danced by the light of the moon,  
The moon, the moon,  
They danced by the light of the moon.

In Tony Palazzo

*Edward Lear's Nonsense Book*

The Owl and the Pussycat

Garden City Books. Garden City, New York, USA. 1956

**Lightner, Alice**  
No biographical data available

Queen of Heaven, fair of face,  
Undefined by alien feet;  
Where the sun's untrammelled heat  
Meets the cold of outer space;  
Soon no more the Queen of Night,  
For your conquest is in sight.

To the Moon

*Nature Magazine*, April 1957 (p. 213)

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Saw the moon rise from the water,  
Rippling, rounding from the water,  
Saw the flecks and shadows on it,  
Whispered, "What is that, Nokomis?"  
And the good Nokomis answered,

“Once a warrior very angry,  
Seized his grandmother and threw her  
Up into the sky at midnight;  
Right against the moon he threw her;  
‘Tis her body that you see there.”

*The Poetical Works of Henry Wadsworth Longfellow*  
Hiawatha, Hiawatha’s Childhood  
Houghton Mifflin Company. Boston, Massachusetts,  
USA. 1883

**Lovell, James A.** 1928–  
American astronaut

The moon is essentially gray, no color. It looks like  
plaster of Paris, like dirty beach sand with lots of foot-  
prints in it.

*Washington Post*  
25 December 1968

**Milton, John** 1608–74  
English poet

...now glow’d the firmament  
With living sapphires; Hesperus, that led  
The starry host, rode brightest, till the moon,  
Rising in clouded majesty, at length  
Apparent queen, unveil’d her peerless light,  
And o’er the dark her silver mantle threw.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book IV, l. 604–609  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Moore, Thomas** 1779–1852  
Irish poet

The moon looks  
On many brooks,  
The brook can see no moon but this.

*The Poetical Works of Thomas Moore*  
While Gazing on the Moon’s Light  
Lee & Shepard. Boston, Massachusetts, USA. 1873

**Muir, John** 1838–1914  
American naturalist

The moon is looking down into the canon, and how mar-  
velously the great rocks kindle to her light! Every dome,  
and brow, and swelling boss touched by her white rays,  
glows as if lighted with snow.

*Steep Trails*  
Chapter II (p. 23)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Rankin, William H.**  
No biographical data available

Someday I would like to stand on the moon, look down  
through a quarter of a million miles of space and say,  
“There certainly is a beautiful earth out tonight.”

*The Man Who Rode the Thunder*  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1960

**Robbins, Tom** 1936–  
American writer

Our Moon has surrendered none of its soft charm to tech-  
nology. The pitter-patter of little spaceboots has in no  
way diminished its mystery.

*Even Cowgirls Get the Blues*  
Chapter 19 (p. 60)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1976

**Ross, Sir Ronald** 1857–1932  
English bacteriologist

O Moon! When I look at thy beautiful face,  
Careening along through the boundaries of space  
The thought has quite frequently come to my mind  
If ever I’ll gaze on thy glorious behind.

In Harriet Monroe (ed)  
*Poetry*  
O Moon  
Modern Poetry Association. Chicago, Illinois, USA.

**Sappho** 630 BCE–570 BCE  
Greek lyric poet

Stars near the lovely moon cover their own bright faces  
when she is roundest and lights up the earth with her sil-  
ver.

*Poems by Sappho* (p. 4)  
Charles Scribner’s Sons. New York, New York, USA. 1924

**Serviss, Garrett P.** 1851–1929  
American science fiction writer

The imagination of mankind has never resisted the fasci-  
nation of the moon.

*Astronomy with the Naked Eye*  
Chapter XVIII (p. 226)  
Harper & Brothers. New York, New York, USA. 1908

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Therefore the moon, the governess of floods,  
Pale in her anger, washes all the air,  
That rheumatic diseases do abound.

And thorough this distemperature we see  
The seasons alter: hoary-headed frosts  
Fall in the fresh lap of the crimson rose,  
And on old Hiems’ thin and icy crown  
An odorous chaplet of sweet summer buds  
Is, as in mockery, set.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
A Midsummer-Night’s Dream  
Act II, Scene I  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is the very error of the moon;  
She comes more nearer earth than she was wont,  
And drives men mad.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume Two)

Othello, The Moor of Venice  
Act V, Scene ii, l. 107–111  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shelley, Mary** 1797–1851  
English Romantic writer

...the moon gazed on my midnight labours, while, with  
unrelaxed and breathless eagerness, I pursued nature to  
her hiding-places.

*Frankenstein*  
Chapter 4 (p. 43)  
Running Press. Philadelphia, Pennsylvania, USA. 1990

**Shelley, Percy Bysshe** 1792–1822  
English poet

The young moon has fed  
Her exhausted horn  
With the sunset's fire.

*The Complete Poetical Works of Percy Bysshe Shelley*  
Hellas Semi-Chorus II  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Tennyson, Alfred (Lord)** 1809–92  
English poet

All night, through archways of the bridged pearl  
And portals of pure silver, walks the moon.

*Alfred Tennyson's Poetical Works*  
Sonnet  
Oxford University Press, Inc. London, England. 1953

**Thurber, James** 1894–1961  
American writer and cartoonist

“The moon is 300,000 miles away,” said the Royal Math-  
ematician. “It is round and flat like a coin, only it is made  
of asbestos, and it is half the size of this kingdom.  
Furthermore, it is pasted on the sky.”

*Many Moons*  
Harcourt Brace & Company. San Diego, California, USA. 1971

**Tolstoy, Alexei** 1882–1945  
Russian writer

“Which is more useful, the Sun or the Moon?” asks  
Kuzma Prutkov, the renowned Russian philosopher, and  
after some reflection he answers himself: “The Moon  
is the more useful, since it gives us its light during the  
night, when it is dark, whereas the Sun shines only in the  
daytime, when it is light anyway.”

Quoted by George Gamow  
*The Birth and Death of the Sun*  
Chapter I (p. 1)  
The Viking Press. New York, New York, USA. 1945

**Verne, Jules** 1828–1905  
French novelist

There is no one among you, my brave colleagues, who  
has not seen the Moon, or at least, heard speak of it.

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter II (p. 12)  
A.L. Burt Company. New York, New York, USA. 1890

**Williams, Dafydd (Dave) Rhys**

We'll go back to the moon, this time for a much longer  
period of time. We'll build lunar outposts. We'll send  
a crew to Mars. There are no ifs around it. It's going  
to happen.

Ground Control to Dr. Dave  
*The McGill Reporter*, Volume 31, Number 3 (8 October 1998)

## MOON LANDING

**Armstrong, Neil A.** 1930–  
American astronaut

That's one small step for a man, one giant leap for  
mankind.

Men Walk on Moon  
*New York Times*, L5, column 3, 21 July 1969

**Beckett, Chris**

No biographical data available

The Moon landings were not about gathering data or  
testing hypotheses; they were about theatre, about the  
enactment of many mythical themes that were fed and  
nurtured by such a spectacular event. It was about the  
power of humankind, the power of technology, our abil-  
ity to overcome the apparently impossible and to con-  
quer not just Earth but the whole Universe. And yet at  
the same time it was about the smallness of humankind,  
our vulnerability the fact that we inhabit a single small  
planet, surrounded by emptiness...

*New Scientist*, November 11, 1989

**Crew of Apollo 11**

Here Men from The Planet Earth  
First Set Foot upon The Moon  
July, 1969 AD

We Came in Peace for All Mankind.  
*Plaque left behind on the moon's surface*

**Hoffer, Eric** 1902–83

American longshoreman and philosopher

Our passionate preoccupation with the sky, the stars, and  
a God somewhere in outer space is a homing impulse. We  
are drawn back to where we came from.

Reactions to Man's Landing on the Moon Show Broad Variations in  
Opinions  
*New York Times*, A6, column 2, 21 July 1969

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

Prometheus is reaching out for the stars with an empty  
grin on his face.



Reactions to Man's Landing on the Moon Show Broad Variations in Opinions  
*New York Times*, A6, column 6, 21 July 1969

**Nabokov, Vladimir** 1899–1977  
 Russian-American writer

Treading the soil of the moon, palpating its pebbles, tasting the panic and splendor of the event, feeling in the pit of one's stomach the separation from terra...these form the most romantic sensation an explorer has ever known...this is the only thing I can say about the matter. The utilitarian results do not interest me.

Reactions to Man's Landing on the Moon Show Broad Variations in Opinions  
*New York Times*, A6, column 5, 21 July 1969

## MORPHOLOGY

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
 Scottish zoologist and classical scholar

The waves of the sea, the little ripples on the shore, the sweeping curve of the sandy bay between the headlands, the outline of the hills, the shape of the clouds, all these are so many riddles of form, so many problems of morphology.

*On Growth and Form* (Volume 1)  
 Chapter I (p. 10)  
 At The University Press. Cambridge, England. 1951

## MOTION

**Burton, Robert** 1577–1640  
 English clergyman and scholar

The heavens themselves run continually round, the sun riseth and sets, the moon increaseth, stars and planets keep their constant motions, the air is tossed by the winds, the waters ebb and flow, to their conservation no doubt, to teach us that we should ever be in motion.

*The Anatomy of Melancholy* (Volume 2)  
 Part II, Sect. II, Memb. IV (p. 80)  
 AMS Press, Inc. New York, New York, USA. 1973

**Butterfield, Herbert** 1900–79  
 English historian and philosopher of history

Of all the intellectual hurdles which the human mind has confronted and has overcome in the last fifteen hundred years, the one which seems to me to have been the most amazing in character and the most stupendous in the scope of its consequences is the one relating to the problem of motion...

*The Origins of Modern Science*  
 Chapter One (p. 3)  
 The Macmillan Company. New York, New York, USA. 1961

**Carroll, Lewis (Charles Dodgson)** 1832–98  
 English writer and mathematician

"Well, in our country," said Alice, still panting a little, "you'd generally get to somewhere else — if you ran very fast for a long time, as we've been doing."

"A slow sort of country!" said the Queen. "Now here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that."

*The Complete Works of Lewis Carroll*  
 Through the Looking-Glass  
 Chapter II (p. 166)  
 The Modern Library. New York, New York, USA. 1936

**Dee, John** 1527–1609  
 English mathematician and occultist

Whatever is in the universe is continuously moved by some species of motion.

Translated by Wayne Schumaker  
*John Dee on Astronomy*  
 XVI (p. 129)  
 University of California Press. Berkeley, California, USA. 1978

**Descartes, René** 1596–1650  
 French philosopher, scientist, and mathematician

... God always preserves in the world just so much motion as He impressed on it at its first creation.

*Principles of Philosophy*  
 Part II, 36, 42  
 E. Mellen Press. Lewistown, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

We not merely deduce [a] three-dimensional world; we see it. But we have no such aid in synthesising different motions. Perhaps if we had been endowed with two eyes moving with different velocities our brains would have developed the necessary faculty; we should have perceived a kind of relief in the fourth dimension so as to combine into one picture the aspect of things seen with different motions.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*  
 Chapter II (p. 32)  
 At The University Press. Cambridge, England. 1921

It is curious that the philosophical denial of absolute motion is readily accepted, whilst the denial of absolute simultaneity appears to many people revolutionary.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*  
 Chapter III (p. 51)  
 At The University Press. Cambridge, England. 1921

**Galilei, Galileo** 1564–1642  
 Italian physicist and astronomer

My purpose is to set forth a very new science dealing with a very ancient subject. There is, in nature, perhaps nothing older than motion, concerning which the books

written by philosophers are neither very few nor small; nevertheless, I have discovered by experiment some properties of it which are worth knowing and which have not hitherto been either observed or demonstrated.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

Third Day, Change of Position (p. 197)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...we have decided to consider the phenomena of bodies falling with an acceleration such as actually occurs in nature and to make this definition of accelerated motion exhibit the essential features of observed accelerated motions.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

Third Day, Naturally Accelerated Motion (p. 200)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Hutton, W.

No biographical data available

Motion is the soul of the universe...

*The Book of Nature Laid Open*

Chapter XV (p. 173)

Joseph Milligan, Georgetown. 1822

### Huygens, Christiaan 1629–95

Dutch mathematician, astronomer, and physicist

It is inconceivable to doubt that light consists in the motion of some sort of matter. For when one considers its production, one sees that here upon the earth it is chiefly engendered by fire and flame which contain without doubt bodies that are in rapid motion, since they dissolve and melt many other bodies, even the most solid; or when one considers its effects, one sees that when light is collected, as by concave mirrors, it has the property of burning as a fire does, that is to say, it disunites the particles of bodies. This is assuredly the mark of motion, at least in the true philosophy, in which once conceives the cause of all natural effects in terms of mechanical motions. This, in my opinion, we must necessarily do, or else renounce all hopes of ever comprehending anything in physics.

In *Great Books of the Western World* (Volume 34)

*Treatise on Light*

Chapter One. On Rays Propagated in Straight Lines (p. 553)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

...the laws which nature obeys are less suggestive of those which a machine obeys in its motion than of those which a musician obeys in writing a fugue, or a poet in composing a sonnet. The motions of electrons and atoms do not resemble those of the parts of a locomotive so much as those of the dancers in a cotillion. And if the "true essence of substances" is for ever unknowable, it does not matter whether the cotillion is danced at a ball

in real life, or on a cinematography screen, or in a story of Boccaccio.

*The Mysterious Universe*

Chapter V (p. 168)

The Macmillan Company. New York, New York, USA. 1932

### Leacock, Stephen 1869–1944

Canadian humorist

It was Einstein who made the real trouble. He announced in 1905 that there was no such thing as absolute rest. After that there never was.

*The Boy I Left Behind Me*

Chapter VI (p. 171)

The Bodely Head. London, England. 1947

### Locke, John 1632–1704

English philosopher and political theorist

The parts of pure space are immovable, which follows from their inseparability; motion being nothing but change of distance between any two things; but this cannot be between parts that are inseparable; which therefore must needs be at perpetual rest one amongst other.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter XIII, Section 14 (p. 151)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Lucretius ca. 99 BCE–55 BCE

Roman poet

For whenever bodies fall through water and thin air, they must quicken their descents in proportion to their weights, because the body of water and subtle nature of air cannot retard everything in equal degree, but more readily give way [when] overpowered by the heavier...

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book Two, l. 230–234 (p. 18)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Maxwell, James Clerk 1831–79

Scottish physicist

Absolute space is conceived as remaining always similar to itself and immovable. The arrangement of the parts of space can no more be altered than the order of the portions of time. To conceive them to move from their places is to conceive a place to move away from itself.

*Matter and Motion*

Chapter I, Section 18

Dover. New York, New York, USA. 1953

### Meredith, George 1828–1909

English novelist and poet

So may we read, and little find them cold:  
Not frosty lamps illuminating dead space,  
Not distant aliens, not senseless Powers.  
The fire is in them whereof we are born;

The music of their motion may be ours.

*A Reading of Earth*

Meditation under Stars (p. 120)

Macmillan & Company Ltd. London, England. 1888

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

The quantity of motion is the measure of the same, arising from the velocity and quantity of matter conjointly.

*Mathematical Principles of Natural Philosophy*

Definitions, Definition II

E.P. Dutton & Company, Inc. New York, New York, USA. 1922

**Plato** 428 BCE–347 BCE

Greek philosopher

Motion...has many forms, and not one only; two of them are obvious enough even to wits no better than ours; and there are others, as I imagine, which may be left to wiser persons.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 530 (p. 396)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Raman, Chandrasekhar Venkata** 1888–1970

Indian physicist

Once during mass, Galileo in church

Conducted a major scientific search.

He measured with his pulse how a lamp did swing

That was to the ceiling tied with a string.

A Fable for Physicists, The Pendulum Period

*The Physics Teacher*, Volume 18, Number 7, October 1990 (p. 488)

**Regnault, Noël** 1702–62

Jesuit mathematician

Nothing seems more clear at first than the Idea of Motion, and yet nothing is more obscure when one comes to search thoroughly into it.

*Philosophical Conversations* (Volume 1)

Conversation VI (p. 58)

Printed for W. Innys, C. Davis & N. Prevost. London, England. 1731

**Sarpi, Fra Paolo** 1552–1623

Venetian patriot, scholar, and church reformer

To give us the science of motion God and Nature have joined hands and created the intellect of Galileo.

In Morris Kline

*Mathematics and the Physical World*

Chapter 12 (p. 181)

Dover Publications, Inc. New York, New York, USA. 1981

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Two stars keep not their motion in one sphere.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The First Part of King Henry the Fourth

Act V, Scene iv

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Steele, Joel Dorman** 1836–86

American educator and textbook writer

Rest is nowhere. The winds that come and go, the ocean that uneasily throbs along the shore, the earth that revolves about the sun, the light that darts through space — all tell of a universal of Nature. The solidest body hides within it inconceivable velocities. Even the molecules of garnet and iron have their orbits as do the stars, and move as ceaselessly.

*Popular Physics*

Chapter II (p. 19)

American Book Company. New York, New York, USA. 1896

**Thierry, Paul Henri, Baron d'Holbach** 1723–89

German-born French philosopher

Every thing in the universe is in motion; the essence of nature is to act; and if we consider attentively its parts, we shall see that there is not a particle which enjoys absolute repose.

Translated by M. Mirabaud

*System of Nature or, The Laws of the Moral and Physical World* (Volume First)

Part First, Chapter II (p. 27)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**Thomson, Thomas**

No biographical data available

Substances may either be examined in a state of rest, or as acting upon each other and producing changes on each other. The knowledge derived from the first of these views, is called Natural History; that which we can obtain by the second, is distinguished by the name Science. But bodies cannot act upon each other without producing motion, and the motions produced by such actions are of two kinds; either so great as to be visible to our senses, and capable of being measured by the space passed over; or so small as not to be distinguishable by our senses, except by the effects produced. The phenomena connected with the first of these kinds of motions constitute what is called Natural Philosophy or Mechanical Philosophy in this country, and on the Continent, Physics. The phenomena connected with the imperceptible motion belong to the science called Chemistry.

*History of the Royal Society from Its Institution to the End of the Eighteenth Century*

Book III (p. 311)

Printed for Robert Baldwin. London, England. 1812

**Tyndall, John** 1820–93

Irish-born English physicist

But is it in the human mind to imagine motion without at the same time imagining something moved? Certainly not. The very conception of motion includes that of a moving body.

*Light and Electricity* (pp. 123–124)  
D. Appleton & Company, New York, New York, USA. 1873

### Walters, Marcia C.

No biographical data available

The fact that the photon gets mass from its motion  
Is a widely accepted Einsteinion notion,  
This doesn't apply to we mortals, alas —  
For the smaller our motion the greater our mass.

Filler

*The Physics Teacher*, Volume 5, Number 8, November 1967 (p. 384)

### Wells, H. G. (Herbert George) 1866–1946

English novelist, historian, and sociologist

“And here,” he said, and opened the hand that held the glass.  
Naturally I winced, expecting the glass to smash. But so far  
from smashing, it did not even seem to stir; it hung in mid-  
air — motionless. “Roughly speaking,” said Gibberne, “an  
object in these latitudes falls 16 feet in the first second. This  
glass is falling 16 feet in a second now. Only, you see, it  
hasn't been falling yet for the hundredth part of a second.  
That gives you some idea of the pace of my Accelerator.”

*28 Science Fiction Stories of H.G. Wells*

The New Accelerator (p. 863)

Dover Publications, Inc. New York, New York, USA. 1952

### Whitman, Walt 1819–92

American poet, journalist, and essayist

The universe is a procession with measured and beautiful  
motion.

*Complete Poetry and Collected Prose*

Leaves of Grass

The Library of America. New York, New York, USA. 1982

### Wittgenstein, Ludwig Josef Johann 1889–1951

Austrian-born English philosopher

The fact that we can describe the motions of the world using  
Newtonian mechanics tells us nothing about the world. The  
fact that we do, does tell us something about the world.

In John D. Barrow

*The World Within the World* (p. 77)

Clarendon Press. Oxford, England. 1988

### Young, Joshua

No biographical data available

Said the earth to a ball falling free,  
“You're enjoying this falling, I see.”  
The ball widened its eyes  
And remarked with surprise,  
“But it's you who is falling, not me!”

Physics Poems

*The Physics Teacher*, Volume 20, Number 9, December 1982 (p. 587)

## MOUNTAIN

### Austen, Jane 1775–1817

English writer

What are men to rocks and mountains?

*Pride and Prejudice*

Chapter 27

G. Allen. London, England. 1894

### Austin, Mary Hunter 1868–1934

American novelist and essayist

Who shall say what another will find most to his liking  
in the streets of the mountains. As for me, once set above  
the country of the silver firs, I must go on until I find  
white columbine.

*The Land of Little Rain*

The Streets of the Mountain (p. 194–195)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

### Avicenna 908–1037

Islamic physician

Mountains may be due to two different causes. Either  
they are effects of upheavals of the crust of the earth,  
such as might occur during a violent earthquake, or they  
are the effect of water, which, cutting for itself a new  
route, has denuded the valleys, the strata being of differ-  
ent kinds, some soft, some hard. The winds and waters  
disintegrate the one, but leave the other intact. Most of  
the eminences of the earth have had this latter origin. It  
would require a long period of time for all such changes  
to be accomplished, during which the mountains them-  
selves might be somewhat diminished in size. But that  
water has been the main cause of these effects is proved  
by the existence of fossil remains of aquatic and other  
animals on many mountains.

In John William Draper

*History of the Intellectual Development of Europe* (Volume 1)

Chapter XIII (pp. 410–411)

Harper & Brothers. New York, New York, USA. 1876

### Brewster, Edwin Tenney 1866–1960

Educator

[M]ountains are always the children of the sea.

*This Puzzling Planet*

Chapter XIII (p. 217)

The Bobbs-Merrill Company, Indianapolis, Indiana. 1928

### Burnet, Thomas 1635–1715

English cleric and scientist

There is nothing in Nature more shapeless and ill-  
figur'd than an old Rock or a Mountain, and all that  
variety that is among them is but the various modes of  
irregularity; so as you cannot make a better character  
of them, in short, than to say they are of all forms and  
figures, except regular.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)

Book I, Chapter XI (p. 112)

Printed by R. Norton. London. 1691

The greatest objects of Nature are, methinks, the most  
pleasing to behold; and next to the great Concave of the

Heavens, and those boundless Regions where the Stars inhabit, there is nothing that I look upon with more pleasure than the wide Sea and the Mountains of the Earth.... And yet these Mountains we are speaking of, to confess the truth, are nothing but great ruins; but such as show a certain magnificence in Nature; as from old Temples and broken Amphitheatres of the Romans we collect the greatness of that people. But the grandeur of a Nation is less sensible to those that never see the remains and monuments that they have left, and those that never see the mountainous parts of the Earth, scarce ever reflect upon the causes of them, or what power in Nature could be sufficient to produce them.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)

Book I, Chapter XI, Concerning the Mountains of the Earth (p. 109)

Printed by R. Norton. London. 1691

Look upon those great ranges of Mountains in Europe or in Asia, whereof we have given a short survey, in what confusion do they lie? They have neither form nor beauty, nor shape, nor order, no more than the Clouds in the Air. Then how barren, how desolate, how naked are they? how they stand neglected by Nature? neither the Rains can soften them, nor the Dews from Heaven make them fruitful.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)

Book I, Chapter XI (p. 111)

Printed by R. Norton. London. 1691

### **Byron, George Gordon,**

**6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

Above me are the Alps,  
The palaces of Nature, whose vast walls  
Have pinnacled in clouds their snowy scalps,  
And throned Eternity in icy halls ...

The Complete Poetical Works of Byron

Childe Harold

Canto III Stanza 62

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

Where rose the mountains, there to him were friends ...

The Complete Poetical Works of Byron

Childe Harold

canto III Stanza 13

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

### **Carr, William H.**

No biographical data available

...the mountains are but the brothers of the hills.

*The Stir of Nature*

Chapter One (p. 26)

Oxford University Press, Inc. New York, New York, USA. 1930

### **Moore, Dudley** 1935–2002

English actor and pianist

### **Cook, Peter** 1937–1995

English comedian

DUDLEY: And will this wind be so mighty as to lay low the mountains of the earth?

PETER: No. It will not be quite as mighty as that. That is why we have come up on the mountain, you stupid nit. Up here we shall be safe—safe as houses.

*Beyond the Fringe*

The End of the World

British stage comedy revue. 1961

### **Cyrano Jones**

Fictional character

Twice nothing is still nothing.

*Star Trek*

The Trouble with Tribbles

Television program

Season 2, 1967

### **Muir, John** 1838–1914

American naturalist

Thousands of God's wild blessings will search you and soak you as if you were a sponge, and the big days will go by uncounted.

*Our National Parks*

Chapter I (p. 17)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Fear not, therefore, to try the mountain-passes. They will kill care, save you from deadly apathy, set you free, and call forth every faculty into vigorous, enthusiastic action. Even the sick should try these so-called dangerous passes, because for every unfortunate they kill, they cure a thousand.

*Mountains of California*

Chapter V (p. 79)

The Century Company. New York, New York, USA. 1911

Climb the mountains and get their good tidings. Nature's peace will flow into you as sunshine flows into trees. The winds will blow their own freshness into you and the storms their energy, while care will drop off like autumn leaves.

*Our National Parks*

Chapter II (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

The time will not be taken from the sum of your life. Instead of shortening, it will indefinitely lengthen it and make you truly immortal. Nevermore will time seem short or long, and cares will never again fall heavily on you, but gently and kindly as gifts from heaven.

*Our National Parks*

Chapter I (p. 19)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

The mountains are fountains not only of rivers and fertile soil, but of men.

*Steep Trails*

Chapter III (p. 47)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

Here I could stay tethered forever with just bread and water, nor would I be lonely; loved friends and neighbors, as love for everything increased, would seem all the nearer however many the miles and mountains between us.

*My First Summer in the Sierra*

June 6 (p. 29)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

...perhaps more than all, I was animated by a mountaineer's eagerness to get my feet in the snow once more, and my head into the clear sky, after lying dormant all winter at the level of the sea.

*Steep Trails*

Chapter IX (p. 128)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

[Mountains] seem to have been built for the human race, as at once their schools and cathedrals; full of treasures of illuminated manuscript for the scholar, kindly in simple lessons to the worker, quiet in pale cloisters for the thinker, glorious in holiness for the worshipper. ...[G]reat cathedrals of the earth, with their gates of rock, pavements of cloud, choirs of stream and stone, altars of snow, and vaults of purple traversed by the continual stars...

*Selections from the Works of John Ruskin*

The Mountain Glory (p. 16)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Sedgwick, Adam** 1854–1913

English geologist

My present objective is to convey some notion of the structure of the great mountain masses, and to show how the several parts are fitted one to another. This can only be done after great labour. The cliffs where the rocks are laid bare by the sea, the clefts and fissures in the hills and valleys, the deep grooves through which the water flows — all must in turn be examined; and out of such seeming confusion order will at length appear. We must, in imagination, sweep off the drifted matter that clogs the surface of the ground; we must suppose all the covering of moss and heath and wood to be torn away from the sides of the mountains, and the green mantle that lies near their feet to be lifted up; we may see the muscular integuments and sinews and bones of our mother Earth, and so judge of the parts played by each of them during those old convulsive movements whereby her limbs were contorted and drawn up into their present positions.

In John Hudson

*Complete Guide to the Lakes*

Second Letter

Longman & Company. London, England. 1842

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The tops of mountains are among the unfinished parts of the globe, whither it is a slight insult to the gods to climb and pry into their secrets, and try their effects upon our humanity.

*The Writings of Henry David Thoreau* (Volume 3)

The Maine Woods

Ktaadn (p. 85)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

## MUCOUS

**Pain, Roger H.**

No biographical data available

If it is love that makes the world go round, then it is surely mucus and slime which facilitate its translational motion.

In Steven Vogel

*Life's Devices: The Physical World of Animals*

Chapter 9 (p. 177)

Princeton University Press. Princeton, New Jersey, USA. 1988

## MULTIPLICATION

**Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

There is no national science, just as there is no national multiplication table; what is national is no longer science.

*Note-Book of Anton Chekhov* (p. 18)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Melrose, A. R.**

No biographical data available

Twy-stymes, noun: 1 arithmetic if it has to do with the number two {2} {which is always a good number to have when doing anything}. 2 multiplication table of the number two {2}.

*The Pooh Dictionary*

Dutton Children's Books. New York, New York, USA. 1995

**Zamyatin, Yevgeny** 1884–1937

Russian novelist, playwright, and satirist

There are no more fortunate and happy people than those who live according to the correct, eternal laws of the multiplication table.

Translated by Gregory Zilboorg

*We*

Record Twelve (p. 64)

E.P. Dutton & Company, Inc. New York, New York, USA. 1952

The multiplication table is more wise and more absolute than the ancient god, for the multiplication table never (do you understand — never) makes mistakes!

Translated by Gregory Zilboorg

*We*

Record Twelve (pp. 63–64)

E.P. Dutton & Company, Inc. New York, New York, USA. 1952

**MUON****Penman, Sheldon**

No biographical data available

For the time being, however, the muon itself qualifies as a “riddle wrapped in a mystery inside an enigma.”

The Muon

*Scientific American*, Volume 205, Number 1, July 1961 (p. 55)

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

Who ordered that?

Attributed, upon learning of the muon

**MUSEUM****Belloc, Hilaire** 1870–1953

French-born poet and historian

The Dodo used to walk around,

And take the sun and air,

The sun yet warms his native ground —

The Dodo is not there!

The voice which used to squawk and squeak

Is now for ever dumb —

You may you see his bones and beak

All in the Mu-se-um.

*Complete Verse*

The Dodo (p. 238)

G. Duckworth. London, England. 1970

**Edwards, R. Y.**

No biographical data available

The physical heart of a museum is its collection, in fact having a collection is what makes a museum a museum, and most activity in most museums is involved with the acquisition, care, understanding, and use of their collections.

Research: A Museum Cornerstone

*Occasional Papers of the British Columbia Provisional Museum*, Volume 25, 1985 (p. 1)

**Flower, Sir William Henry** 1831–99

English zoologist

A museum is like a living organism; it requires constant and tender care; it must grow or it will perish.

In Archie F. Key

*Beyond Four Walls: The Origins and Development of Canadian Museums*

Chapter 6 (p. 52)

McClelland & Stewart Ltd. Toronto, Ontario, Canada. 1973

**Goode, George Brown**

No biographical data available

A finished museum is a dead museum, and a dead museum is a useless museum.

In Museums Association

The Principles of Museum Administration

*Report of Proceedings*, Newcastle, 1895 (p. 78)

**St. Clair, George**

No biographical data available

The crust of the earth, with its embedded fossils, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals.

*Darwinism and Design, or, Creation by Evolution*

Chapter III (p. 52)

Hodder & Stoughton. London, England. 1873

**MUTATION****Crow, J. F.** American geneticist

No biographical data available

...we could still be sure on theoretical grounds that mutants would usually be detrimental. For a mutation is a random change of a highly organized, reasonably smoothly functioning human body. A random change in the highly integrated system of chemical processes which constitute life is certain to impair — just as a random interchange of connections in a television set is not likely to improve the picture.

Genetic Effects of Radiation

*Bulletin of the Atomic Scientists*, Volume 14, Number 1, January 14, 1958 (pp. 19, 20)

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

...a majority of mutations, both those arising in laboratories and those stored in natural populations, produce deteriorations of...viability, hereditary disease and monstrosities. Such changes it would seem, can hardly serve as evolutionary building blocks.

*Genetics and the Origin of Species*

Chapter III (p. 73)

Columbia University Press. New York, New York, USA. 1951

...the mutation process alone, not corrected and guided by natural selection, would result in degeneration and extinction rather than improved adaptiveness.

On Methods of Evolutionary Biology and Anthropology

*American Scientist*, Volume 45, 1957 (p. 385)

**Heinlein, Robert A.** 1907–88

American science fiction writer

“Mutation” is never an explanation; it is simply a name for an observed fact.

*Time Enough for Love*

Chapter IX (p. 246)

G.P. Putnam’s Sons. New York, New York, USA. 1973

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

One would expect that any interference with such a complicated piece of chemical machinery as the genetic constitution would result in damage. And, in fact, this is so: the great majority of mutant genes are harmful in their effects on the organism.

*Evolution in Action*

Chapter 2 (p. 39)

Harper & Brothers. New York, New York, USA. 1953

**Muller, Hermann Joseph** 1890–1967

American geneticist

It is entirely in line with the accidental nature of natural mutations that extensive tests have agreed in showing the vast majority of them detrimental to the organism in its job of surviving and reproducing, just as changes accidentally introduced into any artificial mechanism are predominantly harmful to its useful operation.

How Radiation Changes the Genetic Constitution

*Bulletin of the Atomic Scientists*, Volume 11, Number 9, November 1955 (p. 331)

**Pauling, Linus** 1901–94

American chemist

Every species of plant and animal is determined by a pool of germ plasm that has been most carefully selected over a period of hundreds of millions of years. We can understand now why it is that mutations in these carefully selected organisms almost invariably are detrimental. The situation can be suggested by a statement by Dr. J.B.S. Haldane: “My clock is not keeping perfect time. It is conceivable that it will run better if I shoot a bullet through it; but it is much more probable that it will stop altogether.” Professor George Beadle, in this connection, has asked: “What is the chance that a typographical error would improve Hamlet?”

*No More War!*

Chapter 4 (p. 53)

Dodd, Mead & Company. New York, New York, USA. 1958

## MUTUALISM

**Pound, Roscoe** 1870–1964

American jurist

It is not necessary...in order to establish mutualism to show that the organisms do no injury to each other. Mutualism of the kind we meet with in the vegetable kingdom involves sacrifice on the part of the host. The parasite is not there gratuitously. It is there to steal from its host the living it is hereditarily and constitutionally indisposed to make for itself. If the host gains any advantage from the relation, it can only do so by sacrificing — by giving the parasite the benefit of its labor that it may subsist.

Symbiosis and Mutualism

*The American Naturalist*, Volume XXVII, Number 318, June 1893 (p. 519)

## MYRMECOLOGIST

**Hölldobler, Bert** 1936–

German myrmecologist

**Wilson, Edward O.** 1929–

American biologist and author

Like all myrmecologists...we are prone to view the Earth's surface idiosyncratically, as a network of ant colonies. We carry a global map of these relentless little insects in our heads. Everywhere we go their ubiquity and predictable natures makes us feel at home, for we have learned to read part of their language and we understand certain designs of their social organization better than anyone understands the behavior of our fellow humans.

*Journey to the Ants: A Story of Scientific Exploration*

The Dominance of Ants (p. 1)

Harvard University Press. Cambridge, Massachusetts, USA. 1994

## MYSTERY

**Asimov, Isaac** 1920–92

American author and biochemist

The mysteries of the universe and the questions that scientists strive to answer never come to an end. For that we should be grateful. A universe in which their were no mysteries for curious men to ponder would be a very dull universe indeed.

*The Search for the Elements*

Chapter 16 (p. 152)

Basic Books. New York, New York, USA. 1962

## Author undetermined

“Give me the facts,” said My Lord Judge, “thy conclusions are but the guess-work of imagination; which puzzle the brain, and tend not to solve the mystery.”

In Colin Mackenzie

*One Thousand Experiments in Chemistry*

On Cover page

Printed for Sir Richard Phillips & Company. London, England. 1821

**Burroughs, John** 1837–1921

American naturalist and writer

...after science has done its best the mystery is as great as ever, and the imagination and the emotions have just as free a field as before.

*Indoor Studies Science and Literature*

Science and Literature (pp. 51–52)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1889

**Chargaff, Erwin** 1905–2002

Austrian biochemist

It is the sense of mystery that, in my opinion, drives the true scientist: the same force, blindly seeing, deafly hearing, unconsciously remembering, that drive the larvae



into the butterfly. If he has not experienced, at least a few times in his life, this cold shudder down his spine, this confrontation with an immense, invisible face whose breath moves him to tears, he is not a scientist. The blacker the night, the brighter the light.

*Heracleitian Fire: Sketches from a Life Before Nature*

Part II

In the Light of Darkness (p. 114)

Rockefeller University Press. New York, New York, USA. 1978

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

There is mystery in the universe, beguiling mystery, but it isn't capricious, whimsical, frivolous in its changeability. The universe is an orderly place and, at a deep level, regions of it behave like other regions, times behave like other times.

*Science, Delusion and the Appetite for Wonder*

Richard Dimbleby Lecture, BBC1 Television, November 12<sup>th</sup>, 1996

Newton, Keats agreed with Lamb, had destroyed all the poetry of the rainbow, by reducing it to the prismatic colours.... Newton's dissection of the rainbow into light of different wavelengths led on to Maxwell's theory of electromagnetism and thence to Einstein's theory of special relativity. If you think the rainbow has poetic mystery, you should try relativity.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder* Chapter 3 (p. 39)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

The real universe has mystery enough to need no help from obscurantist hucksters.

The Real Romance in the Stars

*The Independent*, 31 Dec 1995

Mysteries do not lose their poetry when solved. Quite the contrary; the solution often turns out more beautiful than the puzzle and, in any case, when you have solved one mystery you uncover others, perhaps to inspire greater poetry.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder* Chapter 3 (p. 41)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

It is a mistake to confound strangeness with mystery.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 7 (p. 194)

Wings Books. New York, New York, USA. 1967

As a rule, said Holmes, the more bizarre a thing is the less mysterious it proves to be.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Red Headed League (p. 429)

Wings Books. New York, New York, USA. 1967

**Einstein, Albert** 1879–1955

German-born physicist

The most beautiful experience we can have is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science. Whoever does not know it and can no longer wonder, no longer marvel, is as good as dead, and his eyes are dimmed.

*Ideas and Opinions*

The World As I See It (p. 11)

Crown Publishers, Inc. New York, New York, USA. 1954

I claim credit for nothing. Everything is determined, the beginning as well as the end, by forces over which we have no control. It is determined for the insect as well as for the star. Human beings, vegetables, or cosmic dust, we all dance to a mysterious tune, intoned in the distance by an invisible player.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 117)

**Feynman, Richard P.** 1918–88

American theoretical physicist

We choose to examine a phenomenon which is impossible, absolutely impossible to explain in any classical way, and which has in it the heart of quantum mechanics. In reality, it contains the only mystery.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 37–1 (p. 37–2)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...the idea that it [science] takes away mystery or awe or wonder in nature is wrong. It's quite the opposite. It's much more wonderful to know what something's really like than to sit there and just simply, in ignorance, say, "Oooh, isn't it wonderful!"

In Christopher Sykes

*No Ordinary Genius: The Illustrated Richard Feynman*

Chapter Four (p. 108)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

With more knowledge comes a deeper, more wonderful mystery, luring one on to penetrate deeper still. Never concerned that the answer may prove disappointing, with pleasure and confidence we turn over each new stone to find unimagined strangeness leading on to more wonderful questions and mysteries — certainly a grand adventure.

*What Do You Care What Other People Think?*

The Value of Science (p. 243)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

[The law of gravity] is not exact; Einstein had to modify it, and we know it is not quite right yet, because we have still to put the quantum theory in. That is the same with all our other laws — they are not exact. There is always an edge of mystery, always a place where we have some fiddling around to do yet. This may or may not be a property of Nature, but it certainly is common to all the laws

as we know them today. It may be only a lack of knowledge.

*The Character of Physical Law*  
Chapter I (p. 33)  
BBC. London, England. 1965

It is a great adventure to contemplate the universe, beyond man, to contemplate what it would be like without man, as it was in a great part of its long history and as it is in a great majority of places. When this objective view is finally attained, and the mystery and majesty of matter are fully appreciated, to then turn the objective eye back on man viewed as matter, to view life as part of this universal mystery of greatest depth, is to sense an experience which is very rare, and very exciting. It usually ends up in laughter and a delight in the futility of trying to understand what this atom in the universe is, this thing — atoms with curiosity — that looks at itself and wonders why it wonders.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter II (p. 39)  
Perseus Books. Reading, Massachusetts, USA. 1998

[T]hese scientific views end in awe and mystery, lost at the edge in uncertainty, but they appear to be so deep and so impressive that the theory that it is all arranged as a stage for God to watch man's struggle for good and evil seems inadequate.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter II (p. 39)  
Perseus Books. Reading, Massachusetts, USA. 1998

...I can live with doubt and uncertainty and not knowing. I think it's much more interesting to live not knowing than to have answers which might be wrong. I have approximate answers and possible beliefs and different degrees of certainty about different things, but I'm not absolutely sure of anything and there are many things I don't know anything about, such as whether it means anything to ask why we're here...I don't have to know an answer, I don't feel frightened by not knowing things, by being lost in a mysterious universe without any purpose, which it is the way it really is so far as I can tell. It doesn't frighten me.

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
Chapter 1 (pp. 24–25)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

**Fosdick, Harry Emerson** 1878–1969  
American clergyman and educator

I would rather live in a world where my life is surrounded by mystery than live in a world so small that my mind could comprehend it.

*Riverside Sermons*  
The Mystery of Life (p. 22)  
Harper & Brothers Publishers. New York, New York, USA. 1958

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

When you call a thing mysterious, all that means is that you don't understand it.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter IV (p. 56)  
Macmillan & Company Ltd. London, England. 1918

**Lightman, Alan** 1948–  
Physicist, novelist, and essayist

A painter paints a sunset, and a scientist measures the scattering of light. The beauty of nature lies in its logic as well as appearance. And we delight in that logic: The square of the orbital period of each planet equals the cube of its distance from the sun; the shape of a raindrop is spherical, to minimize the area of its surface. Why it is that nature should be logical is the greatest mystery of science. But it is a wonderful mystery.

*Great Ideas in Physics*  
Introduction (p. 1)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1997

**Lindbergh, Anne Morrow** 1906–2001  
American aviator and writer

Today's mystery is not the old veiling by superstition of the things man does not understand, but a new unblinking gaze at the mysteries of the universe that may never be unveiled.

*Earth Shine*  
Back to Earth (pp. 42–43)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Lowell, Percival** 1855–1916  
American astronomer

Discoveries in science have a fatal facility for lying lost in the technical publications which record them. Few persons attend to what is not alluring and columns of figures form but an uninviting protocol to the learning within. Yet these very people would take the keenest interest in scientific progress could its beauty and real simplicity be adequately set out for them. For the whole object of science is to explain and make comprehensible the universe around us. Science consists in solving mysteries not, as the layman might imagine, in making them.

In William Graves Hoyt  
*Lowell and Mars*  
Chapter 7 (p. 96)  
University of Arizona Press. Tucson, Arizona, USA. 1976

**Margenau, Henry** 1901–97  
American physicist

I recognize no subjects and no facts which are alleged to be forever closed to inquiry or understanding: a mystery is but a challenge.

*Open Vistas*

Chapter III Section 3 (p. 76)  
Yale University Press. New Haven, Connecticut, USA. 1961

**Penrose, Roger** 1931–  
English mathematical physicist

...once you have put more and more of your physical world into a mathematical structure, you realize how profound and mysterious this mathematical structure is. How you can get all these things out of it is very mysterious...

In Alan Lightman and Robert Brawer (eds.)  
*Origins: The Lives and Worlds of Modern Cosmologists*  
Roger Penrose (p. 433)  
Harvard University Press. Cambridge, Massachusetts, USA. 1990

**Peterson, Ivars**  
Mathematics writer

The voyage of discovery into our own solar system has taken us from clockwork precision into chaos and complexity. This still unfinished journey has not been easy, characterized as it is by twists, turns, and surprises that mirror the intricacies of the human mind at work on a profound puzzle. Much remains a mystery. We have found chaos, but what it means and what its relevance is to our place in the universe remains shrouded in a seemingly impenetrable cloak of mathematical uncertainty.

*Newton's Clock: Chaos in the Solar System*  
Chapter 12 (p. 293)  
W.H. Freeman & Company. New York, New York, USA. 1993

**Richards, Theodore William** 1868–1928  
American chemist

No one can predict how far we shall be enabled by means of our limited intelligence to penetrate into the mysteries of a universe immeasurably vast and wonderful; nevertheless, each step in advance is certain to bring new blessings to humanity and new inspiration to greater endeavor.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1911* (Faraday Lecture) The Fundamental Properties of the Elements (p. 215)  
Government Printing Office. Washington, D.C. 1912

**Smullyan, Raymond** 1919–  
American mathematician and logician

...I certainly believe that some things may in principle be mysteries, but of what use is a hypothesis for explaining a mystery when the very hypothesis raises another mystery just as baffling as the one it explains?

*5000 B.C. and Other Philosophical Fantasies*  
Chapter 13 (p. 165)  
St. Martin's Press. New York, New York, USA. 1983

**Wilson, Edward O.** 1929–  
American biologist and author

The unsolved mysteries of the rain forest are formless and seductive. They are like unnamed islands hidden in

the blank spaces of old maps, like dark shapes glimpsed descending the far wall of a reef into the abyss.

*The Diversity of Life*  
Chapter One (p. 7)  
W.W. Norton & Company, Inc. New York, New York, USA. 1992

**Young John Zachary** 1907–97  
English zoologist

The scientist is in a better position than anyone else to see that we are set about with mysteries. It is his business to grapple with ghosts every day of his life and he must refuse to allow them to be laid by the process of labeling them with a primitive nomenclature. The mysteries of the universe are too great to be expressed by such simple comparisons as are implicit in either the words "spirit" or "matter."

*Doubt and Certainty in Science: A Biologist's Reflections on the Brain*  
Comment on the First Lecture (p. 23)  
Oxford University Press, Inc. Oxford, England. 1960

## MYSTICISM

**Capra, Fritjof** 1939–  
Austrian-born American physicist

Science does not need mysticism and mysticism does not need science, but man needs both. Mystical experience is necessary to understand the deepest nature of things, and science is essential for modern life. What we need, therefore, is not a synthesis, but a dynamic interplay between mystical intuition and scientific analysis.

*The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism*  
Epigraph (p. 297)  
Shambhala. Berkeley, California, USA. 1975

## MYTH

**Bernal, John Desmond** 1901–71  
Irish-born physicist and x-ray crystallographer

Science, in one aspect, is ordered technique; in another, it is rationalized mythology.

*Science in History*  
Preface (p. ix)  
Watts. London, England. 1957

**Clift, Wallace B.**  
No biographical data available

However, for most of us, science functions like myth in that we have no personal experience in the matter. We put our trust in the scientific view given us by our culture and enshrined in its myths. If asked why leaves are green, most of us would probably mutter something about "chlorophyll." But unless we were specialists, we would simply be repeating the story of someone else's experience.

*Jung and Christianity* (pp. 62–63)  
Publisher undetermined

**Hubbard, Ruth** 1924–  
American biologist

The mythology of science asserts that with many different scientists all asking their own questions and evaluating the answers independently, whatever personal bias creeps into their individual answers is canceled out when the large picture is put together. This might conceivably be so if scientists were women and men from all sorts of different cultural and social backgrounds who came to science with very different ideologies and interests. But since, in fact, they have been predominantly university-trained white males from privileged social backgrounds, the bias has been narrow and the product often reveals more about the investigator than about the subject being researched.

*Women Look at Biology Looking at Women*

Have Only Men Evolved? (p. 31)

Schenkman Publishing Company. Cambridge, Massachusetts, USA. 1979

**Jacob, François** 1920–  
French biologist

...myths and science fulfill a similar function: they both provide human beings with a representation of the world and the forces that are supposed to govern it.

*The Possible and the Actual*

Myth and Science (p. 9)

Pantheon Books. New York, New York, USA. 1982

**Mahadeva, M.**  
No biographical data available

Myths are errors that result [both from] scientists bringing societal preconceptions into science and...scientists feeding society ideas that masquerade as science.

From Misinterpretations to Myths  
*Science Teacher*, Volume 56, Number 4, 1989

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

Thus science must begin with myths — and with the criticism of myths...

In C.A. Mace (ed.)

*British Philosophy in the Mid-Century*

Philosophy of Science: A Personal Report, VII (p. 177)

Science never starts from scratch; it can never be described as free from assumptions; for at every instant it presupposes a horizon of expectations — yesterday's horizon of expectations, as it were. Today's science is built upon yesterday's science (and so it is the result of yesterday's searchlight); and yesterday's science, in turn, is based on the science of the day before. And the oldest scientific theories are built on pre-scientific myths, and these, in their turn, on still older expectations.

*Objective Knowledge: An Evolutionary Approach*

Appendix (pp. 346–347)

Clarendon Press. Oxford, England. 1972

**Whyte, Lancelot Law** 1896–1972  
Scottish physicist

In the ultimate analysis science is born of myth and religion, all three being expressions of the ordering spirit of the human mind.

*The Unconscious Before Freud*

Chapter V (pp. 82–83)

Julian Friedmann Publishers. London, England. 1978

## N

### NAME

#### **Abbey, Edward** 1927–89

American environmentalist and nature writer

...the itch for naming things is almost as bad as the itch for possessing things.

*Desert Solitaire*

Terra Incognita: Into the Maze (p. 288)

Ballantine Books. New York, New York, USA. 1968

#### **Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

The first thing to be determined about a new specimen is not its name, but its most prominent character. Until you know an animal, care not for its name.

In James Orton

*Comparative Zoology; Structural and Systematic*

Preceding Chapter I (p. 18)

Harper & Brothers. New York, New York, USA. 1877

Every art and science has a language of technical terms peculiar to itself. With those terms every student must make himself familiarly acquainted at the outset; and first of all, he will desire to know the names of the objects about which he is to be engaged.

*Principles of Zoology*

Introduction (p. xiii)

Goold, Kendall & Lincoln. Boston, Massachusetts, USA. 1848

Nothing is more to be deprecated than an over-appreciation of technicalities, valuing the name more highly than the thing; but some knowledge of this scientific nomenclature is necessary to every student of Nature.

*Methods of Study in Natural History*

Chapter II (p. 18)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

#### **Borland, Hal** 1900–78

American writer

There is folk poetry in the common names; but science, devoted to order and systematic knowledge, insists on classifying and defining. The poet's buttercup is the botanist's *Ranunculus*. If you would walk with scientist as well as poet, learn both languages.

*Beyond Your Doorstep: A Handbook to the Country*

Chapter 15 (p. 359)

Alfred A. Knopf. New York, New York, USA. 1962

#### **Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

"What's the use of their having names," the Gnat said, "if they won't answer to them?"

"No use to them," said Alice; "but its useful to the people that name them, I suppose."

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter III (p. 173)

The Modern Library. New York, New York, USA. 1936

"My name is Alice...."

"It's a stupid name enough!" Humpty Dumpty interrupted impatiently. "What does it mean?"

"Must a name mean something?" Alice asked doubtfully.

"Of course it must," Humpty Dumpty said with a short laugh; "my name means the shape I am.... With a name like yours, you might be any shape, almost."

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter VI (p. 209)

The Modern Library. New York, New York, USA. 1936

#### **Darwin, Charles Robert** 1809–82

English naturalist

...I have lately been trying to get up an agitation (but I shall not succeed, and indeed doubt whether I have time and strength to go on with it), against the practice of Naturalists appending for perpetuity the name of the first describer to species. I look at this as a direct premium to hasty work, to naming instead of describing. A species ought to have a name so well known that the addition of the author's name would be superfluous, and a [piece] of empty vanity.... Why should Naturalists append their own names to new species, when Mineralogists and Chemists do not do so to new substances?

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to J.D. Hooker, October 6, 1848 (pp. 332–333)

D. Appleton & Company. New York, New York, USA. 1896

I do not think more credit is due a man for defining a species, than to a carpenter for making a box. But I am foolish and rabid against species-mongers, or rather against their vanity; it is useful and necessary work which must be done; but they act as if they had actually made the species, and it was their own property.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to Hugh Strickland, February 4, 1849 (pp. 338–339)

D. Appleton & Company. New York, New York, USA. 1896

How dreadfully difficult it is to name plants.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to J.D. Hooker, June 5, 1855 (p. 418)

D. Appleton & Company. New York, New York, USA. 1896

#### **Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Man, it's Witchcraft! Where in the name of all that is wonderful did you get those names?

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Valley of Fear

Part I, Chapter 1 (p. 476)

Wings Books. New York, New York, USA. 1967

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

The mere fact of naming an object tends to give definiteness to our conception of it — we have then a sign that at once calls up in our minds the distinctive qualities which mark out for us that particular object from all others.

*The George Eliot Letters* (Volume 11) (p. 251)

Yale University Press. New Haven, Connecticut, USA. 1954–78

**Ellis, Havelock** 1859–1939  
English sexuality researcher

For even the most sober scientific investigator in science, the most thoroughgoing Positivist, cannot dispense with fiction; he must at least make use of categories, and they are already fictions, analogical fictions, or labels, which give us the same pleasure as children receive when they are told the “name” of a thing.

*The Dance of Life*

Chapter III, Section II (p. 94)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Faraday, Michael** 1791–1867  
English physicist and chemist

...I am fully aware that names are one thing and science another.

*Experimental Researches in Electricity* (Volume 1)

Seventh Series, 666 (p. 198)

Richard and John Edward Taylor. London, England. 1839–1855

**Ferris, G. F.**  
No biographical data available

The proper aim is not to *name* species but to *know* them.  
*Stanford University Publications: Biological Studies* (Volume 5)  
The Principles of Systematic Entomology (p. 105)  
Stanford University. Stanford, California, USA. 1920–53

**Gahan, A. B.**  
No biographical data available

Objects without names cannot well be talked about or written about; without descriptions they cannot be identified and such knowledge as may have accumulated regarding them is sealed.

The Role of the Taxonomist in Present Day Entomology

*Entomological Society of Washington Proceedings*, Volume 25, 1923 (p. 73)

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

A Pseudo-science consists of a nomenclature, with a self-adjusting arrangement, by which all positive evidence, or such as favors its doctrines, is admitted, and all negative evidence, or such as tells against it, is excluded. It is invariably connected with some lucrative practical application.

*The Professor at the Breakfast Table*

Chapter VIII (p. 249)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

**Isidorus**  
No biographical data available

If you know not the names, the knowledge of things is wasted.

In Carl von Linné

*Critica Botanica*

Generic Names (p. 1)

The Ray Society. London, England. 1938

**Juster, Norton** 1929–  
American architect and writer

Words and numbers are of equal value, for, in the cloak of knowledge, one is warp and the other woof. It is no more important to count the sands than it is to name the stars.

*The Phantom Tollbooth*

Chapter 6 (p. 77)

Alfred A. Knopf. New York, New York, USA. 1989

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

The impossibility of separating the nomenclature of a science from the science itself, is owing to this, that every branch of physical science must consist of three things; the series of facts which are the objects of the science, the ideas which represent these facts, and the words by which these ideas are expressed.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (p. xiv)

Printed for William Creech. Edinburgh, Scotland. 1790

**Le Fèvre, Nicholas** 1615–69  
No biographical data available

This Principle, as well as the others, hath received several names; for it is called Oil, Natural Fire, Light, Vital Fire, Balsom of Life and of Sulphur, and besides, many other appellations have been given by the Sons of Art, which we will not fill up this Section: According to our usual custom, we will content our selves, with examining the nature of the thing, leaving the niceties of Names to the over-curious.

*A Complete Body of Chymistry*

Chapter III, Section IV (p. 25)

Printed for O. Pully. London, England. 1640

**Linnaeus, Carl (von Linné)** 1707–78  
Swedish botanist

The first step of science is to know one thing from another. This knowledge consists in their specific distinctions; but in order that it may be fixed and permanent distinct names must be given to different things, and those names must be recorded and remembered.

In Sir James Edward Smith

*A Selection of the Correspondence of Linnaeus and Other Naturalists from the Original Manuscripts* (Volume 2) (p. 460)

Longman, Hurst, Rees, Orme and Brown. London, England. 1821

The first step in wisdom is to know the things themselves; this notion consists in having the true idea of the object; objects are distinguished and known by their methodical classification and appropriate naming; therefore Classification and Naming will be the foundation of our Science.

In P. F. Stevens

*The Development of Biological Systematics: Antoine-Laurent de Jussieu, Nature and the Natural System*

Chapter Nine (p. 201)

Columbia University Press. New York, New York, USA. 1994

For, even though the knowledge of the true and genuine Tree of Life, which might have delayed the coming of old age, is lost, still herbs remain and renew their flowers, and with perennial gratitude will always breathe forth the sweet memory of your names, and make them more enduring than marble, to outlive the names of kings and heroes. For wealth disappears, the most magnificent houses fall into decay, the most numerous family at some time or other comes to an end: the greatest states and the most prosperous kingdoms can be overthrown: but the whole of Nature must be blotted out before the race of plants passes away, and he is forgotten who in Botany held up the torch.

*Critica Botanica*

Generic Names (p. 68)

The Ray Society. London, England. 1938

Name and plant are two ideas, which ought to be so closely united that they cannot possibly be separated: in order to secure this, the plant ought to lend a hand to the name, and the name in its turn to the plant, while the name in its turn rejoices in the sound principle on which it was given: since there is no connexion between botanist and plant, there is also no sound principle in naming it after him: and so the naming is bad.

*Critica Botanica*

Generic Names (p. 61)

The Ray Society. London, England. 1938

### Lloyd, C. G.

No biographical data available

Botanists meet and pass rules for the naming of plants, but they cannot agree on any set of rules, and never will as long as the members are vitally interested in the particular rules that perpetuate their own names and the plant names that have been proposed by themselves.

Personal Names in Nomenclature

*The American Botanist*, Volume 4, Number 3, March 1903 (p. 48)

### Melville, Herman 1819–91

American novelist

I wonder whether mankind could not get along without all those names which keep increasing every day, and hour, and moment; till at last the very air will be full of them; and even in a great plain men will be breathing each other's breath, owing to the vast multitude of words they use that consume all of the air.... But people seem to have a great love for names; for to know a great many names seems to look like knowing a good many things.

*Redburn*

Chapter XIII

A. & C. Boni. New York, New York, USA. 1924

### Page, Jake

No biographical data available

To name something is, in a sense, to own it.... [It] has been said that it is only by its name that anything can enter into thought and discourse. Naming, in other words, is a serious business.

*Pastorale: A Natural History of Sorts*

What Is in a Name? (p. 119)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

### Savory, Theodore

No biographical data available

...words are in themselves among the most interesting objects of study, and the names of animals and plants are worthy of more consideration than Biologists are inclined to give them.

*Naming the Living World: An Introduction to the Principles of Biological Nomenclature*

Preface (p. vii)

English Universities Press. London, England. 1962

### Sylvester, James Joseph 1814–97

English mathematician

Perhaps I may without immodesty lay claim to the appellation of Mathematical Adam, as I believe that I have given more names (passed into general circulation) of the creatures of the mathematical reason than all the other mathematicians of the age combined.

Notes on a Proposed Addition to the Vocabulary of Ordinary Arithmetic

*Nature*, Volume 37, Number 946, December 15, 1887 (p. 152, fn 1)

### Turnbull, Charles D.

No biographical data available

According to Genesis, "Adam gave names to all cattle and to the fowl of the air and to every beast of the field," and we have therefore authority to declare that although Father Adam named both birds and beasts, he woefully neglected the flower, and left the task to the fancy and haphazard desires of his descendants.

Concerning Nomenclature  
*The American Botanist*, Volume 4, Number 3, March 1903 (p. 45)

### Twain, Mark (Samuel Langhorne

**Clemens)** 1835–1910  
 American author and humorist

Names are not always what they seem. The common Welsh name *Bzjxxlwep* is pronounced Jackson.  
*Following the Equator* (Volume 1)  
 Chapter XXXVI (p. 339)  
 Harper & Brothers. New York, New York, USA. 1899

**Whitehead, Alfred North** 1861–1947  
 English mathematician and philosopher

...in the garden of Eden God saw the animals before he named them: in the traditional system [of education] children named the animals before they saw them.  
*Science and the Modern World*  
 Chapter XIII (p. 285)  
 The Macmillan Company. New York, New York, USA. 1929

## NATURAL HISTORY

**Agassiz, Jean Louis Rodolphe** 1807–73  
 Swiss-born American naturalist, geologist, and teacher

...Natural History must in good time become the analysis of the thoughts of the Creator of the Universe as manifested in the animal and vegetable kingdoms, as well as in the inorganic world.  
*Essay on Classification*  
 Chapter I, Section XXXII (p. 137)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1962

A laboratory of Natural History is a sanctuary where nothing profane should be tolerated. I feel less agony at improprieties in churches than in a scientific laboratory.  
 In David Stair Jordan  
*Popular Science Monthly*, Volume 40, 1891

**Borlase, William** 1696–1772  
 Cornish antiquary

Natural History is the handmaid to Providence, collects into a narrow space what is distributed through the Universe, arranging and disposing the several Fossils, Vegetables and Animals, so as the mind may more readily examine and distinguish their beauties, investigate their causes, combinations, and effects, and rightly know how to apply them to the calls of private and public life.  
*The Natural History of Cornwall*  
 The Air, Climate, Waters, Rivers, Lakes, Seas and Tides, to the Nobility and Gentry of the County of Cornwall (p. iv)  
 Publisher undetermined

**Carroll, Lewis (Charles Dodgson)** 1832–98  
 English writer and mathematician

In one moment I've seen what has hitherto been

Enveloped in absolute mystery,  
 And without extra charge I will give you at large  
 A Lesson in Natural History.  
*The Complete Works of Lewis Carroll*  
 The Hunting of the Snark  
 Fit the Fifth (p. 771)  
 The Modern Library. New York, New York, USA. 1936

**Darwin, Charles Robert** 1809–82  
 English naturalist

What a splendid pursuit Natural History would be if it was all observing and no writing!  
 In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 11)  
 Letter to J.D. Hooker, February 3, 1868 (p. 258)  
 D. Appleton & Company. New York, New York, USA. 1896

Nobody but a person fond of Natural History can imagine the pleasure of strolling under cocoa-nuts in a thicket of bananas and coffee-plants, and an endless number of wildflowers.  
 In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter VI (pp. 201–202)  
 D. Appleton & Company. New York, New York, USA. 1896

**Fleming, Donald**  
 No biographical data available

For the colonial investigator himself, natural history was the ideal refuge from the more perilous enterprise of embarking upon theoretical constructions by which he would be pitched into naked competition with the best scholars of all countries. To be a forager for Linnaeus or correspondent of the Hookers might be an identity in science purchased by bondage to the local and particular; but it was also a shelter against the more bracing winds that would promptly blow upon any man who tired to grapple with undifferentiated Nature in physics.  
*Proceedings of the 10<sup>th</sup> International Congress of the History of Science, Ithaca, 1962*  
 Science in Australia, Canada, and the United States: Some Comparative Remarks (p. 182)  
 Cornell University Press. Ithaca, New York, USA. 1964

**Huxley, Thomas Henry** 1825–95  
 English biologist

To a person uninstructed in natural history, his country or sea-side stroll is a walk through a gallery filled with wonderful works of art, nine-tenths of which have their faces turned to the wall. Teach him something of natural history, and you will place in his hands a catalogue of those which are worth turning around.  
*Lay Sermons, Addresses and Reviews*  
 On the Educational Value of the Natural History Sciences (p. 91)  
 D. Appleton & Company. New York, New York, USA. 1872

**Smellie, William** 1740–95  
 Scottish encyclopedist



Natural History is the most extensive, and perhaps the most instructive and entertaining of all the sciences. It is the chief source from which human knowledge is derived. To recommend the study of it from motives of utility were to affront the understanding of mankind. Its importance, accordingly, in the arts of life, and in storing the mind with just ideas of external objects, as well as of their relations to the human race, was early perceived by all nations in their progress from rudeness to refinement.

In Buffon, Comte de Georges, Louis Leclerc  
*Natural History, General and Particular* (Volume 1)  
 Preface by the Translator (p. ix)  
 T. Caldwell and W. Davies. London, England. 1812

## NATURAL LAW

**Adams, George** 1750–95  
 English instrument maker

The end of natural philosophy is to increase either the knowledge or power of man, and enable him to understand the ways and procedure of nature. By discovering the laws of nature, he acquires knowledge, and obtains power; for when these laws are discovered, he can use them as rules of practice, to equal, subdue, or even excel nature by art.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
 Lecture XIV (pp. 100–101)  
 Printed by R. Hindmarsh. London, England. 1794

**Vogt, Carl** 1817–95  
 German physician and naturalist

The natural laws are rude unbending powers, which have neither morals nor heart.

In Ludwig Buchner  
*Force and Matter*  
 Chapter VI (p. 35)  
 Trubner & Company. London, England. 1864

**Whewell, William** 1794–1866  
 English philosopher and historian

When we speak of material nature as being governed by laws, it is sufficiently evident that we use the term in a manner somewhat metaphorical.

*The Bridgewater Treatises on the Power, Wisdom, and Goodness of God as Manifested in the Creation (Treatise III)*  
 Astronomy and General Physics Considered with Reference to Natural Theology  
 Chapter II (p. 17)  
 Carey, Lea & Blanchard. Philadelphia, Pennsylvania, USA. 1833

## NATURAL SCIENCE

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

We need scarcely add that the contemplation in natural science of a wider domain than the actual leads to a far better understanding of the actual.

*The Nature of the Physical World*  
 Chapter XXII (p. 266–267)  
 The Macmillan Company. New York, New York, USA. 1930

**Faraday, Michael** 1791–1867  
 English physicist and chemist

I do not think that the study of natural science is so glorious a school for the mind that, with the laws impressed on all created things by the Creator, and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
 Chapter I (p. 13)  
 Macmillan & Company Ltd. London, England. 1918

**Whitehead, Alfred North** 1861–1947  
 English mathematician and philosopher

...science conceived as resting on mere sense-perception, with no other source of observation, is bankrupt, so far as concerns its claim to self-sufficiency. Science can find no individual enjoyment in nature: Science can find no aim in nature: Science can find no creativity in nature; it finds mere rules of succession. These negations are true of Natural Science. They are inherent in its methodology.

*Modes of Thought*  
 Chapter III, Lecture Eight (p. 211)  
 The Macmillan Company. New York, New York, USA. 1938

## NATURAL SELECTION

**Bateson, William** 1861–1926  
 English biologist and geneticist

Natural Selection is stern, but she has her tolerant moods.

In A.C. Seward  
*Darwin and Modern Science*  
 Heredity and Variation in Modern Lights (p. 100)  
 University Press. Cambridge, England. 1910

**Crick, Francis Harry Compton** 1916–2004  
 English biochemist

Once we have become adjusted to the idea that we are here because we have evolved from simple chemical compounds by a process of natural selection, it is remarkable how many of the problems of the modern world take on a completely new light.

*Of Molecules and Men*  
 The Prospect Before Us (p. 93)  
 University of Washington Press. Seattle, Washington, USA. 1966

**Darwin, Charles Robert** 1809–82  
 English naturalist

To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have

been formed by natural selection, seems, I freely confess, absurd in the highest degree.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter VI (p. 185)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

We can no longer argue that, for instance, the beautiful hinge of a bivalve must have been made by an intelligent being, like the hinge of a door by man. There seems to be no more design in the variability of organic beings, and in the action of natural selection, than in the course which the wind blows.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter VIII (p. 279)  
 D. Appleton & Company, New York, New York, USA. 1896

When we descend to details, we can prove that no one species has changed (*i.e.*, we cannot prove that a single species has changed): nor can we prove that the supposed changes are beneficial, which is the groundwork of the theory. Nor can we explain why some species have changed and others have not.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
 Chapter IV (p. 210)  
 Letter to G. Bentham, May 22, 1863  
 D. Appleton & Company, New York, New York, USA. 1887

Slow though the process of selection may be, if feeble man can do much by artificial selection, I can see no limit to the amount of change, to the beauty and complexity of the coadaptations between all organic beings, one with another and with their physical conditions of life, which may have been effected in the long course of time through nature's power of selection...

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter IV (p. 52)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that is good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic condition of life. We see nothing of these slow changes in progress, until the hand of time has marked the long lapse of ages...

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter IV (p. 42)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But then arises the doubt, can the mind of man, which has, as I fully believe been developed from a mind as low as that possessed by the lowest animal, be trusted when it draws such grand conclusions?

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter VIII (p. 282)  
 D. Appleton & Company, New York, New York, USA. 1896

As natural selection acts solely by accumulating slight, successive, favorable variations, it can produce no great or sudden modification; it can act only by very short and slow steps. Hence the canon of "*Natura non facit saltum*" [Nature does not make jumps], [to] which every fresh addition to our knowledge tends to conform, is on this theory simply intelligible.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter XV (p. 235)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

By the theory of natural selection all living species have been connected with the parent-species of each genus by differences not greater than we see between the varieties of the same species at the present day; and these parent-species, now generally extinct, have in their turn been similarly connected with more ancient species; and so on backwards, always converging to the common ancestor of each great class. So that the number of intermediate and transitional links, between all living and extinct species, must have been inconceivably great. But assuredly, if this theory be true, such have lived upon this earth.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter X (p. 153)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But just in proportion as this process of extermination has acted on an enormous scale, so must the number of intermediate varieties, which have formerly existed, be truly enormous. Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain; and this, perhaps, is the most obvious and serious objection which can be urged against the theory. The explanation lies, as I believe, in the extreme imperfection of the geological record.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter X (p. 152)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He who rejects this view of the imperfection of the geological record, will rightly reject the whole theory. For he may ask in vain where are the numberless transitional links which must formerly have connected the closely allied or representative species found in the successive stages of the same great formation?

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
 Chapter XI (p. 179)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

As buds give rise by growth to fresh buds, and these, if vigorous, branch out and overtop on all sides many a

feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever branching and beautiful ramifications.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter IV (p. 64)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I could show fight on natural selection having done and doing more for the progress of civilization than you seem inclined to admit. Remember what risk the nations of Europe ran, not so many centuries ago of being overwhelmed by the Turks, and how ridiculous such an idea now is! The more civilised so-called Caucasian races have beaten the Turkish hollow in the struggle for existence. Looking to the world at no very distant date, what an endless number of the lower races will have been eliminated by the higher civilized races throughout the world.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Religion (p. 285)

Letter To W. Graham, July 3<sup>rd</sup>, 1881

D. Appleton & Company. New York, New York, USA. 1887

If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter VI (p. 87)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...extinction and natural selection go hand in hand.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter VI (p. 80)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

[Evolution by natural selection] absolutely depends on what we in our ignorance call spontaneous or accidental variability. Let an architect be compelled to build an edifice with uncut stones, fallen from a precipice. The shape of each fragment may be called accidental. Yet the shape of each has been determined...by events and circumstances, all of which depend on natural laws; but there is no relation between these laws and the purpose for which each fragment is used by the builder. In the same manner the variations of each creature are determined by fixed and immutable laws; but these bear no relation to the living structure which is slowly built up through the power of selection.

*The Variation of Animals and Plants Under Domestication*

Chapter XXI (p. 236)

D. Appleton & Company. New York, New York, USA. 1896

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

All appearances to the contrary, the only watchmaker in nature is the blind forces of physics, albeit deployed in a very special way. A true watchmaker has foresight: he designs his cogs and springs, and plans their interconnections, with a future purpose in his mind's eye. Natural selection, the blind, unconscious, automatic process which Darwin discovered, and which we now know is the explanation for the existence and apparently purposeful form of all life, has no purpose in mind. It has no mind and no mind's eye. It does not plan for the future. It has no vision, no foresight, no sight at all. If it can be said to play the role of the watchmaker in nature, it is the blind watchmaker.

*The Blind Watchmaker*

Chapter 1 (p. 5)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

Darwin's achievement, like Einstein's, is universal and timeless.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 79)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

Maybe we are neo-Darwinists today, but let us spell neo with a very small n! Our neo-Darwinism is very much in the spirit of Darwin himself.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 80)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

Natural selection is the only workable explanation for the beautiful and compelling illusion of "design" that pervades every living body and every organ. Knowledge of evolution may not be strictly useful in everyday commerce. You can live some sort of life and die without ever hearing the name of Darwin. But if, before you die, you want to understand why you lived in the first place, Darwinism is the one subject that you must study.

In John Maynard Smith

*The Theory of Evolution*

Forward (p. xvi)

Penguin Books Ltd. Harmondsworth, England. 1958

As an academic scientist I am a passionate Darwinian, believing that natural selection is, if not the only driving force in evolution, certainly the only known force capable of producing the illusion of purpose which so strikes all who contemplate nature.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 10)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

It is forever true that DNA is a double helix, true that if you are a chimpanzee (or an octopus or a kangaroo) [and] trace your ancestors back far enough you will eventually hit a shared ancestor. To a pedant, these are still hypotheses which might be falsified tomorrow. But they never will be.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love*

(pp. 17–18)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

We may consequently state the fundamental theorems of Natural Selection in the form:

The rate of increase in fitness of any organism at any time is equal to its genetic variance in fitness at that time.

*The Genetical Theory of Natural Selection*

Chapter II (p. 37)

Dover Publications, Inc. New York, New York, USA. 1958

The million, million, million...to one chance happens once in a million, million, million...times no matter how surprised we may be that it results in us.

In K. Mather

*Heredity*, Volume 30, 1973

Natural Selection is not Evolution. Yet, ever since the two words have been in common use, the theory of Natural Selection has been employed as a convenient abbreviation for the Theory of Evolution by means of Natural Selection.... This has had the unfortunate consequences that the theory of Natural Selection itself has scarcely ever, if ever, received separate consideration.

*The Genetical Theory of Natural Selection*

Preface (p. vii)

Dover Publications, Inc. New York, New York, USA. 1958

...it was Darwin's chief contribution, not only to Biology but to the whole of natural science, to have brought to light a process by which contingencies a priori improbable, are given, in the process of time, an increasing probability, until it is their non-occurrence rather than their occurrence which becomes highly improbable.... Let the reader... attempt to calculate the prior probability that a hundred generations of his ancestry in the direct male line should each have left at least one son. The odds against such a contingency as it would have appeared to his hundredth ancestor (about the time of King Solomon) would require for their expression forty-four figures of the decimal notation; yet this improbable event has certainly happened.

In J.S. Huxley, A.C. Hardy and E.B. Ford (eds.)

*Evolution as a Process*

Retrospect of Criticisms of the Theory of Natural Selection (p. 91)

George Allen & Unwin Ltd. London, England. 1954

**Ford, E. B.** 1901–88

English ecological geneticist

...organisms automatically generate their own cycles of abundance and rarity and...the changes in selection pressures with which these are associated may greatly increase the speed of evolution.

*Ecological Genetics*

Chapter 3 (p. 34)

Chapman & Hall Ltd. London, England. 1971

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Natural selection can only produce adaptation to immediately surrounding (and changing) environments. No

feature of such local adaptation should yield any expectation of general progress (however such a vague term be defined). Local adaptation may as well lead to anatomical simplification as to greater complexity.

*Full House*

Chapter 12 (p. 139)

Harmony Books. New York, New York, USA. 1996

The theory of natural selection would never have replaced the doctrine of divine creation if evident, admirable design pervaded all organisms. Charles Darwin understood this, and he focused on features that would be out of place in a world constructed by perfect wisdom.... Darwin even wrote an entire book on orchids to argue that the structures evolved to ensure fertilization by insects are jerry-built of available parts used by ancestors for other purposes. Orchids are Rube Goldberg machines; a perfect engineer would certainly have come up with something better.

This principle remains true today. The best illustrations of adaptation by evolution are the ones that strike our intuition as peculiar or bizarre.

*Ever Since Darwin: Reflections in Natural History*

Chapter 10. Organic Wisdom or Why Should a Fly Eat Its Mother from Inside (p. 91)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Hamilton, William D.** 1936–

English ethologist, evolutionary biologist, and popular science writer

To express the matter more vividly, in the world of our model organisms, whose behavior is determined strictly by genotype, we expect to find that no one is prepared to sacrifice his life for any single person, but that everyone will sacrifice it when he can thereby save more than two brothers, or four half-brothers, or eight first-cousins...

*The Genetical Evolution of Social Behavior*

*The Journal of Theoretical Biology*, Volume 7, 1964 (p. 16)

With very few exceptions, the only parts of the theory of natural selection which have been supported by mathematical models admit to no possibility of the evolution of any characters which are on average to the disadvantage of the individuals possessing them. If natural selection followed the classical model exclusively, species would not show any behavior more positively social than the coming together of the sexes and parental care.

*The Genetical Evolution of Social Behavior*

*The Journal of Theoretical Biology*, Part I, Volume 7, 1964

**Monod, Jacques** 1910–76

French biochemist

Drawn out of the realm of pure chance, the accident enters into that of necessity, of the most implacable certainties. For natural selection operates at the macroscopic level, the level of organisms.... In effect natural selection operates upon the products of chance and can feed nowhere

else; but it operates in a domain of very demanding conditions, and from this domain chance is barred. It is not to chance but to these conditions that evolution owes its generally progressive course, its successive conquests, and the impression it gives of a smooth and steady unfolding.

*Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology*

Chapter VII (pp. 118–119)

Vintage Books. New York, New York, USA. 1972

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

For “Natural Selection” has no moral significance: it deals with that part of evolution which has no purpose, no intelligence, and might more appropriately be called accidental selection, or better still, Unnatural Selection, since nothing is more unnatural than an accident. If it could be proved that the whole universe had been produced by such Selection, only fools and rascals could bear to live.

*Back to Methuselah*

Preface (p. liv)

Constable & Company Ltd. London, England. 1921

**Waddington, Conrad Hal** 1905–75

British biologist and paleontologist

The meaning of natural selection can be epigrammatically summarized as “the survival of the fittest.” Here “survival” does not, of course, mean the bodily advance of a single individual outliving Methuselah. It implies, in its present-day interpretation, perpetuation as a source for future generations. That individual “survives” best which leaves the most offspring. Again, to speak of an animal as “fittest” does not necessarily imply that it is stronger or most healthy, or would win a beauty competition. Essentially it denotes nothing more than leaving most offspring. The general principle of natural selection, in fact, merely amounts to the statement that the individual which leaves most offspring are those which leave most offspring. It is a tautology.

*The Strategy of the Genes: A Discussion of Some Aspects of Theoretical Biology*

Chapter 3 (pp. 64–65)

George Allen & Unwin Ltd. London, England. 1957

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

The proof that there is a selective agency at work is, I think, to be found in the general stability of species during the period of human observation, notwithstanding the large amount of variability that has been proved to exist. If there were no selection constantly going on, why should it happen that the kind of variations that occur so frequently under domestication never maintain themselves in a state of nature? Examples of this class are

white blackbirds or pigeons, black sheep, and unsymmetrically marked animals generally. These occur not unfrequently, as well as such sports as six-toed or stump-tailed cats, and they all persist and even increase under domestication, but never in a state of nature; and there seems no reason for this but that in the latter case they are quickly eliminated through the struggle for existence — that is, by natural selection.

Variation and Natural Selection

*Nature*, Volume 44, Number 1144, October 1, 1891 (p. 518)

**Wallin, Ivan E.** 1883–1969

American biologist

Natural Selection, by itself, is not sufficient to determine the direction of organic evolution.... Natural Selection can only deal with that which has been formed; it has no creative powers. Any directing influence that Natural Selection may have in organic evolution, must, in the nature of the process, be secondary to some other unknown factor.

*Symbioticism and the Origin of Species*

Chapter I (p. 5)

Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

**Wright, Robert**

American journalist and author

...natural selection “wants” us to behave in certain ways. But, so long as we comply, it doesn’t care whether we are made happy or sad in the process, whether we get physically mangled, even whether we die. The only thing natural selection ultimately “wants” to keep in good shape is the information in our genes, and it will countenance any suffering on our part that serves this purpose.

*The Moral Animal: Why We Are the Way We Are*

Chapter 7 (pp. 162–163)

Vintage Books. New York, New York, USA. 1994

## NATURAL THEOLOGY

**Butler, Joseph** 1692–1752

English bishop and exponent of natural theology

...the only distinct meaning of the word “natural” is stated, fixed, or settled; since what is natural as much requires and presupposes an intelligent agent to render it so, *i.e.*, to effect it continually or at stated times, as what is supernatural or miraculous [requires] to effect it for once.

*The Analogy of Religion, Natural and Revealed to the Constitution and Course of Nature*

Part 2, Chapter I (p. 105)

Harper & Brothers. New York, New York, USA. 1880

## NATURALISM

**Dembski, William A.** 1960–

Mathematician and philosopher

Naturalism is the view that the physical world is a self-contained system that works by blind, unbroken natural laws. Naturalism doesn't come right out and say there's nothing beyond nature. Rather, it says that nothing beyond nature could have any conceivable relevance to what happens in nature. Naturalism's answer to theism is not atheism but benign neglect. People are welcome to believe in God, though not a God who makes a difference in the natural order.

*The Design Revolution: Answering the Toughest Questions About Intelligent Design*

Preface (p. 21)

InterVarsity Press. Downers Grove, Illinois, USA. 2004

### Johnson, Philip

Law professor

The assumption of naturalism is the realm of speculative philosophy, and the rule against negative argument is arbitrary. It is as if a judge were to be charged with the crime.

Evolution as Dogma: The Establishment of Naturalism  
*First Things*, October 1990

Scientists committed to philosophical naturalism do not claim to have found the precise answer to every problem, but they characteristically insist that they have the important problems sufficiently well in hand that they can narrow the field of possibilities to a set of naturalistic alternatives.

Absent that insistence, they would have to concede that their commitment to naturalism is based upon faith rather than proof. Such a concession could be exploited by promoters of rival sources of knowledge, such as philosophy and religion, who would be quick to point out that faith in naturalism is no more "scientific" (i.e., empirically based) than any other kind of faith.

Evolution as Dogma: The Establishment of Naturalism  
*First Things*, October 1990

The worldview of scientific naturalism preserves a place for beliefs: a place, that is, among things to be explained by science. The Christian religion thus enters the university with a status precisely that of other comparable religious systems — say, the Aztec system of human sacrifice. Any individual, even a person of eminence in science, can make a personal choice to be "religious." Such choices are made on the basis of "faith," meaning subjective preference. A problem arises only if the Aztecs or the Christians claim access to knowledge. If they do that they are claiming that their own beliefs are normative for unbelievers. Only scientists can claim that kind of authority, because what the scientific community endorses constitutes knowledge, not belief. That is why Darwinian evolution can be taught in schools as fact, however strongly parents or students object, whereas a simple prayer acknowledging God as our Creator is deemed unacceptable — because somebody might object.

How the Universities Were Lost

*First Things*, March 1995

## NATURALIST

### Abbey, Edward 1927–89

American environmentalist and nature writer

For I am not a naturalist... If a label is required say that I am one who loves unfenced country. The open range. Call me a ranger... The only higher honor I've ever heard of is to be called a man.

*The Journey Home: Some Words in Defense of the American West*

Introduction (p. xiii)

E.P. Dutton. New York, New York, USA. 1977

I am — really am — an extremist, one who lives and loves by choice far out on the very verge of things, on the edge of the abyss, where this world falls off into the depths of another. That's the way I like it.

*The Journey Home: Some Words In Defense of the American West*

Introduction (p. xiv)

E.P. Dutton & Company. New York, New York, USA. 1977

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

The education of a naturalist now consists chiefly in learning how to compare.

*Methods of Study in Natural History*

Chapter II (p. 23)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

### Allen, Grant 1848–99

Naturalist

There are two kinds of naturalists, you know... The superior class live in London or Paris, examine everything minutely with a big microscope, tack on inches of Greek nomenclature to an insignificant mite or bit of moss, and split hairs against anybody with marvelous dexterity. That's science. It dwells in a museum. For my part I detest it. The inferior class live in Europe, Asia, Africa or America, as fate or fancy carries; and, instead of looking at everything in a dried specimen, go out into the woods with rifle on shoulder, or box in hand, and observe the birds, and beasts, and green things of the earth, as God made them, in their own natural and lovely surroundings. That's natural history, old-fashioned, simple, commonplace natural history; and I, for my part, am an old-fashioned naturalist.

*The Tents of Shem*

Chapter I (p. 8)

Chatto & Windus. London, England. 1890

### Darwin, Charles Robert 1809–82

English naturalist

It is well to remember that Naturalists value observations far more than reasoning...

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
 Darwin to Farrar, November 26, 1868 (p. 453)  
 D. Appleton & Company. New York, New York, USA. 1896

A naturalist's life would be a happy one if he had only to observe, and never to write.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
 C. Darwin to C. Lyell, June 1<sup>st</sup> [1867] (p. 248)  
 D. Appleton & Company. New York, New York, USA. 1896

**Einstein, Albert** 1879–1955

German-born physicist

In every naturalist there must be a kind of religious feeling; for he cannot imagine that the connections into which he sees have been thought of by him for the first time. He rather has the feeling of a child, over whom a grown-up person rules.

*Cosmic Religion, with Other Opinions and Aphorisms*  
 On Science (pp. 100–101)  
 Covici-Fiede. New York, New York, USA. 1931

**Forbes, Edward** 1815–54

English naturalist

The naturalists of yore esteemed the ocean to be a treasury of wonders, and sought therein for monstrosities and organisms contrary to the law of nature, such as they interpreted it. The naturalists of our own time hold equal faith in the wonders of the sea, but seek therein rather for the links of nature's chain than for apparent exceptions.

*The Natural History of the European Seas*  
 Chapter I (pp. 4–5)  
 John van Voorst. London, England. 1859

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

After he [the traveler] has commenced his journey and has become transplanted, so to speak, into a new world, he should consider it his duty to observe everything, not carelessly or at random, but so that nothing will escape his keen vision and alert attention. In describing objects he must endeavor to depict nature so faithfully that he who reads the description must needs believe he is beholding the very things himself.

In A.G. Nathorst  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*  
 Carl von Linné as a Geologist (p. 711)  
 Government Printing Office. Washington, D.C. 1909

**Montagu, George**

No biographical data available

As natural history has, within the last half century, occupied the attention and pens of the ablest philosophers of the more enlightened parts of the globe, there needs no apology for the following sheets; since the days of dark-

ness are now past, when the researches of the naturalist were considered as trivial and uninteresting.

*Testacea Britannica*  
 Introduction (p. 1)  
 J. White. London, England. 1803

**Muir, John** 1838–1914

American naturalist

Like Thoreau they see forests in orchards and patches of huckleberry brush, and oceans in ponds and drops of dew.

*Our National Parks*  
 Chapter I (p. 2)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

For the naturalist everything lies in the method, in the chance of obtaining an unshakeable, lasting truth; and solely from this point of view, which for him is obligatory, the soul, as a naturalistic principle, is not only unnecessary but even harmful to his work, in vain limiting his courage and the depth of his analysis.

*Experimental Psychology and Other Essays*  
 Experimental Psychology and Psychopathology in Animals (p. 168)  
 Philosophical Library. New York, New York, USA. 1957

**Riley, James Whitcomb** 1849–1916

American poet

In gentlest worship has he bowed  
 To Nature. Rescued from the crowd  
 And din of town and thoroughfare,  
 He turns him from all worldly care  
 Unto the sacred fastness of  
 The forest, and the peace and love  
 That beats there prayer-like in the breeze.

*The Complete Works of James Whitcomb Riley*  
 Volume 7, The Naturalist  
 P.F. Collier & Son, Company. New York, New York, USA. 1916

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Man cannot afford to be a naturalist, to look at Nature directly, but only with the side of his eye. He must look through and beyond her. To look at her is as fatal as to look at the head of Medusa. It turns the man of science to stone.

*The Journal of Henry David Thoreau*  
 March 23, 1853 (p. 43)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

**Wilson, Edward O.** 1929–

American biologist and writer

For the naturalist every entrance into a wild environment rekindles an excitement that is childlike in spontaneity, often tinged with apprehension — in short, the way life ought to be lived, all the time.

*The Future of Life*  
Chapter 6 (p. 146)  
Alfred A. Knopf. New York, New York, USA. 2002

## NATURE

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

There are no vacant lots in nature.

*Desert Solitaire*  
Down the River (p. 189)  
Ballantine Books. New York, New York, USA. 1968

There are enough cathedrals and temples and altars here for a Hindu pantheon of divinities. Each time I look up one of the secretive little side canyons I half expect to see not only the cottonwood tree rising over its tiny spring — the leafy god, the desert's liquid eye — but also a rainbow-colored corona of blazing light, pure spirit, pure being, pure disembodied intelligence, about to speak my name.

If a man's imagination were not so weak, so easily tired, if his capacity for wonder not so limited, he would abandon forever such fantasies of the supernal. He would learn to perceive in water, leaves and silence more than sufficient of the absolute and marvelous, more than enough to console him for the loss of the ancient dreams.

*Desert Solitaire*  
Down the River (p. 200)  
Ballantine Books. New York, New York, USA. 1968

Nature, like Maimonides said, is mainly a good place to throw beer cans on Sunday afternoons.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
Chapter 9 (p. 83)  
St. Martin's Press. New York, New York, USA. 1989

Floating down a portion of Rio Colorado in Utah a rare month in spring, twenty-two years ago, a friend and I found ourselves passing through a world so beautiful it seemed and had to be eternal. Such perfection of being, we thought — these glens of sandstone, these winding corridors of mystery, leading each to its solitary revelation — could not possibly be changed.

*Down the River*  
Part IV, Chapter 19 (p. 231)  
E.P. Dutton. New York, New York, USA. 1982

Nature is indifferent to our love, but never unfaithful.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
Chapter 9 (p. 86)  
St. Martin's Press. New York, New York, USA. 1989

I am here not only to evade for a while the clamor and filth and confusion of the cultural apparatus but also to confront, immediately and directly, if it's possible, the bare bones of existence, the elemental and fundamental, the bedrock which sustains us. I want to be able to look at and into a juniper tree, a piece of quartz, a vulture, a spider,

and see it as it is in itself, devoid of all humanly ascribed qualities, anti-Kantian, even the categories of scientific description. To meet God or Medusa face to face, even if it means risking everything human in myself. I dream of a hard and brutal mysticism in which the naked self merges with a nonhuman world and yet somehow survives still intact, individual, separate. Paradox and bedrock.

*Desert Solitaire*  
The First Morning (p. 6)  
Ballantine Books. New York, New York, USA. 1968

**Ackerman, Diane** 1948–  
American writer

Nature neither gives nor expects mercy.

*The Moon by Whale Light, and Other Adventures Among Bats and Crocodilians, Penguins and Whales*  
Chapter 4 (pp. 239–240)  
Random House, Inc. New York, New York, USA. 1991

Just because we have evolved minds that crave order doesn't mean that nature is orderly. Evolution is a sleeping watchdog. It is possible for us to disturb it, or it may wake on its own. Either way, expect commotion.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*  
Introduction (p. xii)  
Vintage Books. New York, New York, USA. 1997

[N]ature is also great fun. To pretend that nature isn't fun is to miss much of the joy of being alive...

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*  
Introduction (p. xx)  
Vintage Books. New York, New York, USA. 1997

**Ackoff, Russell Lincoln** 1919–  
American operations research and systems scientist

Nature is not organized in the same way that universities are.

Toward an Idealized University  
*Management Science*, Volume 15, December 1970 (p. B–127)

**Adams, Abby** 1939–  
American astronaut and solar physicist

Nature is what wins in the end.

*The Gardener's Gripe Book*  
What Is a Garden Anyway? (p. 10)  
Workman Publishing. New York, New York, USA. 1995

**Adams, George** 1750–95  
English instrument maker

The study of nature is as much distinguished from other subjects by the importance of its matter, as by the variety of its topics.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
Lecture XII (p. 1)  
Printed by R. Hindmarsh. London, England. 1794

Man has before him all nature, the whole world with which he is surrounded for the object of his view, and



the subject of his consideration; but his capacity is so circumscribed, his knowledge so straightened, his powers so limited, that he can by no means conceive the mechanism of so vast and complicate a structure.

*Lectures on Natural and Experimental Philosophy* (Volume 3)  
Chapter XXXV (p. 510)  
Printed by R. Hindmarsh. London, England. 1794

As you advance in the knowledge of nature's varieties, your mind will be opened, and you will find fresh ornament in truth, fresh dignity in devotion, and fresh reason in religion.

*Lectures on Natural and Experimental Philosophy* (Volume 2)  
Lecture XII (p. 2)  
Printed by R. Hindmarsh. London, England. 1794

...our views of nature are like the map of an inland country, where you see rivers without any sources continually discharging their waters without a sea to receive them; roads that you know not whence they come, nor whither they go; mountains, forests, and plains, cut off in the middle by the marginal lines of the paper: but even of those things which we know well, there is much that surpasses the extent of our faculties.

*Lectures on Natural and Experimental Philosophy* (Volume 3)  
Chapter XXXV (pp. 510–511)  
Printed by R. Hindmarsh. London, England. 1794

**Addison, Joseph** 1672–1719  
English essayist, poet, and statesman

If there's a power above us, (and that there is all nature cries aloud through all her works) he must delight in virtue.

*Cato*  
Act V, Scene 1  
J. Dicks. London, England. 1883

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The eye of the Trilobite tells us that the sun shone on the old beach where he lived; for there is nothing in nature without a purpose; and when so complicated an organ was made to receive the light, there must have been light to enter it.

*Geological Sketches*  
Chapter II (pp. 31–32)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1886

Lay aside all conceit. Learn to read the book of nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search.

In David Stair Jordan  
*Popular Science Monthly*  
Volume 40, 1891

The study of nature is an intercourse with the highest mind. You should never trifle with nature. At the lowest her works are the works of the highest powers — the highest something, in whatever way we may look at it.

In David Stair Jordan  
*Popular Science Monthly*, Volume 40, 1891

As long as men inquire, they will find opportunities to know more upon these topics than those who have gone before them, so inexhaustibly rich is nature in the innermost diversity of her treasures of beauty, order, and intelligence.

*Essay on Classification*  
Chapter II, Section I (p. 141)  
Harvard University Press. Cambridge, Massachusetts, USA. 1962

I may say that here, as in most cases where the operations of nature interfere with the designs of man, it is not by a direct intervention on our part that we may remedy the difficulties, but rather by a precise knowledge of [nature's] causes, which may enable us, if not to check, at least to avoid the evil consequences.

*Annual Report of the Superintendent of the Coast Survey, Showing the Progress of that Work During the Year Ending November, 1851*  
Extracts from the report of Professor Agassiz to the Superintendent of the Coast Survey, on the examination of the Florida reefs, keys, and coast (p. 158)  
Printed by Robert Armstrong, Washington. 1852

...it must be for truth's sake, and not even for the sake of its usefulness to humanity, that the scientific man studies Nature.

*Methods of Study in Natural History*  
Chapter II (p. 24)  
Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Aldrich Thomas Bailey** 1836–1907  
American writer and editor

Nature, who loves to do a gentle thing even in her most savage moods, had taken one of those empty water-courses and filled it from end to end with forget-me-nots.

*Queen of Sheba*  
IX (p. 205)  
J.R. Osgood & Company. Boston, Massachusetts, USA. 1877

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation, nor on which side thereof an intermediate form should lie.

In *Great Books of the Western World* (Volume 8)  
*History of Animals*  
Book VIII, Chapter 1  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

No one finds fault with defects which are the result of nature.

In *Great Books of the Western World* (Volume 8)  
*Ethics*  
Book III, Chapter 5  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Arnold, Matthew** 1822–88

English poet and critic

Nature's great law,  
and law of all men's minds? —  
To its own impulse every creature stirs;  
Live by thy light, and earth will live by hers!

*The Poetical Works of Matthew Arnold*

Religious Isolation

Stanza 4

Oxford University Press, Inc. New York, New York, USA. 1950

Man must begin, know this, where Nature ends; Nature  
and man can never be fast friends.

*The Poetical Works of Matthew Arnold*

In Harmony with Nature, I. 12–13

Oxford University Press, Inc. New York, New York, USA. 1950

Know, man hath all which Nature hath, but more,  
And in that more lie all his hopes of good.  
Nature is cruel, man is sick of blood;  
Nature is stubborn, man would fain adore.

*The Poetical Works of Matthew Arnold*

In Harmony with Nature

Oxford University Press, Inc. New York, New York, USA. 1950

**Atherton, Gertrude** 1857–1948

American novelist

Nature is a wicked old matchmaker.

*Senator North*

Book II, VII (p. 174)

John Lane: The Bodley Head. New York, New York, USA. 1900

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

From Nature! — How often are these words used, when  
at a glance he who has seen the perfect and beautiful  
forms of birds, quadrupeds or other objects, as they have  
come from the hand of Nature, discovers that the repre-  
sentation is not that of living Nature!

*Ornithological Biography* (Volume 1)

The Yellow-Billed Cuckoo (p. 18)

Adam Black. Edinburgh, Scotland. 1831

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Those who become practically versed in nature are, the  
mechanic, the mathematician, the physician, the alche-  
mist, and the magician, but all (as matters now stand)  
with faint efforts and meager success.

*In Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 5 (p. 107)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...we can command nature only by obeying her...

*In Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 129 (p. 135)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Man, as the minister and interpreter of nature, dies and  
understands as much as his observations on the order of  
nature, either with regard to things or the mind permit  
him, and neither knows or is capable of more.

*In Great Books of the Western World* (Volume 30)*Novum Organum*

First Book, Aphorism 1 (p. 107)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In nature things move violently to their place, and then  
calmly in their place.

*Bacon's Essays*

Of Great Places (p. 27)

The Macmillan Company. New York, New York, USA. 1930

**Bailey, Philip James** 1816–1902

English poet

The course of Nature seems a course of Death,  
And nothingness the whole substantial thing.

*Festus: A Poem*

Scene III (p. 58)

George Routledge &amp; Sons, Ltd. London, England. 1893

Nature means Necessity.

*Festus: A Poem*

Dedication

George Routledge &amp; Sons, Ltd. London, England. 1893

**Baker, Henry** 1698–1774

English naturalist

That Man is certainly the happiest, who is able to  
find out the greatest Number of reasonable and use-  
ful Amusements, easily attainable and within his  
Power: and, if so, he that is delighted with the Works  
of Nature, and makes them his Study must undoubtedly  
be happy, since every Animal, Flower, Fruit, or Insect,  
nay, almost every Particle of Matter, affords him an  
Entertainment.

*The Microscope Made Easy*

The Introduction (pp. xii–xiv)

Printed for R. Dodsley. London, England. 1743

**Baron von Frankenstein**

Fictional character

Nothing in nature is terrifying when one understands  
it.

*The Son of Frankenstein*

Film (1939)

**Beaumont, Francis** 1584–1616

English playwright and dramatic poet

**Fletcher, John** 1579–1625

Jacobean playwright

Nature too unkind;

That made no medicine for a troubled mind!

*Philaster*

Act III, Scene 1

D.C. Heath. Boston, Massachusetts, USA. 1906

**Beebe, William** 1877–1962  
American ornithologist

There was the ending still unfinished, the finale buried in the future — and in this we find the fascination of Nature and Science.

In William H. Carr  
*The Stir of Nature*  
Chapter Thirteen (p. 167)  
Oxford University Press, Inc. New York, New York, USA. 1930

**Beston, Henry** 1888–1968  
American writer

The three great elemental sounds in nature are the sound of rain, the sound of wind in a primeval wood, and the sound of the outer ocean on a beach. I have heard them all, and of the three elemental voices, that of ocean is the most awesome, beautiful, and varied.

*The Outermost House*  
Chapter III (p. 43)  
Rinehart & Company. New York, New York, USA. 1928

Nature is a part of our humanity, and without some awareness and experience of that divine mystery, man ceases to be man.

*The Outermost House*  
Forward (p. ix)  
Rinehart & Company. New York, New York, USA. 1928

As well expect Nature to answer to your human values as to come into your house and sit in a chair.

*The Outermost House*  
Chapter X (p. 221)  
Rinehart & Company. New York, New York, USA. 1928

A year indoors is a journey along a paper calendar; a year in outer nature is the accomplishment of a tremendous ritual.

*The Outermost House*  
Chapter IV (p. 59)  
Rinehart & Company. New York, New York, USA. 1928

**Bishop, Elizabeth** 1911–79  
American poet and writer

Nature repeats herself, or almost does: repeat, repeat, repeat, revise, revise, revise.

*North Haven*, 1. 19–20  
Farrar, Straus & Giroux. New York, New York, USA. 1984

**Bloomfield, Robert** 1766–1823  
English poet

Strange to the world, he wore a bashful look,  
The fields his study, nature was his book.

In John Aikin  
*Selected Works of the British Poets: In a Chronological Series from Falconer to Sir Walter Scott*  
The Farmer's Boy, Spring, l. 31  
Thomas Wardle. Philadelphia, Pennsylvania, USA. 1838

**Bohm, David** 1917–92  
American physicist

In nature nothing remains constant. Everything is in a perpetual state of transformation, motion, and change.

*Causality and Chance in Modern Physics*  
Chapter One (p. 1)  
University of Pennsylvania Press. Philadelphia, Pennsylvania, USA. 1957

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

In our description of nature the purpose is not to disclose the real essence of phenomena but only to track down as far as possible relations between the multifold aspects of our experiences.

*Atomic Theory and the Description of Nature*  
Introductory Survey (p. 18)  
Cambridge University Press. Cambridge, England. 1934

**Borland, Hal** 1900–78  
American writer

There are some things, but not too many, toward which the countryman knows he must be properly respectful if he would avoid pain, sickness, and injury. Nature is neither punitive nor solicitous, but she has thorns and fangs as well as bowers and grassy banks.

*Beyond Your Doorstep: A Handbook to the Country*  
Chapter 13 (p. 303)  
Alfred A. Knopf. New York, New York, USA. 1962

Nothing in nature is as simple as it sometimes seems when reduced to words.

*The Enduring Pattern*  
Life — Flesh and Blood: Reptiles (p. 189)  
Simon & Schuster. New York, New York, USA. 1959

Nature seems to look after her own only up to a certain point; beyond that they are supposed to fend for themselves.

*The Enduring Pattern*  
Life — Flesh and Blood: Amphibians (p. 185)  
Simon & Schuster. New York, New York, USA. 1959

Nature is an infinitely complex series of facts; it is not an object lesson, and it is not a ready-made sermon on conduct or morality.

*The Enduring Pattern*  
A Place to Live: Time (p. 20)  
Simon & Schuster. New York, New York, USA. 1959

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

Nature always looks out for the preservation of the universe.

In Edward B. Davis and Michael Hunter (eds.)  
*A Free Enquiry into the Vulgarly Received Notions of Nature*  
Section IV (p. 31)  
Cambridge University Press. Cambridge, England. 1996

It is one thing to be able to help nature to produce things, and another thing to understand well the nature of the things produc'd.

*The Sceptical Chymist*

The Third Part (p. 95)  
Dawsons of Pall Mall. London, England. 1965

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Nature flips the coin with a “Heads I win — tails you lose.” She offers her children stagnation and degeneracy on the one hand, or over-specialization and extinction on the other.

*Parade of the Living*  
Part III, Chapter XX (p. 290)  
Coward-McCann, Inc. New York, New York, USA. 1930

**Bridgman, Helen Bartlett**

Nature seems positively to enjoy playing pranks which turn all preconceived notions topsy-turvy.

*Gems*  
How It Began (p. 5)  
Brooklyn, New York, USA. 1916

**Bridgman, Percy Williams** 1882–1961  
American physicist

...our conviction that nature is understandable and subject to law arose from the narrowness of our horizons, and that if we sufficiently extend our range we shall find that nature is intrinsically and in its elements neither understandable nor subject to law...

The New Vision of Science  
*Harper's Magazine*, Volume 158, March 1929 (p. 444)

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Nature is a network of happenings that do not unroll like a red carpet into time, but are intertwined between every part of the world; and we are among those parts. In this nexus, we cannot reach certainty because it is not there to be reached; it goes with the wrong model, and the certain answers ironically are the wrong answers. Certainty is a demand that is made by philosophers who contemplate the world from outside; and scientific knowledge is knowledge for action, not contemplation. There is no God's eye view of nature, in relativity, or in any science: only a man's eye view.

*The Identity of Man*  
The Machinery of Nature, Section 6 (p. 38)  
Doubleday & Company, Inc. Garden City, New York, USA. 1972

A new conception was being made...that whatever fundamental units the world is put together from, they are more delicate, more fugitive, more startling than we catch in the Butterfly Net of our senses.

*The Ascent of Man*  
Chapter 11 (p. 364)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Bronte, Charlotte** 1816–55  
English author

The universal mother, Nature.

*Jane Eyre*  
Chapter XXVIII (p. 320)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1962

**Browne, Sir Thomas** 1605–82  
English writer and physician

There are no grotesques in nature; not anything framed to fill up empty cantons, and unnecessary spaces.

*Religio Medici*  
Part XV  
Elliot Stock. London, England. 1883

Now nature is not at variance with art, nor art with nature; they being both the servants of his providence. Art is the perfection of nature. Were the world now as it was the sixth day, there were yet a chaos. Nature hath made one world, and art another. In brief, all things are artificial; for nature is the art of God.

*Religio Medici*  
Section 16  
Elliot Stock. London, England. 1883

All things are artificial, for nature is the art of God.

*Religio Medici*  
Part I, Section xvi (p. 29)  
Elliot Stock. London, England. 1883

**Browning, Robert** 1812–89  
English poet

I trust in Nature for the stable laws  
Of beauty and utility. Spring shall plant  
And Autumn garner to the end of time.  
I trust in God — the right shall be the right  
And other than the wrong, while he endures;  
I trust in my own soul, that can perceive  
The outward and the inward, Nature's good  
And God's.

*The Poems and Plays of Robert Browning*  
A Soul's Tragedy, Act I (p. 458)  
The Modern Library. New York, New York, USA. 1934

...what I call God.

...fools call Nature...

*The Poems and Plays of Robert Browning*  
The Pope, I. 1073–1074  
The Modern Library. New York, New York, USA. 1934

**Bryan, J. Ingram**  
No biographical data available

Nature does not tolerate the whimsical and the inane; all her structures are on principles, and she allows no others.

*The Interpretation of Nature in English Poetry*  
Chapter I (p. 6)  
Kaitakusha. Tokyo, Japan. 1932

Nature is not static but dynamic; she is not now what she will be, for she moves toward a goal.

*The Interpretation of Nature in English Poetry*  
Chapter I (p. 7)  
Kaitakusha. Tokyo, Japan. 1932

**Bryant, William Cullen** 1794–1878  
American poet

To him who in the love of Nature holds  
Communion with her visible forms, she speaks  
A various language.

*Poems*

Thanatopsis

D. Appleton & Company. New York, New York, USA. 1874

Go forth under the open sky, and list  
To Nature's teachings.

*Poems*

Thanatopsis

D. Appleton & Company. New York, New York, USA. 1874

**Meredith, Owen (Edward Robert  
Bulwer-Lytton, 1st Earl Lytton)** 1831–91  
English statesman and poet

Nature is the great agent of the external universe...

*The Last Days of Pompeii*

Book One, VIII

George Routledge & Sons, Ltd. London, England. 1900

**Burnet, Thomas** 1635–1715  
English cleric and scientist

SINCE I was first inclin'd to the Contemplation of Nature,  
and took pleasure to trace out the Causes of Effects, and  
the dependence of one thing upon another in the visible  
Creation, I had always, methought, a particular curios-  
ity to look back into the first Sources and ORIGINAL of  
Things; and to view in my mind, so far as I was able, the  
Beginning and Progress of a RISING WORLD.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)

Book I, Chapter I (p. 23)

Printed by R. Norton. London. 1691

**Burney, Fanny** 1752–1840  
English novelist and diarist

...the lifeless symmetry of architecture, however beautiful  
the design and proportion, no man would be so mad as to  
put in competition with the animated charms of nature.

*Evelina*

Letter XXIII (p. 100)

J.M. Dent & Sons Ltd. London, England. 1909

**Burroughs, John** 1837–1921  
American naturalist and writer

The love of nature is different from the love of science,  
though the two may go together.

*The Breath of Life*

Preface (p. vii)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

Nature works with such simple means! A little more or a  
little of this or that, and behold the difference!

*The Breath of Life*

Chapter III (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

Nature teaches more than she preaches. There are no ser-  
mons in stone. It is easier to get a spark out of a stone  
than a moral.

*Time and Change*

The Gospel of Nature (p. 247)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

Nature exists to the mind not as an absolute realization,  
but as a condition, as something constantly becoming....  
It is suggestive and prospective; a body in motion, and  
not an object at rest.

Expression *The Atlantic Monthly*, Volume 6, Number XXXVII, Novem-  
ber 1860 (p. 572)

Nature is not benevolent; Nature is just, gives pound for  
pound, measure for measure, makes no exceptions, never  
tempers her decrees with mercy, or winks at any infringe-  
ment of her laws.

*Harvest of a Quiet Eye: The Natural World of John Burroughs*

The Gospel of Nature, 5 (p. 149)

Tamarack Press. Madison, Wisconsin, USA. 1976

**Burton, Robert** 1577–1640  
English clergyman and scholar

See one promontory, said Socrates of old, one mountain,  
one sea, one river, & see all.

*The Anatomy of Melancholy* (Volume 1)

Part I, Sect. II, Memb. IV, Subsec. 7 (p. 422)

AMS Press, Inc. New York, New York, USA. 1973

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

That one great lie she told about the earth being flat,  
when it was round all the time — and again how she  
stuck to it that the sun went round us when it was we  
who are going round her — this double falsehood has  
irretrievably ruined my confidence in her. There is no lie  
which she will not tell and stick to like a Gladstonian.  
How plausibly she told her tale, and how many ages was  
it before she was so much as suspected, and then when  
things did begin to look bad for her, how she brazened it  
out and what a desperate business it was to bring all her  
shifts and prevarications to book.

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 74)

University Press of America, Inc. Lanham, Maryland, USA. 1984

The progress of Nature is effected by steps that are often  
imperceptible and blend into one another with the utmost  
gentleness...

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 158)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Byron, George Gordon, 6<sup>th</sup> Baron  
Byron** 1788–1824

English Romantic poet and satirist

There is a pleasure in the pathless woods,  
There is a rapture on the lonely shore,

There is society, where none intrudes,  
By the deep sea, and music in its roar:  
I love not man the less, but nature more.

*Childe Harold's Pilgrimage*  
Canto IV., Clxxvii–clxxxiv  
Cassell. London, England. 1886

**Cable, George W.** 1844–1925  
American writer and reformer

The book of nature is a catechism. But, after it answers the first question with “God,” nothing but questions follow.

*Madame Delphine*  
Chapter V  
Charles Scribner's Sons. New York, New York, USA. 1896

Shall we ever subdue Nature and make her always submissive and compliant? Who knows what man may do with her when once he has got self, the universal self, under perfect mastery?

*Bonaventure*  
Book III, XVIII (p. 291)  
Charles Scribner's Sons. New York, New York, USA. 1888

**Campbell, Jeremy C.**  
No biographical data available

Evidently nature can no longer be seen as matter and energy alone. Nor can all her secrets be unlocked with the keys of chemistry and physics, brilliantly successful as these two branches of science have been in our century. A third component is needed for any explanation of the world that claims to be complete. To the powerful theories of chemistry and physics must be added a late arrival: a theory of information. Nature must be interpreted as matter, energy, and information.

*Grammatical Man: Information, Entropy, Language and Life*  
Chapter 1 (p. 16)  
Simon & Schuster. New York, New York, USA. 1982

**Campbell, Thomas** 1777–1844  
Scottish poet

There shall be love, when genial morn appears,  
Like pensive Beauty smiling in her tears,  
To watch the brightening roses of the sky,  
And muse on Nature with a poet's eye.

*The Complete Poetical Works*  
The Pleasures of Hope, Part ii, 1. 98–101  
Chadwyck-Healey. Cambridge, England. 1992

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Nature, like the Sphinx, is of womanly celestial loveliness and tenderness; the face and bosom of a goddess, but ending in claws and the body of a lioness.... Nature, Universe, Destiny, Existence, howsoever we name this grand unnamable Fact in the midst of which we live and struggle, is as a heavenly bride and conquest to the wise

and brave, to them who can discern her behests and do them; a destroying fiend to them who cannot.

*Past and Present*  
Chapter II (p. 7)  
Chapman & Hall. London, England. 1843

Nature admits no lie; most men profess to be aware of this, but few in any measure lay it to heart.

*Latter-Day Pamphlets*  
No. 5 (p. 170)  
Chapman & Hall. London, England. 1850

**Carson, Rachel** 1907–64  
American marine biologist and writer

The “control of nature” is a phrase conceived in arrogance, born of the Neanderthal age of biology and philosophy, when it was supposed that nature exists for the convenience of man. The concepts and practices of applied entomology for the most part date from that Stone Age of science. It is our alarming misfortune that so primitive a science has armed itself with the most modern and terrible weapons, and that in turning them against the insects it has also turned them against the earth.

*Silent Spring*  
Chapter 17 (p. 297)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

Exploring nature with your child is largely a matter of becoming receptive to what lies around you. It is learning again to use your eyes, ears, nostrils, and finger tips, opening up the disused channels of sensory impression.

*The Sense of Wonder* (p. 52)  
Harper & Row, Publishers, New York 1984

A rainy day is the perfect time for a walk in the woods.

*The Sense of Wonder* (p. 30)  
Harper & Row, Publishers, New York 1984

**Cawein, Madison Julius** 1865–14  
American poet

I am a part of all you see  
In Nature: part of all you feel:  
I am the impact of the bee  
Upon the blossom; in the tree  
I am the sap — that shall reveal  
The leaf, the bloom — that flows and flutes  
Up from the darkness through its roots.

*Poems*  
Penetratia  
The Macmillan Company. New York, New York, USA. 1911

**Chaisson, Eric J.** 1946–  
American astrophysicist

Without a brainy seat of consciousness and its inherent awareness of self and environment, galaxies would twirl and stars would shine, but no one or thing could comprehend the majesty of the reality that is nature.

*The Life Era: Cosmic Selection and Conscious Evolution*

Chapter 1 (p. 43)

The Atlantic Monthly Press. New York, New York, USA. 1987

**Chargaff, Erwin** 1905–2002

Austrian biochemist

We manipulate nature as if we were stuffing an Alsatian goose. We create new forms of energy; we make new elements; we kill crops; we wash brains. I can hear them in the dark sharpening their lasers.

The Paradox of Biochemistry

*Columbia Forum*, Volume 12, Number 2, Summer 1969 (p. 18)

What makes the study of nature so magnificent is its very givenness; it is because it is; it is as it is; and tolle, lege! (pick up and read!) remains its eternal admonition.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 3 (pp. 18–19)

The Seabury Press. New York, New York, USA. 1977

**Chaucer, Geoffrey** 1343–1400

English poet

Nature, the vicar of the almyghty Lord...

*The Complete Works of Geoffrey Chaucer*

The Parliament of Fowls, l. 379

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Child, Lydia M.** 1802–80

American writer and abolitionist

That man's best works should be such bungling imitations of Nature's infinite perfection, matters not much: but that he should make himself an imitation, this is the fact which Nature moans over, and deprecates beseechingly. Be spontaneous, be truthful, be free, and thus be individuals! is the song she sings through warbling birds, and whispering pines, and roaring waves, and screeching winds.

*Letters from New York*

Letter XXXVIII (p. 276)

C.S. Francis & Company. New York, New York, USA. 1945

**Chiras, Daniel D.**

No biographical data available

In nature, virtually nothing is wasted.

*Lessons from Nature: Learning to Live Sustainably on the Earth*

Chapter 2 (pp. 31–32)

Island Press. Washington, D.C. 1992

**Churchill, Charles** 1731–64

English poet and satirist

Not without art, but yet to Nature true.

The Rosicad and the Apology

The Rosciad, l. 699

Lawrence & Bullen. London, England. 1891

It can't be nature, for it is not sense.

*The Poems of Charles Churchill* (Volume 2)

The Farewell, l. 201

Eyre & Spottiswoode Ltd. London, England. 1933

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE

Roman orator, politician, and philosopher

...*ab interitu naturam abhorrere.*

...nature shrinks from destruction.

Translated by H. Rackham

*Cicero: De Finibus Bonorum, Et Malorum*

De Finibus

V, XI, 31 (p. 427)

William Heinemann. London, England. 1931

**Clarke, Arthur C.** 1917–

English science and science fiction writer

How inappropriate to call this planet Earth when it is clearly Ocean.

In James E. Lovelock

Hands Up for the Gaia Hypothesis

*Nature* Volume 344, Number 6262, 8 March 1990 (p. 102)

...Nature always balances her books...

*2061: Odyssey Three*

Chapter 37 (p. 177)

Ballantine Books. New York, New York, USA. 1987

**Close, Frank**

Writer and physicist

**Marten, Michael**

No biographical data available

**Sutton, Christine**

No biographical data available

Even at subatomic level nature presents images of itself that reflect our own imaginings.

*The Particle Explosion*

Chapter 1 (p. 15)

Oxford University Press, Inc. Oxford, England. 1987

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

And what if all of animated nature

Be but organic harps diversely fram'd,

That tremble into thought, as o'er them sweeps,

Plastic and vast, one intellectual breeze,

At once the soul of each, and God of all?

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

The Eolian Harp, Stanza 4

The Clarendon Press. Oxford, England. 1912

In nature there is nothing melancholy.

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

The Nightingale, Stanza I, l. 15

The Clarendon Press. Oxford, England. 1912

**Collingwood, Robin George** 1889–1943

English historian and philosopher

The only condition on which there could be a history of nature is that the events of nature are actions on the part of some thinking being or beings, and that by studying these actions we could discover what were the thoughts which they expressed and think these thoughts

for ourselves. This is a condition which probably no one will claim is fulfilled. Consequently the processes of nature are not historical processes and our knowledge of nature, though it may resemble history in certain superficial ways, e.g., by being chronological, is not historical knowledge.

*The Idea of History*

Part V, Section 5 (p. 302)

At The Clarendon Press. Oxford, England. 1967

**Colman, George (The Younger)** 1762–1836

English playwright

All argument will vanish before one touch of nature.

*The Poor Gentleman*

Act V, 1

J. Dicks. London, England. 1883

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

My beloved planet has reminded me of my lowly and inconsequential place in her affairs, and I have no answer fit to offer, no excuses to give, no apologies I know how to phrase.

*The Endless Adventure*

The Off-Shore Islands (p. 9)

Henry Regnery Company. Chicago, Illinois, USA. 1972

Nature is neither harsh nor cruel nor sentimentally sweet and kind.

*The Endless Adventure*

From Mushrooms to Bats (p. 19)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Commoner, Barry** 1917–

American biologist, ecologist, and educator

Nature knows best.

*The Closing Circle: Nature, Man & Technology*

Chapter 2 (p. 41)

Alfred A. Knopf. New York, New York, USA. 1971

**Connell, Joseph**

No biographical data available

**Sousa, Wayne**

No biographical data available

If a balance of nature exists, it has proved exceedingly hard to demonstrate.

On the Evidence Needed to Judge Ecological Stability or Persistence

*The American Naturalist*, Volume 121, Number 6, June 1983 (p. 808)

**Conrad, Joseph** 1857–1924

Polish-born English novelist

...Nature — the balance of colossal forces.... Nature — the great artist.

*Lord Jim*

Chapter XIX (p. 179)

Rinehart & Company, Inc. New York, New York, USA. 1957

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

But we should rather follow the wisdom of nature, which, as it takes very great care not to have produced anything superfluous or useless, often prefers to endow one thing with many effects.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, Chapter 10 (p. 526)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Corbett, Jim** 1875–1955

Indian-born hunter and naturalist

...for the book of nature has no beginning as it has no end. Open the book where you will at any point of your life, and if you have the desire to acquire knowledge, you will find it of intense interest, and no matter how long or how intently you study the pages, your interest will not flag for in nature there is no finality.

*Jungle Lore*

Chapter IV (p. 33)

Oxford University Press, Inc. New York, New York, USA. 1953

**Cousins, Norman** 1912–90

American editor and writer

It is unscientific to say that within the many billions of galactic systems, ours is the only planet that supports life in advanced form. Nature shuns one of a kind as much as it abhors a vacuum. Given infinite time and space, anything that occurs at one place or time in the universe will occur elsewhere or “elsewhen.”

Rendezvous with Infinity

*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979 (p. 30)

**Cowper, William** 1731–1800

English poet

Nature, exerting an unwearied power,  
Forms, opens, and gives scent to every flower;  
Spreads the fresh verdure of the field, and leads  
The dancing Naiads through the dewy meads.

*The Poetical Works of William Cowper*

Table Talk, l. 690

John W. Lovell Company. New York, New York, USA. No date

Nor rural sights alone, but rural sounds,

Exhilarate the spirit, and restore

The tone of languid Nature.

*The Poetical Works of William Cowper*

The Task

Book I, The Sofa, l. 181

John W. Lovell Company. New York, New York, USA. No date

Nature indeed looks prettily in rhyme.

*The Poetical Works of William Cowper*

Retirement, l. 576

John W. Lovell Company. New York, New York, USA. No date

**Crick, Francis Harry Compton** 1916–2004

English biochemist



The basic trouble is that nature is so complex that many quite different theories can go some way to explaining the results.... [W]hat constraints can be used as a guide through the jungle of possible theories? It seems to me that the only useful constraints are contained in the experimental evidence.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 13 (p. 141)  
Basic Books, Inc., Publishers. New York, New York, USA. 1988

**Crookes, Sir William** 1832–1919  
English chemist and physicist

...Nature — the word that stands for the baffling mysteries of the Universe. Steadily, unflinchingly, we strive to pierce the inmost heart of Nature, from what she is to reconstruct what she has been, and to prophesy what she yet shall be. Veil after veil we have lifted, and her face grows more beautiful, august, and wonderful, with every barrier that is withdrawn.

In William Walker Atkinson  
*Practical Mind Reading*  
Lesson I (p. 9)  
Address  
British Association for the Advancement of Science, Bristol, England  
Advanced Thought Publishing Company. Chicago, Illinois, USA. 1908

**Curie, Marie Skłodowska** 1867–1934  
Polish-born French physical chemist

All my life through, the new sights of Nature made me rejoice like a child.

*Pierre Curie*  
Autobiographical Notes  
Chapter I (p. 162)  
The Macmillan Company. New York, New York, USA. 1926

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Whoever flatters himself that he can retain in his memory all the effects of Nature is deceived, for our memory is not so capacious: therefore consult Nature for everything.

*A Treatise on Painting*  
#365 (p. 156)  
J.B. Nichols and Son. London, England. 1835

Necessity is the theme and the inventress of nature, the curb and law and theme.

In Jean Paul Richter  
*The Literary Works of Leonardo da Vinci* (Volume 2)  
Philosophical Maxims, 1135 (p. 237)  
University of California Press. Berkeley, California, USA. 1977

Nature is constrained by the order of her own law which lives and works within her.

...

Nature never breaks her own law.  
*Leonardo da Vinci's Note Books*  
Book I, Life (p. 55)  
Duckworth & Company. London, England. 1906

In nature there is no effect without cause; once the cause is understood there is no need to test it by experience.

In Jean Paul Richter  
*The Literary Works of Leonardo da Vinci* (Volume 2)  
Philosophical Maxims, 1148B (p. 239)  
University of California Press. Berkeley, California, USA. 1977

**Darwin, Charles Robert** 1809–82  
English naturalist

Truly the schemes and wonders of Nature are illimitable.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Letter to C. Lyell, September 14, 1849 (p. 345)  
D. Appleton & Company. New York, New York, USA. 1896

What a book a devil's chaplain might write on the clumsy, wasteful, blundering, low, and horribly cruel works of nature.

*More Letters of Charles Darwin*  
Letter To J.D. Hooker, 13 July 1856 (p. 94)  
D. Appleton and Company. New York, New York, USA. 1903

Nature will tell you a direct lie if she can.

In W.I.B. Beveridge  
*The Art of Scientific Investigation*  
Chapter Two (p. 25)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

Nature...cares nothing for appearances, except insofar as they are useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life.

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter IV (p. 41)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Darwin, Erasmus** 1731–1802  
English physician and poet

Nature may seem to have been niggardly to mankind in bestowing upon them so few senses; since a sense to have perceived electricity, and another to have perceived magnetism might have been of great service to them, many ages before these fluids were discovered by accidental experiment, but it is possible an increased number of senses might have incommoded us by adding to the size of our bodies.

*The Botanic Garden*  
Part I, Canto I (p. 19, fn I. 365)  
Jones & Company. London, England. 1825

In earth, sea, air, around, below, above,  
Life's subtle woof in Nature's loom is wove,  
Points glued to points in living line extends,  
Touch'd by some goad approach the bending ends.

*The Botanic Garden*  
Production of Life, Canto I, IV, I. 251–4  
Jones & Company. London, England. 1825

**Davy, Sir Humphry** 1778–1829  
English chemist

Oh, most magnificent and noble Nature!  
 Have I not worshipped thee with such a love  
 As never a mortal man before displayed?  
 Adored thee in thy majesty of visible creation,  
 And searched into thy hidden and mysterious ways  
 As Poet, as Philosopher, as Sage?

In J. Davy

*Fragmentary Remains*

Chapter I (p. 14)

John Churchill. London, England. 1858

**Dawson, Sir John William** 1820–99

Canadian geologist and educator

Few words are used among us more loosely than “nature.” Sometimes it stands for the material universe as a whole. Sometimes it is personified as a sort of goddess, working her own sweet will with material things. Sometimes it expresses the forces which act on matter, and again it stands for material things themselves. It is spoken of as subject to law, but just as often natural law is referred to in terms which imply that nature itself is the lawgiver.

*Some Salient Points in the Science of the Earth*

Chapter XVIII (p. 481)

Hodder & Stroughton. London, England. 1893

**de Fontenelle, Bernard le Bovier** 1657–1757

French writer

There is no need of fance...do but trust your eyes, and you will easily perceive how nature diversifies her works in these several worlds.

*Conversations on the Plurality of Worlds*

The Third Evening (p. 95)

Printed for Peter Wilson. Dublin, Ireland. 1761

**de Montaigne, Michel Eyquem** 1533–92

French Renaissance writer

Let us a little permit Nature to take her own way; she better understands her own affairs than we.

Translated by Charles Cotton

In *Great Books of the Western World* (Volume 25)

*The Essays of Michel Eyquem de Montaigne*

Essays III, Chapter 13 (p. 528)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Delacroix, Eugene** 1798–1863

French romantic painter

The true wisdom of the philosopher ought to consist in enjoying everything. Yet we apply ourselves to dissecting and destroying everything that is good in itself, that has virtue, albeit the virtue there is in mere illusions. Nature gives us this life like a toy to a weak child. We want to see how it all works; we break everything. There remains in our hands and before our eyes, stupid and opened too late, the sterile wreckage, fragments that will not again make a whole. The good is so simple.

Translated by Walter Pach

*The Journal of Eugene Delacroix*

Tuesday, June 1, 1824 (p. 92)

Covici. New York, New York, USA. 1937

**Desaguliers, J. T.** 1683–1744

French-born English natural philosopher

Nature compell'd, his piercing Mind obeys,  
 And gladly shows him all her secret Ways;  
 'Gainst Mathematicks she has no Defence,  
 And yields t' experimental Consequence.

In H.N. Fairchild

*Religious Trends in English Poetry* (Volume 1)

The Newtonian System of the World (p. 357)

Columbia University Press. New York, New York, USA. 1939

**Dickens, Charles** 1812–70

English novelist

It is not easy to walk alone in the country without musing upon something.

*Little Dorrit*

Book the First, Chapter XVI (p. 178)

Bradbury & Evans. London, England. 1857

...nature gives to every time and season some beauties of its own, and from morning to night, as from the cradle to the grave, is but a succession of changes so gentle and easy, that we can scarcely mark their progress.

*Nicholas Nickleby*

Chapter XXII (p. 234)

Dodd, Mead & Company. New York, New York, USA. 1944

...we are all children of one great mother, Nature.

*Bleak House (Part II)*

Chapter XLIII (p. 605)

P.F. Collier & Son. New York, New York, USA. 1911

**Dickinson, Emily** 1830–86

American lyric poet

Nature — the Gentlest Mother is,  
 Impatient of no Child —  
 The feeblest — or the waywardest —  
 Her Admonition mild —

*The Complete Poems of Emily Dickinson*

No. 790 (p. 385)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

How Strange that Nature does not knock, and yet does not intrude!

*Letters of Emily Dickinson*

Letter to Mrs. J.S. Cooper (p. 395)

Robert Brothers. Boston, Massachusetts, USA. 1894

**Dickinson, G. Lowes** 1862–1932

English historian and political activist

I'm not much impressed by the argument you attribute to Nature, that if we don't agree with her we shall be knocked on the head. I, for instance, happen to object strongly to her whole procedure: I don't much believe in the harmony of the final consummation...and I am sensibly aware of

the horrible discomfort of the intermediate stages, the pushing, kicking, trampling of the host, and the wounded and dead left behind on the march. Of all this I venture to disapprove; then comes Nature and says, “but you ought to approve!” I ask why, and she says, “Because the procedure is mine.” I still demur, and she comes down on me with a threat — “Very good, approve or no, as you like; but if you don’t approve you will be eliminated!” “By all means,” I say, and cling to my old opinion with the more affection that I feel myself invested with something of the glory of a martyr.... In my humble opinion it’s nature, not I, that cuts a poor figure!

*The Meaning of Good*

Good as the End of Nature (p. 46)

Brimley Johnson & Ince. London, England. 1906

**Diderot, Denis** 1713–84

French encyclopedist and materialist philosopher

Man is merely a common product, the monster an uncommon product; both equally natural, equally necessary, equally part of this universal and general order of things.... And what is astonishing about this?... All creatures intermingle with each other, consequently all species...everything is in perpetual flux.... Every animal is more or less man; every mineral is more or less plant; every plant more or less animal. There is nothing precise in nature...

Translated by Jean Stewart and Jonathan Kemp

*Diderot: Interpreter of Nature*

D’Alembert’s Dream (pp. 78–79)

International Publishers. New York, New York, USA. 1938

**Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

Unfortunately, nature is very much a now-you-see-it, now-you-don’t affair. A fish flashes, then dissolves in the water before my eyes like so much salt. Deer apparently ascend bodily into heaven; the brightest oriole fades into leaves.

*Pilgrim at Tinker Creek*

Chapter 2 (p. 16)

Harper’s Magazine Press. New York, New York, USA. 1974

The general rule in nature is that live things are soft within and rigid without. We vertebrates are living dangerously...like so many peeled trees.

*Pilgrim at Tinker Creek*

Chapter 6, II (p. 91)

Harper’s Magazine Press. New York, New York, USA. 1974

The creator is no puritan.... There is something that profoundly fails to be exuberant about these crawling, translucent lice and white, fat-bodied grubs, but there is an almost manic exuberance about a creator who turns them out, creature after creature after creature, and sets them buzzing and lurking and flying and flying and swimming about.

*Pilgrim at Tinker Creek*

Chapter 13, II (p. 233)

Harper’s Magazine Press. New York, New York, USA. 1974

Nature will try anything once. This is what the sign of the insects says. If you’re dealing with organic compounds, then let them combine. If it works, if it quickens, set it clacking in the grass; there’s always room for one more...

*Pilgrim at Tinker Creek*

Chapter 4, II (p. 65)

Harper’s Magazine Press. New York, New York, USA. 1974

Nature is, above all, profligate. Don’t believe them when they tell you how economical and thrifty nature is, whose leaves return to the soil. Wouldn’t it be cheaper to leave them on the tree in the first place?

*Pilgrim at Tinker Creek*

Chapter 4, II (p. 65)

Harper’s Magazine Press. New York, New York, USA. 1974

In nature, improbabilities are the one stock in trade.

*Pilgrim at Tinker Creek*

Chapter 8, II (p. 144)

Harper’s Magazine Press. New York, New York, USA. 1974

**Dirac, Paul Adrian Maurice** 1902–84

English theoretical physicist

It has become increasingly evident in recent times, however, that nature works on a different plan. Her fundamental laws do not govern the world as it appears in our mental picture in any very direct way, but instead they control a substratum of which we cannot form a mental picture without introducing irrelevancies.

*The Principles of Quantum Mechanics*

Preface to the First Edition (p. vi)

At the Clarendon Press. Oxford, England. 1935

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

One may detest nature and despise science, but it becomes more and more difficult to ignore them. Science in the modern world is not an entertainment for some devotees. It is on its way to becoming everybody’s business.

*The Biology of Ultimate Concern*

Chapter 1 (p. 9)

The New American Library, Inc. New York, New York, USA. 1967

**Douglas, Andrew Ellicott** 1867–1962

American astronomer

Nature is a book of many pages and each page tells a fascinating story to him who learns her language. Our fertile valleys and craggy mountains recite an epic poem of geologic conflicts. The starry sky reveals gigantic suns and space and time without end.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1922*

Some Aspects of the Use of the Annual Rings of Trees in Climatic Study (p. 223)

Government Printing Office. Washington, D.C. 1924

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

How sweet the morning air is! See how that one little cloud floats like a pink feather from some giant flamingo. Now the red rim of the sun pushes itself over the London cloud-bank. It shines on a good many folk, but on none, I dare bet, who are on a stranger errand than you or I. How small we feel with our petty ambitions and strivings in the presence of the great elemental forces of Nature.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
The Sign of the Four, Chapter 7 (p. 648)  
Wings Books. New York, New York, USA. 1967

**Draper, John William** 1811–82  
American scientist, philosopher, and historian

As a cataract shows from year to year an invariable shape, though the water composing it is perpetually changing, so the aspect of Nature is nothing more than a flow of matter presenting an impermanent form. The universe considered as a whole is unchangeable. Nothing is eternal but space, atoms, force. The forms of Nature that we see are essentially transitory, they must all pass away.

*History of the Conflict between Religion and Science*  
Chapter I (p. 24)  
D. Appleton & Company. New York, New York, USA. 1898

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

For Art may err, but Nature cannot miss.

*The Poetical Works of Dryden*  
The Cock and the Fox, I. 452  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

By viewing nature, nature's handmaid, art,  
Makes mighty things from small beginnings grow;  
That fishes first to shipping did impart,  
Their tail the rudder, and their head the prow.

*The Poetical Works of Dryden*  
Annus Mirabilis  
Stanza 155  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

**du Bartas, Guillaume de Salluste** 1544–90  
French poet

Out of the book of Nature's learned breast.

*Divine Weeks and Works*  
Second week, fourth day, Book III. 566  
Humfrey Lownes. London, England. 1611

**de Spinoza, Baruch** 1632–77  
Dutch philosopher

...Nature has set no end before herself, and...all final causes are nothing but human fictions.

Translated by William Hale White  
*Ethic: Demonstrated in Geometrical Order and Divided into Five Parts*  
Section 8 (p. 41)  
Trubner & Company. London, England. 1883

**Dulbecco, Renato** 1914–  
Italian-born American virologist

Nature does not abide by hard and fast rules — it follows opportunity.

*The Design of Life*  
Chapter 4 (p. 88)  
Yale University Press. New Haven, Connecticut, USA. 1987

In biology, once a door is opened, the space behind it is quickly filled.

*The Design of Life*  
Chapter 9 (p. 190)  
Yale University Press. New Haven, Connecticut, USA. 1987

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

In the study of Nature conjecture must be entirely put aside, and vague hypothesis carefully guarded against. The study of Nature begins with facts, ascends to laws, and raises itself, as far as the limits of man's intellect will permit, to the knowledge of causes, by the threefold means of observation, experiment and logical deduction.

In Faraday Lectures  
*Lectures Delivered Before the Chemical Society*  
The First Faraday Lecture (p. 2)  
The Chemical Society. London, England. 1928

**Dunbar, Paul Laurence** 1872–06  
African-American poet

There is no rebel like Nature. She is an iconoclast.

*The Uncalled*  
VI (p. 57)  
International Association of Newspapers and Authors. New York, New York, USA, 1901

**Durell, Clement V.** 1882–1968  
English mathematician

The scientists, in playing their game with Nature, are meeting an opponent on her own ground, who has not only made the rules of the game to suit herself, but may have even queered the pitch or cast a spell over the visiting team.

*Readable Relativity*  
Chapter II (p. 11)  
Harper & Brothers. New York, New York, USA. 1960

Nature is a conjurer for supermen. Generations of scientists have attempted to penetrate her secrets. Bit by bit the disguise is being torn away, but each new discovery seems only to open out fresh avenues demanding further exploration. Nature is a true woman, who will have the last word.

*Readable Relativity*  
Chapter I (p. 9)  
Harper & Brothers. New York, New York, USA. 1960

**Eckert, Allan W.** 1931–  
American historian, naturalist and author

...in nature's book, everything has its place and its time; there exists a persistent interdependency of its creatures one upon another.

And there is never waste.

*Wild Season*

Epilogue (p. 244)

Little, Brown & Company. Boston, Massachusetts, USA. 1967

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The future is not predetermined, and Nature has no need to protect herself from giving away plans which she has not yet made.

*New Pathways in Science*

Chapter V, Section II (p. 102)

At The University Press. Cambridge, England. 1947

Philosophically the notion of a beginning of Nature is repugnant to me.

The End of the World: From the Standpoint of Mathematical Physics

*Nature*, Supplement, Volume 127, Number 3203, March 21, 1931 (p. 447)

So far as broader characteristics are concerned we see in Nature what we look for or are equipped to look for.

*The Nature of the Physical World*

Chapter XV (p. 330)

The Macmillan Company. New York, New York, USA. 1930

**Egerton, E. N.**

No biographical data available

The balance of nature has been a background assumption in natural history since antiquity.

Changing Concepts of the Balance of Nature

*Quarterly Review of Biology*, No. 48, Number 2, 1973 (p. 322)

**Einstein, Albert** 1879–1955

German-born physicist

What I see in Nature is a magnificent structure that we can comprehend only imperfectly, and that must fill a thinking person with a feeling of "humility." This is a genuinely religious feeling that has nothing to do with mysticism.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives* (p. 39)

Princeton University Press. Princeton, New Jersey, USA. 1979

Nature is not an engineer or contractor...

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 12 November, 1930 (p. 92)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Nature has her language, and she is not unvarnished; but we don't know all the intricacies of her syntax just yet, and in a hasty reading we may happen to extract the very opposite of her real meaning.

*Adam Bede*

Chapter XV (p. 142)

Dodd, Mead & Company. New York, New York, USA. 1947

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

To the intelligent, nature converts itself into a vast promise, and will not be rashly explained. Her secret is untold. Many and many an Oedipus arrives: he has the whole mystery teeming in his brain.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

*Nature* (p. 554)

The Library of America. New York, New York, USA. 1983

The first steps in Agriculture, Astronomy, Zoology (those first steps which the farmer, the hunter, and the sailor take,) teach that nature's dice are always loaded; that in her heaps and rubbish are concealed sure and useful results.

*Ralph Waldo Emerson: Essays and Lectures*

*Nature: Addresses, and Lectures*

Discipline (p. 27)

The Library of America. New York, New York, USA. 1983

The great mother Nature will not quite tell her secret to the coach or the steamboat, but says, One to one, my dear, is my rule also, and I keep my enchantments and oracles for the religious soul coming alone, or as good as alone, in true-love.

In James Elliot Cabot

A Memoir of Ralph Waldo Emerson (Volume 2)

Letter to Mrs. Emerson, 20 May 1871 (p. 650)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1888

Nature, like a cautious testator, fires up her estate so as not to bestow it all on one generation, but has a forelooking tenderness and equal regard to the next and the next, and the fourth and the fortieth age.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Society and Solitude

Farming (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Nothing bizarre, nothing whimsical will endure. Nature is ever interfering with Art. You cannot build your house or pagoda as you will but as you must. Gravity, Wind, sun, rain, the size of men & animals, & such other aliens have more to say than the architect. Beneath the almighty necessity therefore I regard what is artificial in man's life & works as petty & insignificant by the side of what is natural. Every violation, every suicide, every miracle, every willfulness however large it may show near us, melts quickly into the All, & at a distance is not seen. The outline is as smooth as the curve of the moon.... A writer must have l'abandon, he must be content to stand aside & let truth & beauty speak for him, or he cannot expect to be heard far.

*Journals of Ralph Waldo Emerson*

May 28, 1836 (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1910

Nature, as we know her, is no saint.... She comes eating, drinking and sinning...

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

Experience (p. 481)

The Library of America. New York, New York, USA. 1983

Nature is full of a sublime family likeness throughout her works and delights in startling us with resemblances in the most unexpected quarters.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

History (p. 243)

The Library of America. New York, New York, USA. 1983

Nature never hurries: atom by atom, little by little, she achieves her work.

*The Complete Works of Ralph Waldo Emerson* (Volume 10)

Society and Solitude

Farming (p. 139)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

Nature is a rag-merchant, who works up every shred and ort and end into new creations; like a good chemist, whom I found, the other day, in his laboratory, converting his old shirts into pure white sugar.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Considerations by the Way (p. 1088)

The Library of America. New York, New York, USA. 1983

Nature is an endless combination and repetition of a very few laws. She hums the old well-known air through innumerable variations.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

History (p. 243)

The Library of America. New York, New York, USA. 1983

Nature is no spendthrift, but takes the shortest way to her ends.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Fate (p. 961)

The Library of America. New York, New York, USA. 1983

By fate, not option, frugal Nature gave

One scent to hyson and to wall-flower,

One sound to pine-groves and to waterfalls,

One aspect to the desert and the lake.

It was her stern necessity.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

Xenophanes (p. 137)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Evans, Howard Ensign** 1919–2002

Entomologist

One's appreciation of nature is never more acute than when a bit of nature is injected into one's flesh.

*The Pleasures of Entomology: Portraits of Insects and the People Who Study them*

Chapter 18 (p. 221)

Smithsonian Institution Press. Washington, D.C. 1985

**Fermi, Enrico** 1901–54

Italian-born American physicist

Whatever nature has in store for mankind, unpleasant as it may be, men must accept, for ignorance is never better than knowledge.

In Laura Fermi

*Atoms in the Family*

Part II, Chapter 23 (p. 244)

The University of Chicago Press. Chicago, Illinois, USA. 1954

**Feuerbach, Ludwig** 1804–72

German philosopher

Nature returns no answer to the questions and lamentations of man; inexorably it refers him to himself.

In Ludwig Buchner

*Force and Matter*

Chapter VI (p. 35)

Trubner & Company. London, England. 1864

**Fevre, R. W.**

No biographical data available

The real truth is that, not only has man failed to overcome nature in any sphere whatsoever but that at best he has merely succeeded in getting hold of and lifting a tiny corner of the enormous veil which she has spread over her eternal mysteries and secret. He never creates anything. All he can do is discover something. He does not master nature but has only come to be the master of those living things who have not gained the knowledge he has arrived at by penetrating into some of nature's laws and mysteries. Apart from all this, an idea can never subject to its own sway those conditions which are necessary for the existence and development of mankind; for the idea itself has come only from man. Without man there would be no human idea in this world. The idea as such is therefore always dependent on the existence of man and consequently is dependent on those laws which furnish the conditions of his existence.

*The Demoralization of Western Culture: Social Theory and the Dilemmas of Modern Living* (p. 28)

Continuum. London, England. 2000

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Everywhere science is enriched by unscientific methods and unscientific results...the separation of science and non-science is not only artificial but also detrimental to the advancement of knowledge. If we want to understand nature, if we want to master our physical surroundings, then we must use all ideas, all methods, and not just a small selection of them.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 18 (pp. 305, 306)

Verso. London, England. 1978

Trying to understand the way nature works involves a most terrible test of human reasoning ability. It involves

subtle trickery, beautiful tightropes of logic on which one has to walk in order not to make a mistake in predicting what will happen.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 15)  
Perseus Books. Reading, Massachusetts, USA. 1998

There was a moment when I knew how nature worked. It had elegance and beauty. The goddam thing was gleaming.

In Lee Edson  
Two Men in Search of a Quark  
*New York Times Magazine*, October 8, 1967

People may come along and argue philosophically that they like one better than another; but we have learned from much experience that all philosophical intuitions about what nature is going to do fail.

*The Character of Physical Law*  
Chapter 2 (p. 53)  
BBC. London, England. 1965

But see that the imagination of nature is far, far greater than the imagination of man. No one who did not have some inkling of this through observations could ever have imagined such a marvel as nature is.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter I (p. 10)  
Perseus Books. Reading, Massachusetts, USA. 1998

**Fielding, Henry** 1707–54

English novelist, playwright, and barrister

Nature seems to wear one universal grin.

*The Tragedy of Tragedies, or, The Life and Death of Tom Thumb the Great*  
Act I, Scene 1  
Printed by S. Powell. Dublin, Ireland. 1730

**Flammarion, Camille** 1842–1925

French astronomer and writer

Nature, O immense, fascinating, infinite Nature! Who can divine, who can hear, the sounds of thy celestial harmony! What can we include in these childish formulae of our young science? We lisp an alphabet while the eternal Bible is still closed to us. But it is thus when all reading begins, and these first words are surer than all the antique affirmations of ignorance and human vanity.

*Popular Astronomy: A General Description of the Heavens*  
Book II, Chapter III (p. 112)  
Chatto & Windus. London, England. 1894

Nature is immense in the little as in the great, or, to speak more correctly, for here there is neither little nor great.

*Popular Astronomy: A General Description of the Heavens*  
Book III, Chapter II (p. 239)  
Chatto & Windus. London, England. 1894

...it has been said that nature has implanted in our bosoms a craving after the discovery of truth, and assuredly that glorious instinct is never more irresistibly awakened than

when our notice is directed to what is going on in the heavens.

*Popular Astronomy: A General Description of the Heavens*  
Book III, Chapter VII (p. 328)  
Chatto & Windus. London, England. 1894

**Florio, John** 1553?–1625

English teacher, writer, and translator

Nature is the right law.

*Florio's Firste Fruites* (p. 88)  
Taihoku Imperial University. Formosa, Japan. 1936

**Ford, Kenneth W.** 1926–

American physicist

One of the elementary rules of nature is that, in the absence of a law prohibiting an event or phenomenon, it is bound to occur with some degree of probability. To put it simply and crudely: Anything that can happen does happen.

Magnetic Monopoles  
*Scientific American*, Volume 209, Number 6, December 1963 (p. 122)

**Foster, Sir Michael** 1836–1907

English physiologist and educator

Nature is ever making signs to us, she is ever whispering to us the beginnings of her secrets; the scientific man must be ever on the watch, ready at once to lay hold of Nature's hint, however small, to listen to her whisper, however low.

In J.A. Thomson  
*Introduction to Science*  
Chapter I (p. 16)  
Williams & Norgate Ltd. London, England. 1916

**Fraenkel, Aviezri S.**

Applied mathematician

Nature might be somehow more powerful than a digital computer.

*New York Times*, March 25, 1997 (p. C5, col. 6)

**Fuller, R. Buckminster** 1895–1983

American engineer and architect

Nature is trying very hard to make us succeed, but nature does not depend on us. We are not the only experiment.

*Minneapolis Tribune*, 30 April 1978

**Garth, Sir Samuel** 1661–1719

English physician and poet

As distant prospects please us, but when near  
We find but desert rocks and fleeting air.

*The Dispensary*  
Canto III, l. 27  
Printed by J. Lister, at St. John's Gate. London, England. 1768

**Gay, John** 1685–1732

English poet and dramatist

But he who studies nature's laws

From certain truth his maxims draws.

*The Poetical Works of John Gay* (Volume 3)

Introduction to the Fables, l. 76–77

Lawrence & Bullen. London, England. 1893

**Gillispie, Charles Coulston** 1918–

French writer and editor of philosophy and history of science

[T]he renewals of the subjective approach to nature make a pathetic theme. Its ruins lie strewn like good intentions all along the ground traversed by science, until it survives only in strange corners like Lysenkoism [doctrine centered on belief in acquired characteristics] and anthroposophy, where nature is socialized or moralized.

*The Edge of Objectivity: An Essay in the History of Scientific Ideas*

Chapter V (pp. 199–200)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The need to distinguish sturdy facts (pervasive pattern) from shaky factual claim (single cases with dubious documentation) has never been more evident to me than in the current debate between evolutionists and so-called “scientific creationists.” The fact of evolution is as sturdy as any claim in science. Its sturdiness resides in a pervasive pattern detected by several disciplines — for examples, the age of the earth and life as affirmed by astronomy and geology, and the pattern of imperfections in organisms that record a history of physical descent.

*Hen’s Teeth and Horses Toes*

Quaggas, Coiled Oysters, and Flimsy Facts (p. 384)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

I do not believe that nature frustrates us by design, but I rejoice in her intransigence nonetheless.

*Hen’s Teeth and Horses Toes*

What, if Anything, Is a Zebra? (p. 365)

W.W. Norton & Company, Inc. New York, New York, USA. 1983

**Gray, George W.**

Freelance science writer

Our knowledge of nature is limited by our ability to apprehend the materials and the forces which meet us — both those of the Earth, which we encounter in their hurrying to and fro, and those of the Universe outside, which beat upon us from the stars and the darkness beyond the stars.

*The Advancing Front of Science*

Chapter I, Section 5 (pp. 20–21)

Whittlesey House. New York, New York, USA. 1937

**Gray, Thomas** 1716–71

English poet

E’en from the tomb the voice of nature cries,  
E’en in our ashes live their wonted fires.

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*

Elegy in a Country Churchyard

Stanza 23

J. Blackwood. London, England. 1800

**Greene, Brian** 1963–

American physicist

You must allow Nature to dictate what is, and what is not, sensible.

*The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory*

Part II, Chapter 5 (p. 111)

W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Gregory, Dick** 1932

American comedian and social activist

Nature is not affected by finance. If someone offered you ten thousand dollars to let them touch you on your eyeball without your blinking, you would never collect the money. At the very last moment, Nature would force you to blink your eye. Nature will protect her own.

*The Shadow that Scares Me*

Chapter VIII (p. 175)

Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The study of Nature is elevating, and its material value is of the highest, yet it is deplorably neglected with the result that only very rarely is the simplest scientific subject referred to accurately in the works of literary men.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 13)

Macmillan & Company Ltd. London, England. 1918

Nature, like the rich man of the parable, requires importunate pleading before she will bestow any of her riches upon a suppliant at her temple.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 12)

Macmillan & Company Ltd. London, England. 1918

Nature must be loved for herself and not for her dowry.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 54)

Macmillan & Company Ltd. London, England. 1918

**Haeckel, Ernst** 1834–1919

German biologist and philosopher

The anthropomorphic notion of a deliberate architect and ruler of the world has gone forever from this field; the “eternal iron laws of nature” have taken its place.

*The Riddle of the Universe*

Chapter XIV (p. 267)

Watts & Company. London, England. 1900

**Hales, Stephen** 1677–1761

English physiologist and clergyman

...our reasonings about the wonderful and intricate operations of Nature are so full of uncertainty, that, as the



wise-man truly observes, hardly do we guess aright at the things that are upon earth, and with labour do we find the things that are before us.

*Vegetable Staticks*

Chapter VII (p. 181)

The Scientific Book Guild. London, England. 1961

**Harkness, William** 1837–1903

Scottish-American astronomer and surgeon

All nature is one, but for convenience of classification we have divided our knowledge into a number of sciences which we usually regard as quite distinct from each other.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1896*

On the Magnitude of the Solar System (p. 93)

Government Printing Office. Washington, D.C. 1896

**Hartwell, Leland H.** 1939–

American genome scientist

Sometimes nature rewards foolish optimism.

*Lex Prix Nobel. The Nobel Prizes in 2001*

Nobel banquet speech for award received in 2001

Nobel Foundation. Stockholm, Sweden. 2002

**Harvey, William** 1578–1657

English physician

Nature...is the best and most faithful interpreter of her own secrets; and what she presents either more briefly or obscurely in one department, that she explains more fully and clearly in another.

In *Great Books of the Western World* (Volume 28)

*Anatomical Exercises on the Generation of Animals*

Dedication (p. 329)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hazlitt, William Carew** 1834–1913

English bibliographer

Nature is stronger than reason: for nature is, after all, the text, reason but the comment.

In W. Carew Hazlitt (ed.)

*The Round Table; Northcotes Conversations; Characteristics*

Characteristics, CXXXV (p. 476)

George Bell & Sons. London, England. 1884

**Heine, Heinrich** 1797–1856

German poet

Nature, like a true poet, abhors abrupt transitions.

*The German Classics of the Nineteenth and Twentieth Centuries* (Volume 6)

Translated by Charles Godfrey Leland

The Journey to the Harz (p. 73)

The German Publication Society. New York, New York, USA.

1913–1914

Nature knows how to produce the greatest effects with the most limited means.

*The German Classics of the Nineteenth and Twentieth Centuries* (Volume 6)

Translated by Charles Godfrey Leland

The Journey to the Harz (p. 73)

The German Publication Society. New York, New York, USA.

1913–1914

**Heinlein, Robert A.** 1907–88

American science fiction writer

He shut up, realizing that grim old Mother Nature, red of tooth and claw, invariably punished damn fools who tried to ignore Her or repeal Her ordinances.

*Time Enough for Love*

Chapter VI (p. 205)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The laws of nature [that] we formulate mathematically in quantum theory deal no longer with the particles themselves but with our knowledge of the elementary particles.

*Daedalus*

Volume 87, 1958 (p. 99)

Natural science does not simply describe and explain nature; it is part of the interplay between nature and ourselves; it describes nature as exposed to our method of questioning.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter V (p. 81)

Harper & Row, Publishers. New York, New York, USA. 1958

**Henley, William Ernest** 1849–1903

English poet

What Nature has writ with her lusty wit

Is worded so wisely and kindly

That whoever has dipped in her manuscript

Must up and follow her blindly.

*Echoes of Life and Death*

Number XXXIII

T.B. Mosher. Portland, Maine, USA. 1908

**Heraclitus** 540 BCE–480 BCE

Greek philosopher

The real constitution of things is accustomed to hide itself.

In G.S. Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 211 (p. 193)

At The University Press. Cambridge, England. 1963

Nature loves to hide.

*Fragments*

Fragment x (p. 4)

Publisher undetermined

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

From the least of nature's work he may learn the greatest lesson.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 10 (p. 14)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

...Nature builds up by her refined and invisible architecture, with a delicacy eluding our conception, yet with a symmetry and beauty which we are never weary of admiring.

*The Cabinet of Natural Philosophy*

Part III, Chapter II, Section 292 (p. 263)

Longman, Rees, Orme, Brown & Green. London, England. 1831

**Herschel, Friedrich Wilhelm** 1738–1822

English astronomer

The phenomena of nature, especially those that fall under the inspection of the astronomer, are to be viewed, not only with the usual attention to facts as they occur, but with the eye of reason and experience.

An Account of Three Volcanoes in the Moon

*Philosophical Transactions of the Royal Society of London*, Volume 67, 1787 (p. 229)

**Holton, Gerald** 1922–

Research professor of physics and science history

The study of nature is a study of the artifacts that appear during an engagement between the scientist and the world in which he finds himself.

The Roots of the Complementarity

*Daedalus*, Number 4, Fall 1970 (p. 1019)

**Hooke, Robert** 1635–1703

English physicist

...the footsteps of Nature are to be trac'd, not in her ordinary course, but when she seems to be put to her shifts, to make many doublings and turnings, and to use some kind of art in endeavoring to avoid our discovery.

*Micrographia*

Preface (third page)

Printed by Jo. Martyn and Ja. Allestry. London, England. 1665

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE

Roman philosopher and dramatic critic

You may turn nature out of doors with violence, but she will still return.

*Satires, Epistles, and Ars Poetica*

Epistles, Book I, Epistle 10, l. 24

W. Heinemann. London, England. 1929

**Housman, Alfred Edward** 1859–1936

English poet, scholar and satirist

For nature, heartless, witless nature,

Will neither care nor know

What stranger's feet may find the meadow

And trespass there and go.

*Last Poems*

Number XL (p. 76)

Henry Holt & Company. New York, New York, USA. 1922

**Hudson, William Henry** 1841–1922

Argentinian/English ornithologist, naturalist, and author

Here Nature is unapproachable with her green, airy canopy, a sun-impregnated cloud — cloud above cloud — and though the highest may be reached by the eye, the beams yet filter through, illuming the wide spaces beneath — chambers succeeded by chamber, each with its own special lights and shadows.

*Green Mansions*

Chapter 2 (p. 28)

Grosset & Dunlap. New York, New York, USA. 1931

**Huggins, Sir William** 1824–1910

English astronomer

Since the time of Newton our knowledge of the phenomena of nature has wonderfully increased, but man asks, perhaps more earnestly now than in his days, What is the ultimate reality behind the reality of the perceptions? Are they only the pebbles of the beach with which we have been playing? Does not the ocean of ultimate reality and truth lie beyond?

*Annual Report of the Board of Regents of the Smithsonian Institution, 1891*

Celestial Spectroscopy (p. 102)

Government Printing Office. Washington, D.C. 1893

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Nature eludes calculation. Number is a grim pullulation.

Nature is the thing that cannot be numbered.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 416)

The Heritage Press. New York, New York, USA. 1961

Nature has no candor. She shows herself to man with her face turned away.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 415)

The Heritage Press. New York, New York, USA. 1961

Because of nature's unity it has been concluded that she is simple. An error.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 405)

The Heritage Press. New York, New York, USA. 1961

**Hutton, W.**

No biographical data available

Every page of the volume of Nature is fraught with instruction.

*The Book of Nature Laid Open*

Chapter I (p. 1)

Joseph Milligan. Georgetown, Virginia, USA. 1822

**Huxley, Thomas Henry** 1825–95

English biologist

There is not throughout Nature a law of wider application than this, that a body impelled by two forces takes the direction of their resultant.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 32)

Macmillan & Company Ltd. London, England. 1904

To every one of us the world was once as fresh and new as to Adam. And then, long before we were susceptible of any other mode of instruction, Nature took us in hand, and every minute of waking life brought its educational influence, shaping our actions into rough accordance with Nature's laws, so that we might not be ended untimely by too gross disobedience. Nor should I speak of this process of education as past for any one, be he as old as he may. For every man the world is as fresh as it was at the first day, and as full of untold novelties for him who has the eyes to see them. And Nature is still continuing her patient education of us in that great university, the universe, of which we are all members — Nature having no Test-Acts.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 84)

Macmillan & Company Ltd. London, England. 1904

Those who take honours in Nature's university, who learn the laws which govern men and things and obey them, are the really great and successful men in this world. The great mass of mankind are the "Poll," who pick up just enough to get through without much discredit. Those who won't learn at all are plucked; and then you can't come up again. Nature's pluck means extermination.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 85)

Macmillan & Company Ltd. London, England. 1904

The investigation of Nature is an infinite pasture-ground, where all may graze, and where the more bite, the longer the grass grows, the sweeter is its flavor, and the more it nourishes.

*Collected Essays* (Volume 1)

*Method and Result*

Administrative Nihilism (p. 282)

Macmillan & Company Ltd. London, England. 1904

Education is the instruction of the intellect in the laws of Nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws.

*Collected Essays* (Volume 3)

*Science and Education*

A Liberal Education; and Where to Find It (p. 83)

Macmillan & Company Ltd. London, England. 1904

The student of Nature wonders the more and is astonished the less, the more conversant he becomes with her opera-

tions; but of all the perennial miracles she offers to his inspection, perhaps the most worthy of admiration is the development of a plant or of an animal from its embryo.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 29)

Macmillan & Company Ltd. London, England. 1904

Nature is never in a hurry, and seems to have had always before her eyes the adage, "keep a thing long enough and you will find a use for it.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

On the Formation of Coal (p. 159)

Macmillan & Company Ltd. London, England. 1904

Harmonious order governing eternally continuous progress — the web and woof of matter and force interweaving by slow degrees, without a broken thread, that veil which lies between us and the Infinite — that universe which alone we know or can know; such is the picture which science draws of the world, and in proportion as any part of that picture is in unison with the rest, so may we feel sure that it is rightly painted.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 59)

Macmillan & Company Ltd. London, England. 1904

...the "Law of Nature" is not a command to do, or to refrain from doing, anything. It contains, in reality, nothing but a statement of that which a given being tends to do under the circumstances of its existence; and which, in the case of a living and sensitive being, it is necessitated to do, if it is to escape certain kinds of disability, pain, and ultimate dissolution.

*Collected Essays* (Volume 1)

*Method and Result*

Natural and Political Rights (p. 349)

Macmillan & Company Ltd. London, England. 1904

## Huygens, Christiaan 1629–95

Dutch mathematician, astronomer, and physicist

Nature seems to court variety in her Works, and may have made them widely different from ours either in their matter or manner of Growth, in their outward Shape, or their inward Contexture; she may have made them such as neither our Understanding nor Imagination can conceive.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, their Inhabitants and Productions*

Book the First, Not to be imagin'd too unlike ours (p. 22)

Printed for T. Childe. London, England. 1698

...we may mount from this dull Earth, and viewing it from on high, consider whether Nature has laid out all her cost and finery upon this small speck of Dirt. So, like Travelers into other distant Countries, we shall be better able to judge of what's done at home, know how to make a true estimate of, and set its own value upon every thing.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, their Inhabitants and Productions*  
Book the First, These Studies useful to Religion (p. 10)  
Printed for T. Childe. London, England. 1698

### Irwin, Keith Gordon

No biographical data available

It is nature, of course, that is the great chemist. Every growing plant is a marvelous chemical factory, every living thing a brilliant shifter of atoms from one bewildering compound to another. And down in the depths of the earth enormous forces operate to create the minerals that someday may be close to the earth's surface.

*The Romance of Chemistry*

Forward (p. xi)

The Viking Press. New York, New York, USA. 1959

### James, William 1842–1910

American philosopher and psychologist

Visible nature is all plasticity and indifference, — a moral multiverse... and not a moral universe. To such a harlot we owe no allegiance; with her as a whole we can establish no moral communion; and we are free in our dealing with her several parts to obey or to destroy, and to follow no law but that of prudence in coming to terms with such of her particular features as will help us to our private ends.

*The Will to Believe and Other Essays in Popular Philosophy*

Is Life Worth Living? (p. 43)

Dover Publications, Inc. New York, New York, USA. 1956

It seems a priori improbable that the truth should be so nicely adjusted to our needs and powers.... In the great boarding-house of nature, the cakes and the butter and the syrup seldom come out so even and leave the plates so clean.

*The Will to Believe and Other Essays in Popular Philosophy*

The Will to Believe

Section VIII (p. 27)

Dover Publications, Inc. New York, New York, USA. 1956

### Juvenal (Decimus Junius Juvenal)

Roman poet

*Nunquam aliud Natura aliud Sapientia dicit.*

Nature never says one thing, Wisdom another.

*Satires*

Chapter XIV, 321

Indiana University Press. Bloomington, Indiana, USA. 1958

### Kant, Immanuel 1724–1804

German philosopher

...in every study of nature there can be only so much genuine science as there is a priori knowledge, by the same token, natural philosophy will contain genuine science only to the extent in which mathematics can be applied to it.

Translated by James Ellington

*Metaphysical Foundations of Natural Science*

Preface (p. 7)

The Bobbs-Merrill Company, Inc. Indianapolis, Indiana, USA. 1970

### Kepler, Johannes 1571–1630

German astronomer

...the closer I approach her [Nature], the more petulant her games become, and the more she again and again sneaks out of the seeker's grasp just when he is about to seize her through some circuitous route. Nevertheless, she never ceases to invite me to seize her, as though delighting in my mistakes.

Translated by William H. Donahue

*New Astronomy*

Part IV, 58 (p. 573)

At the University Press. Cambridge, England. 1992

### Kingsley, Charles 1819–75

English clergyman and writer

Nature's deepest laws, her own true laws, are her invisible ones.

*Alton Locke, Taylor and Poet*

Chapter XXXVIII (p. 289)

Macmillan & Company Ltd. London, England. 1911

...there is no lie in Nature; no discords in the revelations of science, in the laws of the Universe.

*Alton Locke, Taylor and Poet*

Chapter XVIII (p. 141)

Macmillan & Company Ltd. London, England. 1911

### Kolb, Edward W. (Rocky) 1951–

American cosmologist

Nature, as read by patient observation and experiment, is the ultimate philosopher.

*Blind Watchers of the Sky*

Chapter Three (p. 59)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

### Krutch, Joseph Wood 1893–1970

American naturalist, conservationist, and writer

To those who study her, Nature reveals herself as extraordinarily fertile and ingenious in devising means, but she has no ends which the human mind has been able to discover or comprehend.

*The Modern Temper*

Chapter Two, Section iii (p. 27)

Harcourt, Brace & Company. New York, New York, USA. 1929

### Lamarck, Jean-Baptiste Pierre Antoine 1744–1829

French biologist

Do we not therefore perceive that by the action of the laws of organization...nature has in favorable times, places, and climates multiplied her first germs of animality, given place to developments of their organizations... and increased and diversified their organs? Then...aided by much time and by a slow but constant diversity of circumstances, she has gradually brought about in this respect the state of things which we now observe. How

grand is this consideration, and especially how remote is it from all that is generally thought on this subject!

In Alpheus Spring Packard

*Lamarck, the Founder of Evolution: His Life and Work*

Chapter 16 (p. 259)

Longmans, Green & Company. London, England. 1901

Nature has produced all the species of animals in succession, beginning with the most imperfect or simplest, and ending her work with the most perfect, so as to create a gradually increasing complexity in their organisation; these animals have spread at large throughout all the habitable regions of the globe, and every species has derived from its environment the habits that we find in it and the structural modifications which observation shows us.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VII (p. 126)

The University of Chicago Press. Chicago, Illinois, USA. 1984

### **Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

Nature is so various in her productions and phenomena, that it is extremely difficult to ascertain their causes, hence it is requisite for a great number of men to unite their intellect and exertions in order to comprehend and develop her laws.

*System of the World* (Volume 2)

Book V, Chapter IV (p. 286)

Longman, Rees, Orme, Brown & Green. Dublin, Ireland. 1830

...[if] the result of a long series of precise observations approximates a simple relation so closely that the remaining difference is undetectable by observation and may be attributed to the errors to which they are liable, then this relation is probably that of nature.

*Pierre Simon Laplace 1749–1827: A Life in Exact Science*

Chapter 16 (p. 130)

Princeton University Press. Princeton, New Jersey, USA. 1997

### **Lawrence, Louise de Kiriline** 1894–1992

Canadian naturalist, author, and nurse

Nature is a deep reality and whether we understand it or not it is true and elemental.

*The Lovely and the Wild*

Chapter Three (p. 33)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

### **Leclerc, Georges-Louis, Comte de Buffon** 1707–88

French naturalist

Nature turns upon two steady pivots, unlimited fecundity which she has given to all species; and those innumerable causes of destruction which reduce the product of this fecundity...

*Natural History, General and Particular* (Volume 5) (p. 88)

T. Caldwell and W. Davies. London, England. 1812

Nature is that system of laws established by the Creator for regulating the existence of bodies, and the succession of beings. Nature is not a body; for this body would comprehend every thing. Either is it a being; for this being would necessarily be God. But nature may be considered as an immense living power, which animates the universe, and which, in subordination to the first and supreme Being, began to act by his command, and its action is still continued by his concurrence or consent.

*Natural History, General and Particular* (Volume 6)

Of Nature, First View (p. 249)

T. Caldwell and W. Davies. London, England. 1812

### **Lederman, Leon** 1922–

American high-energy physicist

The laws of nature must have existed before even time began in order for the beginning to happen. We say this, we believe it, but can we prove it?

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 9 (p. 401)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

### **Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

If ants had a language they would, no doubt, call their anthill an artifact and describe the brick wall in its neighborhood an a natural object. Nature in fact would be for them all that was not “ant-made.” Just so, for us, nature is all that is not man-made; the natural state of anything is its state when not modified by man.

*Studies In Words*

Nature (pp. 45–46)

The University Press. Cambridge, England. 1960

### **Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

It is the exclusive property of man, to contemplate and to reason on the great book of nature. She gradually unfolds herself to him, who with patience and perseverance, will search into her mysteries; and when the memory of the present and of past generations shall be obliterated, he shall enjoy the high privilege of living in the minds of his successors, as he has been advanced in the dignity of his nature, by the labours of those who went before him.

In Thomas Steele Hall

*A Source Book in Animal Biology* (p. 32)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

### **Longfellow, Henry Wadsworth** 1807–82

American poet

Nature with folded hand seemed there,  
Kneeling at her evening prayer!

*The Poetical Works of Henry Wadsworth Longfellow*

Voices of The Night

Prelude, Stanza 11

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

No tears

Dim the sweet look that Nature wears.

*The Poetical Works of Henry Wadsworth Longfellow*

Sunrise on the Hills, l. 35

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

So Nature deals with us, and takes away

Our playthings one by one, and by the hand

Leads us to rest so gently, that we go,

Scarce knowing if we wish to go or stay,

Being too full of sleep to understand

How far the unknown transcends the what we know.

*The Poetical Works of Henry Wadsworth Longfellow*

Nature, l. 9

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

And Nature, the old nurse, took

The child upon her knee,

Saying: "Here is a story-book

Thy Father has written for thee."

"Come, wander with me," she said,

"Into regions yet untrod;

And read what is still unread

In the manuscripts of God."

*Fiftieth Birthday of Agassiz*

Sackett & Wilhelms Lithographing Corp. New York, New York, USA. 1935

**Lorenz, Konrad** 1903–89

Austrian zoologist

Much of the beauty and wonder of nature is based on the fact that organic life is directed towards goals — towards survival, reproduction, and the attainment of higher perfection.

In Niko Tinbergen

*The Herring Gull's World: A Study of the Social Behavior of Birds*

Foreword (p. vi)

Basic Books, Inc. Publishers. New York, New York, USA. 1960

**Lubbock, Sir John** 1834–1913

English banker, writer, and scientist

...we are not the only tenants of our farms — that the fields and hedges, woods and waters, all around us, teem with a complex, rich, and interesting life. ...[N]ature will speak only to those who listen with love and sympathy...

In Henry C. McCook

*Tenants of an Old Farm; Leaves from the Note-Book of a Naturalist*

Introduction (p. vi)

George W. Jacobs & Company. Philadelphia, Pennsylvania, USA. 1895

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

This terror then and darkness of mind must be dispelled not by the rays of the sun and glittering shafts of day, but by the aspects and the law of nature; the warp of whose design we shall begin with this first principle, nothing is ever gotten out of nothing by divine power.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book One, l. 146 (pp. 2–3)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Luther Standing Bear** 1868–1939

Oglala Lakota chief, 1905–1939

Only to the white man was nature a "wilderness" and only to him was the land "infested" with "wild" animals and "savage" people. To us it was tame. Earth was bountiful and we were surrounded with the blessings of the Great Mystery. Not until the hairy man from the east came and with brutal frenzy heaped injustices upon us and the families that we loved was it "wild" for us. When the very animals of the forest began fleeing from his approach, then it was that for us the "Wild West" began.

*Land of the Spotted Eagle*

Boyhood (p. 38)

University of Nebraska Press. Lincoln, Nebraska, USA. 1978

**Lyell, Sir Charles** 1797–1875

English geologist

So in Geology, if we could assume that it is part of the plan of nature to preserve, in every region of the globe, an unbroken series of monuments to commemorate the vicissitudes of the organic creation, we might infer the sudden extirpation of species, and the simultaneous introduction of others, as often as two formations in contact include dissimilar organic fossils. But we must shut our eyes to the whole economy of the existing causes, aqueous, igneous, and organic, if we fail to perceive that such is not the plan of Nature.

*Principles of Geology* (Volume 3)

Chapter III (p. 34)

John Murray. London, England. 1830

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

Nature never errs in the long-run. She made man from a shred of the Milky Way, and she may be trusted to look after the creature she has made.

*Science, Matter and Immortality*

Chapter XVIII (p. 224)

William & Norgate. London, England. 1909

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

In the infinite variety of nature many ordinary events occur; while others appear uncommon, perplexing, astonishing, or even contradictory to the ordinary run of things. As long as this is the case we do not possess a well-settled and unitary conception of nature.

*The Science of Mechanics* (5<sup>th</sup> edition)

Introduction (p. 6)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Maclaurin, Colin** 1698–1746  
Scottish mathematician and natural philosopher

The processes of nature lie so deep, that, after all the pains we can take, much, perhaps, will remain undiscovered beyond the reach of human art or skill. But this is no reason why we should give ourselves up to the belief of fictions, be they ever so ingenious, instead of hearkening to the unerring voice of nature...

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books*

Book I, Chapter I (p. 12)

Printed for the Author's Children. London, England. 1748

A strong curiosity has prompted men in all times to study nature; every useful art has some connexion with the science; and the unexhausted beauty and variety of things makes it ever agreeable, new and surprising.

*An Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books*

Book I, Chapter I (p. 3)

Printed for the Author's Children. London, England. 1748

### **Manning, Richard**

No biographical data available

Now I take this thought as necessary to humble our science, to understand that everything we know was taught us by nature, but nature gave us brains evolved to their niche, so they are limited in their understanding. All that we know we have learned from nature, but we do not know all that nature knows.

*Grassland*

Chapter 12 (p. 263)

The Viking Press. New York, New York, USA. 1995

### **Marsh, George Perkins** 1801–82

American scholar, writer, and statesman

Nature, left undisturbed, so fashions her territory as to give it almost unchanging permanence of form, outline, and proportion, except when shattered by geologic convulsions; and in these comparatively rare cases of derangement, she sets herself at once to repair the superficial damage, and to restore, as nearly as practicable, the former aspect of her dominion.

*The Earth as Modified by Human Action: A New Edition of Man and Nature*

Chapter I (p. 26)

Scribner, Armstrong & Company. New York, New York, USA. 1874

### **Mason, Frances**

No biographical data available

Nature shows nothing finished and perfect in the beginning; she shows orderly divergence and an advance from lower to higher levels of creation.

*Creation by Evolution*

Editors Preface (p. vii)

The Macmillan Company. New York, New York, USA. 1928

**McKibben, Bill** 1960–  
Freelance writer

The end of nature sours all my material pleasures. The prospect of living in a genetically engineered world sickens me. And yet it is toward such a world that our belief in endless material advancement hurries us. As long as that desire drives us, there is no way to set limits.

*The End of Nature*

A Path of More Resistance (p. 173)

Random House, Inc. New York, New York, USA. 1989

### **McLennan, Evan**

No biographical data available

There is a charm for man in the study of Nature. It elevates his soul to real greatness. It frees his mind from stormy life, and thrills him with the purest joy.

*Cosmical Evolution: A New Theory of the Mechanism of Nature*

Introduction (p. 23)

Donohue, Henneberry & Company. Chicago, Illinois, USA. 1890

### **Meldola, R.**

No biographical data available

It is only the active worker — the original investigator — who, by personal appeal to Nature through artificially imposed considerations, *i.e.*, experiment, or through observation, *i.e.*, ready-made phenomena, has come to understand fully what a fact really means in the scientific sense; to realise how laborious is the process of wooing truth and ambiguous are the answers often given by Nature to his cross-examinations.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 40)

Macmillan & Company Ltd. London, England. 1918

### **Melville, Herman** 1819–91

American novelist

...nature is an immaculate virgin, forever standing unrobed before us.

*Typee, Omoo, Mardi*

Mardi

Chapter 137 (p. 1094)

The Library of America. New York, New York, USA. 1982

### **Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Nature abhors a moron.

*A Mencken Chrestomathy*

Chapter XXX (p. 616)

Alfred A. Knopf. New York, New York, USA. 1949

### **Mill, John Stuart** 1806–73

English political philosopher and economist

Nature means the sum of all phenomena, together with the causes which produce them; including not only all that happens, but all that is capable of happening...

*Three Essays on Religion*

Nature (p. 5)

Longmans, Green, Reader &amp; Dyer. London, England. 1875

**Milton, John** 1608–74

English poet

Wherefore did Nature power her bounties forth  
 With such a full and unwithdrawing hand,  
 Covering the earth with odours, fruits, flocks,  
 Thronging the seas with spawn innumerable,  
 But all to please and sate the curious taste?

In *Great Books of the Western World* (Volume 32)*Comus*, I. 710

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Accuse not Nature, she hath done her part;

Do thou but thine...

In *Great Books of the Western World* (Volume 32)*Paradise Lost*

Book VIII, l. 561–562

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Moleschott, Jacob** 1822–93

Dutch scientist, physiologist, and philosopher

The law of nature is a stringent expression of necessity.

In Ludwig Buchner

*Force and Matter*

Chapter VI (p. 33)

Trubner &amp; Company. London, England. 1864

**Montgomery, Robert**

No biographical data available

...not from Nature up to Nature's God,

But down from Nature's God look Nature through.

*Luther: Or, the Spirit of the Reformation*

A Landscape of Domestic Life

Francis Baisler. London, England. 1843

**Morley, John 1<sup>st</sup> Viscount Morley****of Blackburn** 1838–1923

English statesman and writer

Nature, in her most dazzling aspects or stupendous parts,  
 is but the background and theatre of the tragedy of man.

*Critical Miscellanies*

Byron (p. 140)

Macmillan &amp; Company Ltd. London, England. 1886

**Morrison, A. Cressy** 1884–1951

American scientist

Although nature, the great chemist, has provided man with  
 the prototypes and methods by which he has attempted,  
 with considerable success, to conquer his environment,  
 her motives and objectives have seldom been man's.  
 The beautiful silks with which man bedecks himself and  
 his womankind...were created for far different purposes  
 than those to which man has put them.

*Man in a Chemical World*

Chapter 2 (p. 13)

Charles Scribner's Sons. New York, New York, USA. 1937

**Motherwell, William** 1797–1835

Scottish poet

And we, with Nature's heart in tune,  
 Concerted harmonies.

In Frederick Saunders and Minnie K. Davis (eds.)

*Gems of Genius in Poetry and Art*

Jeannie Morrison

Thompson &amp; Thompson. Chicago, Illinois, USA. 1899

**Muir, John** 1838–1914

American naturalist

Then to think of the infinite numbers of smaller fellow  
 mortals, invisibly small, compared with which the smallest  
 ants are as mastodons.

*My First Summer in the Sierra*

June 13 (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Thus review the eventful past, we see Nature working  
 with enthusiasm like a man, blowing her volcanic forges  
 like a blacksmith blowing his smithy fires, shoving gla-  
 ciers over the landscapes like a carpenter shoving his  
 planes, clearing, ploughing, harrowing, irrigating, plant-  
 ing, and sowing broadcast like a farmer and gardener,  
 doing rough work and fine work, planting sequoias and  
 pines, rosebushes and daisies; working in gems, fill-  
 ing every crack and hollow with them; distilling fine  
 essences; painting plants and shells, clouds, mountains,  
 all the earth and heavens, like an artist, ever working  
 toward beauty higher and higher.

*Our National Parks*

Chapter II (p. 73)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

When we are with Nature we are awake, and we discover  
 many interesting things and reach many a mark we are  
 not aiming at.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter VII, Section I, June, 1890 (p. 300)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

None may wholly escape the Good of Nature, however  
 imperfectly exposed to her blessings.

*Steep Trails*

Chapter III (p. 48)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

None of Nature's landscapes are ugly so long as they are  
 wild.

*Our National Parks*

Chapter I (p. 4)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

One is constantly reminded of the infinite lavishness and  
 fertility of Nature — inexhaustible abundance amid what  
 seems enormous waste. And yet when we look into any  
 of her operations that lie within reach of our minds, we  
 learn that no particle of her material is wasted or worn



out. It is eternally flowing from use to use, beauty to yet higher beauty.

*Gentle Wilderness* (p. 139)  
Ballantine Books. New York, New York, USA. 1968

Nature...leading us with work...yet cheers us like a mother with tender prattle words of love...

In Linnie Marsh Wolfe (ed.)  
*John of the Mountains*  
Chapter II, Section 2, Undated (pp. 66–67)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

Nature has always something rare to show us...and the danger to life and limb is hardly greater than one would experience crouching deprecatingly beneath a roof.

*Mountains of California*  
Chapter X (p. 249)  
The Century Company. New York, New York, USA. 1911

[I]n every walk with Nature one receives far more than he seeks.

*Steep Trails*  
Chapter IX (p. 128)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

How fiercely, devoutly wild is Nature in the midst of her beauty loving tenderness.

*My First Summer in the Sierra*  
July 29 (p. 177)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### Musser, George

No biographical data available

The basic rules of nature are simple, but their consummation may never lose its ability to surprise.

From the Editors  
*Scientific American*, Volume 280, Number 1, January 1999 (p. 6)

### Newton, Sir Isaac 1642–1727

English physicist and mathematician

For Nature is very consonant and conformable to herself.

In Eugene Hecht  
*Optics*  
Book III, Part 1, Question 31 (p. 531)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I wish we could derive the rest of the phenomena of Nature by the same kind of reasoning from mechanical principles, for I am induced by many reasons to suspect that they may all depend upon certain forces by which the particles of bodies, by some causes hitherto unknown, are either mutually impelled toward one another, and cohere in regular rigors, or are repelled and recede from one another.

In *Great Books of the Western World* (Volume 34)  
*Mathematical Principles*  
Preface to the First Edition (p. 2)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Oliver, Mary 1935–

American poet

Nature, the total of all of us, is the wheel that drives our world; those who ride it willingly might yet catch a glimpse of a dazzling, even a spiritual restfulness, while those who are unwilling simply to hang on, who insist that the world must be piloted by man for his own benefit, will be dragged around and around all the same, gathering dust but no joy.

*Blue Pastures*  
A Few Words (p. 92)  
Harcourt Brace & Company. New York, New York, USA. 1995

### Oppenheimer, J. Robert 1904–67

American theoretical physicist

Despite all the richness of what men have learned about the world of nature, of matter and of space, of change and of life, we carry with us today an image of the giant machine as a sign of what the objective world is really like.

*Science and the Common Understanding*  
Chapter 1 (pp. 14–15)  
Simon & Schuster. New York, New York, USA. 1954

### O'Rourke, P. J. 1947–

Political satirist

Worship of nature may be ancient, but seeing nature as cuddlesome, hug-a-bear and too cute for words is strictly a modern fashion.

*Parliament of Whores: A Lone Humorist Attempts to Explain the Entire U.S. Government*  
Dirt of the Earth (p. 196)  
Vintage Books. New York, New York, USA. 1992

### Orton, James 1830–77

Explorer

The Kingdom of Nature is a literal Kingdom. Order and beauty, law and dependence, are seen everywhere. Amidst the great diversity of the forms of life, there is unity; and this suggests that there is one general plan, but carried out in a variety of ways.

*Comparative Zoology; Structural and Systematic*  
Chapter XXI (p. 222)  
Harper & Brothers. New York, New York, USA. 1877

### Pagels, Heinz R. 1939–88

American physicist and science writer

Nature avoids infinities.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Four, Chapter 1 (p. 354)  
Simon & Schuster. New York, New York, USA. 1985

Nature has been generous to astronomers, offering an abundance of different stars and galaxies at all stages in their lives to look at.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part One, Chapter 1 (p. 28)  
Simon & Schuster. New York, New York, USA. 1985

### Peattie, Donald Culrose 1896–1964

American botanist, naturalist and writer

Futile for science to try to discover what the forces of Nature are; it can only discover how they operate.

*An Almanac for Moderns*

March Twenty-Eighth (p. 10)

G.P. Putnam's Sons. New York, New York, USA. 1935

It is Nature herself, as we grow in comprehension of her, who weans us from our early faith.

*An Almanac for Moderns*

March Thirtieth (p. 12)

G.P. Putnam's Sons. New York, New York, USA. 1935

### Peters, Ted

No biographical data available

Nature as we daily experience it is ambiguous, fraught with benefits and liabilities.

*Playing God?: Genetic Determinism and Human Freedom*

Playing God with DNA (p. 20)

Routledge. New York, New York, USA. 1997

### Petrarch (Francesco Petrarca) 1304–74

Italian poet and humanist

There are fools who seek to understand the secrets of nature.

In Richard Olson

*Science Deified and Science Defied: The Historical Significance of Science in Western Culture* (Volume 1)

Chapter 7 (p. 210)

University of California Press. Berkeley, California, USA. 1982

### Planck, Max 1858–1947

German physicist

In all cases, the quantum hypothesis has given rise to the idea, that in Nature, changes occur which are not continuous, but of an explosive nature.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

New Paths of Physical Knowledge (p. 51)

Methuen & Company Ltd. London, England. 1925

If one wishes to obtain a definite answer from Nature one must attack the question from a more general and less selfish point of view.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Unity of the Physical Universe (p. 15)

Methuen & Company Ltd. London, England. 1925

### Pliny (C. Plinius Secundus) 23–79

Roman savant and writer

Hail, Nature, mother of all creation, and mindful that I alone of the men of Rome have praised thee in all thy manifestations, be gracious to me.

*Natural History*

Volume 10, Book XXXVII, sec 205

Harvard University Press. Cambridge, Massachusetts, USA. 1947

### Poincaré, Henri 1854–1912

French mathematician and theoretical astronomer

The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living.

*The Foundations of Science*

Science and Method, Book I

Chapter I (p. 366)

The Science Press. New York, New York, USA. 1913

### Pope, Alexander 1688–1744

English poet

See plastic Nature working to this end,  
The single atoms each to other tend,  
Attract, attracted to, the next in place  
Form'd and impell'd its neighbor to embrace.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle III, l. 9

Houghton Mifflin Company. New York, New York, USA. 1903

Eye nature's walks, shoot folly as it flies,  
And catch the manners, living as they rise;  
Laugh where we must, be candid where we can,  
But vindicate the ways of God to man.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle I, l. 13

Houghton Mifflin Company. New York, New York, USA. 1903

All are but parts of one stupendous whole,  
Whose body Nature is, and God the soul;  
That chang'd thro' all, and yet in all same,  
Great in the earth as in th' ethereal frame;  
Warms in the sun, refreshes in the breeze,  
Glow's in the stars, and blossoms in the trees;  
Lives thro' all life, extends thro' all extent,  
Spreads undivided, operates unspent;  
Breathes in our soul, informs our mortal part,  
As full, as perfect, in a hair as heart.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle I, l. 267

Houghton Mifflin Company. New York, New York, USA. 1903

All nature is but art, unknown to thee.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle I, l. 289

Houghton Mifflin Company. New York, New York, USA. 1903

### Poynting, John Henry 1852–1914

English physicist

While the investigation of Nature is ever increasing our knowledge, and while each new discovery is a positive addition never again to be lost, the range of the investigation and the nature of the knowledge gained form the theme of endless discussion.

*Collected Scientific Papers*

Presidential Address

The Mathematical and Physical Section

The British Association (Dover) 1899 (p. 599)  
At The University Press. Cambridge. 1920

**Priestley, Joseph** 1733–1804  
English theologian and scientist

I view with rapture the glorious face of nature, and I admire its wonderful constitution, the laws of which are daily unfolding themselves to our view.

In F.W. Gobbs

*Joseph Priestley: Adventure in Science and Champion of Truth*  
Chapter 10 (p. 168)  
Thomas Nelson & Sons Ltd. London, England. 1965

**Quammen, David** 1948–  
American science writer and naturalist

Nature grants no monopolies in resourcefulness. She does not even seem to hold much with the notion of portioning it out hierarchically. Gold, she decrees, is where you find it.

*Natural Acts: A Sidelong View of Science and Nature*  
A Better Idea (p. 3)  
Shocken Books. New York, New York, USA. 1985

**Raman, Chandrasekhar Venkata** 1888–1970  
Indian physicist

The face of Nature as presented to us is infinitely varied, but to those who love her it is ever beautiful and interesting.

*The New Physics: Talks on Aspects of Science*  
Chapter V (p. 29)  
Philosophical Library, New York. 1951

**Rey, Hans Augusto** 1898–1977  
Author and illustrator of children's books

No matter what part of nature one studies — microbes or Milky Ways — there is a point where one begins, but never an end.

*The Stars: A New Way to See Them*  
Part 4 (p. 108)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

**Richet, Charles** 1850–1935  
French physiologist

Nature guards her secrets jealously: it is necessary to lay violent siege to her for a long time to discover a single one of them, however small it be.

*The Natural History of a Savant*  
Chapter XIII (p. 149)  
J.M. Dent & Sons Ltd. London, England. 1927

**Rolleston, George** 1916–2001  
English physician and physiologist

Let us hope that in the interludes of rhetoric the logic of facts may find a moment to make itself heard. It will teach men...to hold of Nature that her ways are not as our ways, nor her thoughts as our thoughts.

*Scientific Papers and Addresses* (Volume 1)

Chapter IV (p. 61)  
At The Clarendon Press. Oxford, England. 1884

**Russell, Henry Norris** 1877–1957  
American astronomer

In the grandeur of its sweep in space and time, and the beauty and simplicity of the relations which it discloses between the greatest and the smallest things of which we know, it reveals as perhaps nothing else does, the majesty of the order about us which we call nature, and, as I believe, of that Power behind the order, of which it is but a passing shadow.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1923*  
Constitution of the Stars (p. 158)  
Government Printing Office, Washington, D.C. 1925

**Sagan, Carl** 1934–96  
American astronomer and author

Scientists do not seek to impose their needs and wants on Nature, but instead humbly interrogate Nature and take seriously what they find.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 2 (p. 32)  
Random House, Inc. New York, New York, USA. 1995

**Saunders, W. E.**  
Naturalist

Lovers of nature feel so confidently that their hobby is an enormous asset in life that there is no feeling of hesitancy in advocating that every person should become acquainted with new species of birds, trees, insects, etc., just as often as opportunity offers. And the time to do so is always NOW!

In R.J. Rutter (ed.)  
*W.E. Saunders, Naturalist: A Memorial Volume*  
Saundersisms (p. 50)  
Federation of Ontario Naturalists. Toronto, Ontario, Canada. 1949

**Sayers, Dorothy L.** 1893–1957  
English novelist and essayist

**Eustace, R.**  
No biographical data available

Nature never worked by rule and compass.

*The Documents in the Case*  
Letter 16, Agatha Milsom to Olive Farebrother (p. 56)  
Victor Gollancz LTD, London, England; 1978

**Schrieber, Hermann** 1920–  
Austrian historian

If nature and earth, those kindest of mother-goddesses, were so aroused as to annihilate cities, men could only conclude that the fault was theirs.

Translated by Richard and Clara Winston  
*Vanished Cities*  
Part One (p. 4)  
Alfred A. Knopf. New York, New York, USA. 1962

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

As our mental eye penetrates into smaller and smaller distances and shorter and shorter times, we find nature behaving so entirely differently from what we observe in visible and palpable bodies of our surroundings that no model shaped after our large-scale experiences can ever be “true.” A complete satisfactory model of this type is not only practically inaccessible, but not even thinkable. Or, to be precise, we can, of course, think of it, but however we think it, it is wrong; not perhaps quite as meaningless as a “triangular circle,” but more so than a “winged lion.”

*Science and Humanism*

The Nature of Our “Models” (p. 25)

At The University Press. Cambridge, England. 1952

**Sears, Paul Bigelow** 1891–1990

American plant ecologist and conservationist

Nature is not to be conquered save on her own terms. She is not conciliated by cleverness or industry in devising means to defeat the operation of one of her laws through the workings of another.

*Deserts on the March*

Chapter I (p. 3)

University of Oklahoma Press. Norman, Oklahoma, USA. 1935

**Selye, Hans** 1907–82

Austrian-American endocrinologist

To me nature created man, and nature is superior.

In Denis Brian

*Genius Talk: Conversations with Nobel Scientists and Other Luminaries*

Chapter 13 (p. 267)

Plenum Press. New York, New York, USA. 1995

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

Nature does not turn out her work according to a single pattern; she prides herself upon her power of variation...

*Physical Science in the Time of Nero, Being a Translation of the**Quaestiones Naturales of Seneca*

Book VII, Chapter XXVII (p. 301)

Macmillan &amp; Company Ltd. London, England. 1910

Nature does not reveal all her secrets at once. We imagine we are initiated in her mysteries: we are, as yet, but hanging around her outer courts.

*Physical Science in the Time of Nero, Being a Translation of the**Quaestiones Naturales of Seneca*

Book VII, Chapter XXXI (p. 306)

Macmillan &amp; Company Ltd. London, England. 1910

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Thou, nature, art my goddess; to thy laws

My services are bound.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

King Lear

Act I, Scene ii, l. 1–2

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

One touch of nature makes the whole world kin,  
That all with one consent praise new-born gawds,  
Though they are made and moulded of things past,  
And give to dust that is a little gilt  
More laud than gilt o’er-dusted.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

Troilus and Cressida

Act III, Scene iii, l. 175–179

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...nature is made better by no mean

But nature makes that mean.

So, over that art

Which you say adds to nature, is an art

That nature makes.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

The Winter’s Tale

Act IV, Scene iv, l. 88–90

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

How sometimes nature will betray its folly,  
Its tenderness, and make itself a pastime

To harder bosoms!

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

The Winter’s Tale

Act I, Scene ii, l. 151–153

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In Nature’s infinite book of secrecy

A little I can read.

In *Great Books of the Western World* (Volume 27)*The Plays and Sonnets of William Shakespeare* (Volume 2)

Anthony and Cleopatra

Act I, Scene ii, l. 9–10

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

The notion that Nature does not proceed by jumps is only one of the budget of plausible lies that we call classical education. Nature always proceeds by jumps. She may spend twenty thousand years making up her mind to jump; but when she makes it up at last, the jump is big enough to take us into a new age.

*Back to Methuselah*

Part II, XXXIII (p. 81)

Constable &amp; Company Ltd. London, England. 1921

**Smyth, Nathan A.**

No biographical data available

By the pull of pleasure and prod of pain nature keeps the individual in tune with her purposes.

*Through Science to God*

Chapter X (p. 146)

The Macmillan Company. New York, New York, USA. 1936

**Spencer, Herbert** 1820–1903  
English social philosopher

Nature's rules...have no exceptions.

*Social Statics*

Introduction, Lemma II (p. 39)

John Chapman. London, England. 1851

Is it not, indeed, an absurd and almost sacrilegious belief that the more a man studies Nature the less he reveres it? Think you that a drop of water, which to the vulgar eye is but a drop of water, loses anything in the eye of the physicist who knows that its elements are held together by a force which, if suddenly liberated, would produce a flash of lightning?

*Education: Intellectual, Moral and Physical*

A.L. Fowle. New York, New York, USA. 1860

**Spenser, Edmund** 1552–99  
English poet

Yet neither spinnes, nor cards, ne cares nor fretts,  
But to her mother Nature all her care she lettts.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book II, Canto VI

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Steele, Joel Dorman** 1836–86  
American educator and textbook writer

In Nature all is common, and no use is base. She keeps no selected elements done up in gilt papers for sensitive people.

*A Fourteen Weeks Course in Chemistry*

Conclusion (p. 223)

A.S. Barnes & Company. New York, New York, USA. 1870

**Stevenson, Adlai E.** 1900–65  
American political leader and diplomat

Nature is neutral. Man has wrested from nature the power to make the world a desert or to make the deserts bloom.

*High Fidelity Record Annual 1955*

Speech (p. 338)

30 April 1946, House of Commons

J. B. Lippincott & Company. Philadelphia, Pennsylvania, USA. 1956

Nature is indifferent to the survival of the human species, including Americans.

*Adlai's Almanac: The Wit and Wisdom of Stevenson of Illinois* (p. 27)

H. Schuman. New York, New York, USA. 1952

**Swann, William Francis Gray** 1884–1962  
Anglo-American physicist

There are times...in the growth of human thought when nature, having led man to the hope that he may understand her glories, turns for a time capricious and mockingly challenges his powers to harmonize her mysteries by revealing new treasures.

In Bernard Jaffe

*Crucibles: The Story of Chemistry*

Chapter XVI (p. 322)

Dover Publications. New York, New York, USA. 1976

**Swift, Jonathan** 1667–1745  
Irish-born English writer

He said that new systems of nature were but new fashions, which would vary in every age; and even those who pretend to demonstrate them from mathematical principles, would flourish but a short period of time, and be out of vogue when that [system of nature] was determined.

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter VIII (pp. 118–119)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Teale, Edwin Way** 1899–1980  
American naturalist

Nature is shy and noncommittal in a crowd. To learn her secrets, visit her alone or with a single friend, at most.

*Circle of the Seasons*

May 4 (p. 85)

Dodd, Mead & Company. New York, New York, USA. 1953

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Who trusted

God was love indeed

And love Creation's final law —

Tho' Nature, red in tooth and claw

With ravine, shriek'd against his creed.

*Alfred Tennyson's Poetical Works*

In Memoriam A.H.H., LVI, Stanza IV

Oxford University Press, Inc. London, England. 1953

Nothing in Nature is unbeautiful.

*Alfred Tennyson's Poetical Works*

Lover's Tale, I. 348

Oxford University Press, Inc. London, England. 1953

A void was made in Nature;

all her bonds

Crack'd; and I saw the flaring atom-streams

And torrents of her myriad universe

Ruining along the illimitable inane,

Fly on to clash together again...

*Alfred Tennyson's Poetical Works*

Lucretius, I. 37–39

Oxford University Press, Inc. London, England. 1953

**Thierry, Paul Henri, Baron d'Holbach** 1723–89  
German-born French man of leisure

Man is only unhappy because he is ignorant of nature.

Translated by M. Mirabaud

*System of Nature or, The Laws of the Moral and Physical World* (Volume 1)

Preface by the Author (p. vii)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

...man disdains the study of nature, to pursue phantoms, which resemble the Will with the Wisp, which at once

terrifies and dazzles the benighted traveler, and which make him quit the simple road to truth, without pursuing which, he can never arrive at happiness.

Translated by M. Mirabaud

*System of Nature or, The Laws of the Moral and Physical World* (Volume 1)

Preface by the Author (p. vii)

Published by R. Benson. Philadelphia, Pennsylvania, USA. 1808

**Thomson, J. Arthur** 1861–1933

Scottish biologist

When we are thrilled with the wonder of the world, the heights and depths of things; when our Nature-feeling is informed with knowledge; when our science leaves us with a conviction of the mysteriousness of Nature — the unfathomed universe; when our philosophical outlook leads us towards a realisation of a meaning behind the process; then there may be a total reaction on our part worthy of the name of Natural Religion.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 42)

William & Norgate. London, England. 1920

In her manifold opportunities Nature has thus helped man to polish the mirror of [man's] mind, and the process continues. Nature still supplies us with abundance of brain-stretching theoretical puzzles and we eagerly tackle them; there are more worlds to conquer and we do not let the sword sleep in our hand; but how does it stand with feeling? Nature is beautiful, gladdening, awesome, mysterious, wonderful, as ever, but do we feel it as our forefathers did?

*The System of Animate Nature* (Volume 1)

Lecture I (p. 25)

William & Norgate. London, England. 1920

**Thomson, James** 1700–48

Scottish poet

O nature!...

Enrich me with the knowledge of thy works;

Snatch me to Heaven.

*Seasons*

Autumn, l. 1,352

Printed by John Mycall. Newburyport, Massachusetts, USA. 1790

I care not, Fortune, what you me deny;  
You cannot rob me of free Nature's grace,  
You cannot shut the windows of the sky,  
Through which Aurora shows her brightening face;  
You cannot bar my constant feet to trace  
The woods and lawns, by living stream, at eve.

*Castle of Indolence*

Canto II, Stanza 3

William Smith. London, England. 1842

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Nature will bear the closest inspection; she invites us to lay our eye level with the smallest leaf, and take an insect

view of its plain. She has no interstices; every part is full of life.

*The Writings of Henry David Thoreau* (Volume 9)

Natural History of Massachusetts (p. 132)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Nature must be viewed humanly to be viewed at all; that is, her scenes must be associated with humane affections, such as are associated with one's native place. She is most significant to a lover. A lover of Nature is preeminently a lover of man. If I have no friend, what is Nature to me? She ceases to be morally significant...

*The Journal of Henry David Thoreau* (Volume 4)

June 30, 1852 (p. 163)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

I love Nature partly *because* she is not man, but a retreat from him. None of his institutions control or pervade her. There a different kind of right prevails. In her midst I can be glad with an entire gladness. If this world were all man, I could not stretch myself, I should lose all hope. He is constraint, she is freedom to me. He makes me wish for another world. She makes me content with this.

*The Journal of Henry David Thoreau* (Volume 4)

January 3, 1853 (p. 440)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

I have a room all to myself; it is nature.

*The Journal of Henry David Thoreau* (Volume 4)

January 3, 1853 (p. 446)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

I sit in my boat on Walden, playing the flute this evening, and see the perch, which I seem to have charmed, hovering around me, and the moon traveling over the bottom, which is strewn with the wrecks of the forest, and feel that nothing but the wildest imagination can conceive of the manner of life we are living. Nature is a wizard. The Concord nights are stranger than the Arabian nights.... Heaven lies above, because the air is deep.

*Journal* (Volume 1: 1837–1844)

May 27, 1841 (p. 311)

Princeton University Press. Princeton, New Jersey, USA. 1981

If we knew all the laws of Nature, we should need only one fact, or the description of one actual phenomenon, to infer all the particular results at that point. Now we know only a few laws, and our result is vitiated, not, of course, by any confusion or irregularity in Nature, but by our ignorance of essential elements in the calculation. Our notions of law and harmony are commonly confined to those instances which we detect; but the harmony which results from a far greater number of seemingly conflicting, but really concurring, laws, which we have not detected, is still more wonderful. The particular laws are as our points of view, as to the traveler, a mountain outline varies with every step, and it has an infinite number of profiles, though absolutely but one form. Even when cleft or bored through it is not comprehended in its entirety.

*The Writings of Henry David Thoreau* (Volume 2)  
Walden  
Chapter XVI (p. 448)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1893

### **Thurlow, Lord Edward, 1<sup>st</sup> Baron**

**Thurlow** 1731–1806  
English jurist and statesman

Nature is always wise in every part.

*Select Poems*  
The Harvest Moon  
Chadwyck-Healey, Cambridge, England. 1992

**Tomonaga, Sin-Itiro** 1906–79  
Japanese physicist

We are too powerless to make assumptions based only on reasoning. We must beg instruction from Nature herself.

T. Miyazima (ed.)  
*Scientific Papers* (Volume 1) (p. 545)  
Misuzu-Shobo, Tokyo, Japan. 1971

**Turgenev, Ivan** 1818–83  
Russian novelist and dramatist

Nature is no temple, but a workshop, and man is the worker therein.

Translated by Bernard Guilbert Guerney  
*Fathers and Sons*  
Chapter 9 (p. 58)  
The Modern Library, New York, New York, USA. 1961

However much you knock at nature's door, she will never answer you in comprehensible words because she is dumb. She will utter a musical sound, or a moan like a harp string, but you don't expect a song from her.

*On the Eve*  
Chapter I (p. 10)  
Charles Scribner's Sons, New York, New York, USA. 1903–04

**Tuttle, Hudson** 1836–1910  
American medium

We find in the constant harmony of nature a sufficient proof in favor of the immutability of its laws. Every miracle would involve their infraction; a process to which nature would submit as little as to any other intervention in its empire; in which every thing, from the gnat which dances in the sunbeam up to the human mind which issues from the brain, is governed by fixed principles.

In Ludwig Buchner  
*Force and Matter*  
Chapter VI (p. 38)  
Trubner & Company, London, England. 1864

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Architects cannot teach nature anything.

*The Complete Essays of Mark Twain*

A Memorable Midnight Experience (p. 30)  
De Capo Press, New York, New York, USA. 2000

How blind and unreasoning and arbitrary are some of the laws of nature — most of them, in fact!

*The Man That Corrupted Hadleyburg, and Other Stories and Essays*  
A Double-Barreled Detective Story  
Chapter III (p. 296)  
Harper & Brothers, New York, New York, USA. 1917

...Nature's attitude toward all life is profoundly vicious, treacherous and malignant.

*Mark Twain's Notebook*  
Chapter XXIII (pp. 255–256)  
Harper & Brothers, New York, New York, USA. 1935

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

What are you, Nature? Live in you? But I have been searching for you for fifty years, and have never been able to find you.

*The Works of Voltaire* (Volume 12)  
*Philosophical Dictionary* (Volume 8)  
Nature (p. 48)  
The St. Hubert Guild, Akron, Ohio, USA. 1901

**von Baeyer, Adolf** 1835–1917  
German research chemist

What makes a great scientist? He must not command but listen; he must adapt himself to what he hears and reshape himself accordingly.... The ancient empiricists already did this. They put their ear to Nature. The modern scientist does the same.... Coming nearer to Nature has a very special effect on people. They develop very differently from someone who confronts Nature with preconceived ideas. Someone who approaches Nature with set ideas will, so to speak, stand before it like a general. He will want to issue orders to Nature.

In Richard Willstätter  
*From My Life: The Memoirs of Richard Willstätter*  
Chapter 6 (p. 140)  
W.A. Benjamin, New York, New York, USA. 1965

**von Baeyer, Hans Christian** 1938–  
German-born physicist and author

Not the scientist, but nature has the last word.

*Rainbows, Snowflakes, and Quarks: Physics and the World Around Us*  
The Measure of Things (p. 189)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1984

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

When a man of lively intellect first responds to Nature's challenge to be understood, he feels irresistibly tempted to impose his will upon the natural objects he is studying. Before long, however, they close in upon him with such force as to make him realize that he in turn must now acknowledge their might and hold in respect the authority they exert over him.

*Goethe's Botanical Writings*

Formation and Transformation (p. 21)

University of Hawaii Press. Honolulu, Hawaii, USA. 1952

We live in her midst and know her not. She is incessantly speaking to us, but betrays not her secret. We constantly act upon her, and yet have no power over her.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

Whoever wishes to deny nature as an organ of the divine must begin by denying all revelation.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter VIII (p. 303)

Suhrkamp. New York, New York, USA. 1988

That which is most unnatural is still Nature; the stupidest philistinism has a touch of her genius. Whoso cannot see her everywhere, sees her nowhere rightly.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She tosses her creatures out of nothingness, and tells them not whence they came, nor whither they go. It is their business to run, she knows the road.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She loves herself, and her innumerable eyes and affections are fixed upon herself. She has divided herself that she may be her own delight. She causes an endless succession of new capacities for enjoyment to spring up, that her insatiable sympathy may be assuaged.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She rejoices in illusion. Whoso destroys it in himself and others, him she punishes with the sternest tyranny. Whoso follows her in faith, him she takes as a child to her bosom.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

She creates needs because she loves action. Wondrous! that she produces all this action so easily. Every need is a benefit, swiftly satisfied, swiftly renewed. Every fresh want is a new source of pleasure, but she soon reaches an equilibrium.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 10)

She has always thought and always thinks; though not as a man, but as Nature. She broods over an all-comprehending idea, which no searching can find out.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

Every instant she commences an immense journey, and every instant she has reached her goal.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 10)

Each of her works has an essence of its own; each of her phenomena a special characterisation: and yet their diversity is in unity.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

The one thing she seems to aim at is Individuality; yet she cares nothing for individuals. She is always building up and destroying; but her workshop is inaccessible.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

Nature goes her own way, and all that to us seems an exception is really according to order.

In Johann Peter Eckermann

*Conversations with Goethe*

Thursday, December 9, 1824 (p. 75)

J.M. Dent & Sons Ltd. London, England. 1970

Her crown is love. Through love alone dare we come near her. She separates all existences, and all tend to intermingle. She has isolated all things in order that all may approach one another. She holds a couple of draughts from the cup of love to be fair payment for the pains of a lifetime.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 10)

Her mechanism has few springs — but they never wear out, are always active and manifold.

Translated by Thomas Huxley

Nature: Aphorisms by Goethe

*Nature*, Volume 1, Thursday, November 4, 1869 (p. 9)

It is not easy for us to grasp the vast, the super colossal, in nature; we have lenses to magnify tiny objects but none to make things smaller. And even for the magnifying glass we need eyes like Carus and Nees to profit intellectually from its use. However, since nature is always the same, whether found in the vast or the small, and every piece of turbid glass produces the same blue as the whole of the atmosphere covering the globe, I think it right to seek out prototypal examples and assemble them before me. Here, then, the enormous is not reduced; it is present within the small, and remains as far beyond our grasp as it was when it dwelt in the infinite.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter VIII (p. 304)

Suhrkamp. New York, New York, USA. 1988



We shall never succeed in exhausting the immeasurable riches of nature; and no generation of men will ever have cause to boast of having comprehended the total aggregation of phenomena.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 73)  
Harper & Brothers. New York, New York, USA. 1869

Mere communion with nature, mere contact with the free air, exercise a soothing yet strengthening influence on the wearied spirit, calm the storm of passion, and soften the heart when shaken by sorrow to its inmost depths.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 25)  
Harper & Brothers. New York, New York, USA. 1869

In order to depict nature in its exalted sublimity, we must not dwell exclusively on its external manifestations, but we must trace its image, reflected in the mind of man, at one time filling the dreamy land of physical myths with forms of grace and beauty, and at another developing the noble germ of artistic creations.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)  
Description of Nature by the Ancients (p. 20)  
Harper & Brothers. New York, New York, USA. 1869

### von Schelling, Friedrich Wilhelm

**Joseph** 1775–1854  
German philosopher

What then is that secret bond which couples our mind to Nature, or that hidden organ through which Nature speaks to our mind or our mind to Nature? For what we want is not that Nature should coincide with the laws of our mind by chance (as if through some third intermediary), but that she herself, necessarily and originally, should not only express, but even realize, the laws of our mind, and that she is, and is called, Nature only insofar as she does so.

Nature should be Mind made visible, Mind the invisible Nature. Here then, in the absolute identity of Mind in us and Nature outside us, the problem of the possibility of a Nature external to us must be resolved.

Translated by Errol E. Harris and Peter Heath  
*Ideas for a Philosophy of Nature as Introduction to the Study of this Science*  
Introduction (pp. 41–42)  
Cambridge University Press. Cambridge, England. 1988

The purest exercise of man's rightful dominion over dead matter, which was bestowed upon him together with reason and freedom, is that he spontaneously operates upon Nature, determines her according to purpose and intention, lets her act before his eyes, and as it were spies on her at work. But that the exercise of this dominion is possible, he owes yet again to Nature, whom he would strive in vain to dominate, if he would not put her in conflict with herself and set her own forces in motion against her.

Translated by Errol E. Harris and Peter Heath  
*Ideas for a Philosophy of Nature as Introduction to the Study of this Science*  
Book I (p. 57)  
Cambridge University Press. Cambridge, England. 1988

**von Siemens, Werner** 1816–1892  
German inventor and entrepreneur

The deeper the insight we obtain into the mysterious workings of nature's forces...the more we are convinced that we are still standing in the vestibule of science; that an unexplored world still lies before us; and however much we may discover, we know not whether mankind will ever arrive at a full knowledge of nature.

In Gardner G. Hubbard  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1891*  
The Evolution of Commerce (p. 660)  
Government Printing Office. Washington, D.C. 1893

**Walcott, Charles D.** 1850–1927  
Geologist

Nature has a habit of placing some of her most attractive treasures in places where it is difficult to locate and obtain them.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1915*  
Evidences of Primitive Life (p. 246)  
Government Printing Office. Washington, D.C. 1916

**Walker, John** 1731–1803  
English minister and educator

Nature consults no philosophers.  
*Lectures on Geology: Including Hydrography, Mineralogy, and Meteorology with an Introduction to Biology*  
Biographical Introduction (p. xxxi)  
The University of Chicago Press. Chicago, Illinois, USA. 1966

**Ward, Lester Frank** 1898–1970  
American sociologist

An entirely new dispensation has been given to the world. All the materials and forces of nature have been thus placed completely under the control of one of the otherwise least powerful of the creatures inhabiting the earth.... Nature has thus been made the servant of man.

*Glimpses of the Cosmos* (Volume 3)  
Mind as a Social Factor (p. 370)  
G.P. Putnam's Sons. New York, New York, USA. 1913

**Warner, Charles Dudley** 1829–1900  
American editor and author

Nature is, in fact, a suggester of uneasiness, a promoter of pilgrimages and of excursions of the fancy which never come to any satisfactory haven.

*Backlog Studies*  
Ninth Study, Section II (p. 203)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Watts, Alan Wilson** 1915–73

American philosopher

The form of Christianity differs from the form of nature because in the Church and in its spiritual atmosphere we are in a universe that has been made. Outside the Church we are in a universe that has grown.

*Nature, Man, and Woman*

Part I, Chapter 1 (p. 40)

Vintage Books. New York, New York, USA. 1970

For the notion that the interrelatedness of nature is complex and highly detailed is merely the result of translating it into the linear units of thought. Despite its rigor and despite its initial successes, this is an extremely clumsy mode of intelligence. Just as it is a highly complicated task to drink water with a fork instead of a glass, so the complexity of nature is not innate but a consequence of the instruments used to handle it. There is nothing complex about walking, breathing, and circulating one's blood. Living organisms have developed these functions without thinking about them at all.

*Nature, Man, and Woman*

Part I, Chapter 2 (p. 62)

Vintage Books. New York, New York, USA. 1970

The rush of waterfalls and the babbling of streams are not loved for their resemblance to speech; the irregularly scattered stars do not excite us because of the formal constellations which have been traced out between them; and it is for no symmetry or suggestion of pictures that we delight in the patterns of foam, of the veins in rock, or of the black branches of trees in wintertime.

*Nature, Man, and Woman*

Part I, Chapter 5 (p. 124)

Vintage Books. New York, New York, USA. 1970

**Webber, Charles Wilkins** 1819–56

American explorer and journalist

God's own presence is felt lingering yet, as if, in love with his own work, he stayed to touch it again — creating new charms in multiplied duration.

*Old Hicks, the Guide: Or, Adventures in the Comanche Country in Search of a Gold Mine*

VIII

Harper &amp; Brothers. New York, New York, USA. 1848

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Has anything arisen to show...that where the life and breeding of every individual of a species is about equally secure, a degenerative process must not inevitably supervene?...Natural Selection grips us more grimly than it ever did, because the doubts thrown upon the inheritance of acquired characteristics have deprived us of our trust in education as a means of redemption for decadent families. In our hearts we wish that the case were not so, we all hate

Death and his handiwork; but the business of science is not to keep up the courage of men, but to tell the truth.

Bio-Optimism

*Nature*, Volume 52, Number 1348, August 29, 1895 (p. 411)**Weyl, Hermann** 1885–1955

German mathematician

Once and for all I wish to record my unbounded admiration for the work of the experimenter in his struggle to wrest interpretable facts from an unyielding Nature who knows so well how to meet our theories with a decisive No — or with an inaudible Yes.

Translated by H.P. Robertson

*The Theory of Groups and Quantum Mechanics*

Introduction (p. xx)

Methuen &amp; Company Ltd. London, England. 1931

**Wheeler, John Archibald** 1911–

American physicist and educator

...nature at the quantum level is not a machine that goes its inexorable way. Instead what answer we get depends on the question we put, the experiment we arrange, the registering device we choose. We are inescapably involved in bringing about that which appears to be happening.

In John Archibald Wheeler and Wojciech Hubert Zurek (eds.)

*Quantum Theory and Measurement* (p. 185)

Princeton University Press. Princeton, New Jersey, USA. 1982

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The primary task of a philosophy of natural science is to elucidate the concept of nature, considered as one complex fact for knowledge, to exhibit the fundamental entities and the fundamental relations between entities in terms of which all laws of nature have to be stated, and to secure that the entities and relations thus exhibited are adequate for the expression of all the relations between entities which occur in nature.

*The Concept of Nature*

Chapter II (p. 46)

At The University Press. Cambridge, England. 1920

Thus we gain from the poets the doctrine that a philosophy of nature must concern itself with at least these five notions: change, value, eternal objects, endurance, organism, interfusion.

*Science and the Modern World*

Chapter V (p. 127)

The Macmillan Company. New York, New York, USA. 1929

You cannot talk vaguely about Nature in general.

*Nature and Life*

Part I (p. 1)

At the University Press. Cambridge, England. 1934

We have to remember that while nature is complex with timeless subtlety, human thought issues from the

simple-mindedness of beings whose active life is less than half a century.

*An Enquiry Concerning the Principles of Natural Knowledge*

Part I (p. 15)

At the University Press. Cambridge, England. 1919

Nature, even in the act of satisfying anticipation, often provides a surprise.

*Adventures of Ideas*

Chapter VIII (p. 161)

The Macmillan Company. New York, New York, USA. 1956

...nature gets credit which in truth should be reserved for ourselves: the rose for its scent: the nightingale for his song: and the sun for his radiance. The poets are entirely mistaken. They should address their lyrics to themselves, and should turn them into odes of self-congratulation on the excellence of the human mind. Nature is a dull affair, soundless, scentless, colorless; merely the hurrying of material, endlessly, meaninglessly.

*Science and the Modern World*

Chapter III (p. 80)

The Macmillan Company. New York, New York, USA. 1929

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

The fields of Nature long prepared and fallow,  
the silent, cyclic chemistry,

The slow and steady ages plodding, the unoccupied  
surface ripening, the rich ores forming beneath.

*Complete Poetry and Collected Prose*

Song of the Redwood Tree

The Library of America. New York, New York, USA. 1982

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Nature is so uncomfortable. Grass is hard and lumpy and damp, and full of dreadful insects.

*The Works of Oscar Wilde* (Volume 10)

Intentions

The Decay of Lying

AMS Press. New York, New York, USA. 1909

It seems to me that we all look at nature too much, and live with her too little.

*The Complete Writings of Oscar Wilde*

De Profundis (p. 158)

Nottingham Society. New York, New York, USA. 1907

And then Nature is so indifferent, so unappreciative. Whenever I am walking in the park here, I always feel that I am no more to her than the cattle that browse on the slope, or the burdock that blooms in the ditch.

*The Works of Oscar Wilde* (Volume 10)

Intentions

The Decay of Lying

AMS Press. New York, New York, USA. 1909

**Willstätter, Richard** 1872–1942

German chemist

It is the scientist's lot, as it is the artist's, to be less important than his work. He who is chosen to lift the veil from Nature's secrets will be easily overshadowed by the creation he has revealed and which will make him immortal.

*From My Life: The Memoirs of Richard Willstätter*

Chapter 6 (p. 141)

W.A. Benjamin. New York, New York, USA. 1965

**Wilson, David Scofield**

No biographical data available

Nature is present to naturalists the way God is to saints or the past is to humanists — not simply as a matter of fact but as an insistent and live reality.

*In the Presence of Nature*

Chapter I (p. 1)

University of Massachusetts Press. Amherst. 1978

**Winchell, Alexander** 1824–91

American geologist

Any thing which is a plan has been thought out. The plans of Nature are the expressions of the mind.

*Walks and Talks in the Geological Field*

Chapter XXXII (p. 190)

Chautauqua Press. New York, New York, USA. 1890

**Wöhler, Friedrich** 1800–82

German chemist

**von Liebig, Justus** 1803–73

German organic chemist

When in the dark province of organic nature, we succeed in finding a light point, appearing to be one of those inlets whereby we may attain to the examination and investigation of this province, then we have reason to congratulate ourselves, although conscious that the object before us is unexhausted.

Translated by James C. Booth

Researches Respecting the Radical of Benzoic Acid

*American Journal of Science and Arts*, Volume 26, Number 2, July 1834 (p. 261)

**Woodbridge, Frederick James Eugene** 1867–1940

American philosopher

The incorporation of man into nature may well do something to man, but it must also do something to nature. It is impossible that the word “nature” can mean the same after this incorporation that it meant before.

*Nature and Mind: Selected Essays of Frederick J.E. Woodbridge* (p. 7)

Columbia University Press. New York, New York, USA. 1937

**Wordsworth, William** 1770–1850

English poet

To the solid ground

Of Nature trusts the Mind that builds for aye.

*The Complete Poetical Works of William Wordsworth*

A Violent Tribe of Bards on Earth

Crowell. New York, New York, USA. 1888

Come forth into the light of things;  
Let Nature be your teacher.

*The Complete Poetical Works of William Wordsworth*  
The Tables Turned, l. 15–16  
Crowell. New York, New York, USA. 1888

Nature never did betray  
The heart that loved her.

*The Complete Poetical Works of William Wordsworth*  
Lines Composed a Few Miles Above Tintern Abbey  
Crowell. New York, New York, USA. 1888

As in the eye of Nature he has lived,  
So in the eye of Nature let him die!

*The Old Cumberland Beggar* (last lines)  
Crowell. New York, New York, USA. 1888

I have learned  
To look on nature, not as in the hour  
Of thoughtless youth; but hearing oftentimes  
The still, sad music of humanity.

*The Complete Poetical Works of William Wordsworth*  
Lines Composed a Few Miles above Tintern Abbey, l. 88–91  
Crowell. New York, New York, USA. 1888

**Wright, Thomas** 1711–86  
English cosmologist

...three of the finest Sights in Nature, are a rising Sun  
at Sea, a verdant Landskip with a Rainbow, and a clear  
Star-light Evening...

*An Original Theory or New Hypothesis of the Universe*  
Letter the Fifth (p. 37)  
Printed for the Author. London, England. 1750

**Yogananda, Paramahansa** 1893–1952  
Indian yogi

Because modern science tells us how to utilize the powers of Nature, we fail to comprehend the Great Life in back of all names and forms. Familiarity with Nature has bred a contempt for her ultimate secrets; our relation with her is one of practical business. We tease her, so to speak, to discover the ways in which she may be forced to serve our purposes; we make use of her energies, whose Source yet remains unknown. In science our relation with Nature is like that between an arrogant man and his servant; or, in a philosophical sense, Nature is like a captive in the witness box. We cross-examine her, challenge her, and minutely weigh her evidence in human scales that cannot measure her hidden values.

*Autobiography of a Yogi*  
Chapter 35 (pp. 337–338)  
Self-Realization Fellowship. Los Angeles, California, USA. 1971

**Young, Edward** 1683–1765  
English poet and dramatist

The course of nature governs all!  
The course of nature is the heart of God.  
The miracles thou call'st for, this attest;  
For say, could nature nature's course control?

But miracles apart, who sees Him not?

*Night Thoughts*  
Night IX, l. 1,280  
Printed by R. Nobels for R. Edwards. London, England. 1797

Read Nature, Nature is a friend of truth...

*Night Thoughts*  
Printed by R. Nobels for R. Edwards. London, England. 1797

## NEANDERTHAL

**Constable, George** 1941–  
No biographical data available

Place him in a landscape of tall, waving grass, with the sun shining down and the bubbling music of summer in the air. Who is this man? He is an evolutionary bridge, just shy of fully modern status. He is a true human — our ancestor. We should regard him with honour, because almost everything that we are springs directly from him.

*The Neanderthals*  
Chapter Five (p. 134)  
Time-Life Books. New York, New York, USA. 1973

**Margulis, Lynn** 1938–  
American cell biologist and evolutionist

**Sagan, Dorion** 1959–  
American science writer

Neanderthalers, whatever else they were, were people. They were artists and poets and buriers of the dead.

*Microcosmos*  
Chapter 12 (p. 225)  
Summit Books. New York, New York, USA. 1986

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Hairy or grisly, with a big face like a mask, great brow ridges and no forehead, clutching an enormous flint, and running like a baboon with his head forward, and not, like a man, with his head up, he must have been a fearsome creature for our forefathers to come upon.

*The Grisly Man*  
*Storyteller Magazine*, April 1921

## NEBULA

**Flammarion, Camille** 1842–1925  
French astronomer and writer

These are lights which glimmer on the frontiers of creation; they are the beginnings which show us the birth of other universes; they are the voices of the past which speak to us from the depths of the vanished ages.

*Popular Astronomy: A General Description of the Heavens*  
Book VI, Chapter X (p. 668)  
Chatto & Windus. London, England. 1894

**Herschel, Friedrich Wilhelm** 1738–1822  
English astronomer

On the 15<sup>th</sup> of February, 1786, I discovered that one of my planetary nebula, had a spot in the center, which was more luminous than the rest, and with long attention, a very bright, round, well defined center became visible. I remained not a single moment in doubt, but that the bright center was connected with the rest of the apparent disk.

On Nebulous Stars, Properly So Called  
*Philosophical Transactions of the Royal Society of London*, Volume 81, 1791

**Hubble, Edwin Powell** 1889–1953  
American astronomer

The term nebulae offers the values of tradition...the term galaxies, the glamour of romance.

In Timothy Ferris  
*The Red Limit: The Search for the Edge of the Universe*  
Chapter 1 (p. 41)  
William Morrow & Company, Inc. New York, New York, USA. 1977

**Huggins, Sir William** 1824–1910  
English astronomer

On the evening of August 29, 1864, I directed the spectroscope for the first time to a planetary nebula in Draco. I looked into the spectroscope. No spectrum such as I had expected. A single bright line only!...The riddle of the nebulae was solved. The answer, which had come to us in the light itself, read: Not an aggregation of stars, but a luminous gas.

In George E. Hale  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*  
Stellar Evolution in the Light of Recent Research (p. 155)  
Government Printing Office. Washington, D.C. 1903

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

A nebula is, as it were, a universe in the cocoon.

Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
Part II, Book Third, Chapter III (p. 413)  
The Heritage Press. New York, New York, USA. 1961

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

...nebulae are the birthplaces of the stars, so that each nebula consists of stars born and stars not yet born.

*The Universe Around Us*  
Chapter I (p. 67)  
The Macmillan Company. New York, New York, USA. 1929

## NECESSITY

**Huxley, Thomas Henry** 1825–95  
English biologist

Fact I know; and Law I know; but what is this Necessity, save an empty shadow of my own mind's throwing?

*Collected Essays* (Volume 1)  
*Method and Result*  
On the Physical Basis of Life (p. 161)  
Macmillan & Company Ltd. London, England. 1904

## NEURONS

**Sherrington, Sir Charles** 1857–1952  
English physiologist

More than one way for doing the same thing is provided by the natural constitution of the nervous system. This luxury of means of compassing a given combination seems to offer the means of restitution of an act after its impairment or loss in one of its several forms.

*Nobel Lectures, Physiology or Medicine 1922–1941*  
Nobel lecture for award received in 1932  
Inhibition as a Coordinative Factor (p. 289)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## NEUROPHYSIOLOGY

**Hodgkin, Alan L.** 1914–98  
English physiologist and biophysicist

Research in neurophysiology is much more like paddling a small canoe on a mountain river. The river which is fed by many distant springs carries you along all right, though often in a peculiar direction. You have to paddle quite hard to keep afloat. And sooner or later some of your ideas are upset and are carried downstream like an upturned canoe.

*Lex Prix Nobel. The Nobel Prizes in 1963*  
Nobel banquet speech for award received in 1963  
Nobel Foundation. Stockholm, Sweden. 1964

## NEUROSCIENCE

**Young John Zachary** 1907–97  
English zoologist

What would be the use of a neuroscience that cannot tell us anything about love?

*Programs of the Brain*  
Chapter 14 (p. 143)  
Oxford University Press. Oxford, England. 1978

## NEUTRINO

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

The chances of a neutrino actually hitting something as it travels through all this howling emptiness are roughly comparable to that of dropping a ball bearing at random from a cruising 747 and hitting, say, an egg sandwich.

*The Ultimate Hitchhiker's Guide to the Galaxy*

Mostly Harmless

Chapter 3 (p. 656)

The Ballantine Book Company. New York, New York, USA. 2002

### Author undetermined

The neutrino is about as close to intangibility as we can get in this world — the human soul, perhaps is the next stage.

*Engineering and Science*, February 1973 (p. 15)

Mister Jordan

Takes neutrinos

And from those he

Builds the light.

And in pairs they

Always travel

One neutrino's

Out of sight.

In Abraham Pais

*Inward Bound*

To the tune "Mac the Knife" (p. 419)

Clarendon Press. Oxford, England. 1986

### Crane, H. Richard

No biographical data available

Not everyone would be willing to say that he believes in the existence of the neutrino, but it is safe to say there is hardly one of us who is not served by the neutrino hypothesis as an aid in thinking about beta-decay process.

The Energy and Momentum Relations in the Beta-Decay and the Search for the Neutrino

*Review of Modern Physics*, Volume 20, Number 2, March 1948 (p. 278)

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

The neutrino is just barely a fact.

The Two-Neutrino Experiment

*Scientific American*, Volume 208, Number 3, March 1963 (p. 60)

In an ordinary way I might say that I do not believe in neutrinos. But I have to reflect that a physicist may be an artist, and you never know where you are with artists. My old-fashioned kind of disbelief in neutrinos is scarcely enough. Dare I say that experimental physicists will not have sufficient ingenuity to make neutrinos? Whatever I may think, I am not going to be lured into a wager against the skill of the experimenters under the impression that it is a wager against the truth of a theory. If they succeed in making neutrinos, perhaps even in developing industrial application of them, I suppose I shall have to believe — though I may feel they have not been playing quite fair.

*The Philosophy of Physical Science*

Chapter VII, Section II (p. 112)

The Macmillan Company. New York, New York, USA. 1939

### Gamow, George 1904–68

Russian-born American physicist

My mass is zero,

My Charge is the same.

You are my hero,

Neutrino's my name.

*Thirty Years That Shook Physics*

First Part (p. 188)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

...one of the students asked whether the "Chadwick neutron" was the same "neutron" proposed by Pauli for the phenomena of beta transformation. "No," answered Fermi, "*il neutrone di Pauli è mol to più piccolo, cio è un neutrino.*" The name stuck.

The Reality of Neutrinos

*Physics Today*, Volume 1, Number 3, July 1948 (p. 5)

### Haag, Joel

No biographical data available

The Poet, J. Alfred Neutrino

Who subsisted sublimely on vino,

With a spin of one-half

Wrote his own epitaph:

"No rest-ness, no charge, no bambino."

In R.L. Weber

*A Random Walk in Science* (p. 138)

Institute of Physics Publishing. Bristol, England. 1973

### Harari, Haim

Theoretical physicist

Neutrino physics is largely an art of learning a great deal by observing nothing.

*Proceedings 13<sup>th</sup> International Conference on Neutrino Physics and Astrophysics*

Boston, June 5–11, 1999 (p. 574)

### Pauli, Wolfgang 1900–58

Austrian-born physicist

I have committed the ultimate sin, I have predicted the existence of a particle that can never be observed.

In Frank Wilczek and Betsy Devine

*Longing For the Harmonies*

Ego and Survival (p. 65)

W. W. Norton & Company, Inc., Publishers. New York, New York, USA. 1988

### Perry, Georgette

No biographical data available

To trap them is almost impossible.

You may wait for months in a deep mine

Inside an anti-coincidence shield.

No charge deflects them.

Desireless, they cruise through the world

As if it's nothing, not there.

*Twigs*

Neutrinos, 1977

### Pontecorvo, Bruno 1913–93

Italian-born English physicist

It is difficult to find a case where the word “intuition” characterises a human achievement better than in the case of the neutrino invention by Pauli.

*Journal de Physique*

Supplement C8, Volume 48, 1982 (p. 221)

**Reines, Frederick** 1918–

American physicist

**Cowan, C.**

No biographical data available

We are happy to inform you that we have definitely detected neutrinos from fission fragments by observing beta-decay of protons.

Translated by R. Schlapp

In Wolfgang Pauli, Charles Paul Enz and Karl von Meyenn (eds)

*Writings on Physics and Philosophy*

Telegram to W. Pauli

14 June 1956

Springer-Verlag. Berlin, Germany. 1994

**Ruderman, M. A.**

No biographical data available

**Rosenfeld, A. H.**

No biographical data available

Every second, hundreds of billions of these neutrinos pass through each square inch of our bodies, coming from above during the day and from below at night, when the sun is shining on the other side of the earth!

An Elementary Statement on Elementary Particle Physics

*American Scientist*, Volume 48, Number 2, June 1960 (p. 214)

**Stenger, Victor J.** 1935–

Physicist

Neutrinos are neither rare nor anomalous — just hard to detect.

*Physics and Psychics: The Search for a World Beyond the Senses*

Physics and Psychics, Chapter 1 (p. 20)

Prometheus Books. Buffalo, New York, USA. 1990

**Updike, John** 1932–

American novelist, short story writer and poet

Neutrinos, they are very small.

They have no charge and have no mass

And do not interact at all.

*Telephone Poles and Other Poems*

Cosmic Gall (p. 4)

Alfred A. Knopf. New York, New York, USA. 1969

## NEUTRON

**Chadwick, James** 1891–1974

English physicist

I think we shall have to make a real search for the neutron.

In Henry Abraham Boorse and Lloyd Motz

*The World of the Atom*

Letter to E. Rutherford (p. 1293)

Basic Books, Inc., Publishers. New York, New York, USA. 1966

It is to be expected that many of the effects of a neutron in passing through matter should resemble those of a quantum of high energy, and it is not easy to reach the final decision between the two hypotheses. Up to the present, all the evidence is in favor of the neutron, while the quantum hypothesis can only be upheld if the conservation of energy and momentum be relinquished at some point.

Possible Existence of a Neutron *Nature*, Volume 129, Number 3252,

February 27, 1932 (p. 312)

**Gamow, George** 1904–68

Russian-born American physicist

The Neutron has come to be.

Loaded with Mass is he.

Of Charge, forever free.

Pauli, do you agree?

*Thirty Years That Shook Physics*

Finale (p. 213)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

The basic idea is: shove all fundamental difficulties on to the neutron and practice quantum mechanics inside the nucleus.

In Abraham Pais

*Inward Bound*

Letter to Niels Bohr, 20 June 1932 (p. 413)

Clarendon Press. Oxford, England. 1986

**Pauli, Wolfgang** 1900–58

Austrian-born physicist

Dear Radioactive Ladies and Gentlemen,

As the bearer of these lines, for whom I pray the favor of a hearing will explain in more detail, I have...hit upon a desperate remedy for rescuing the “alternation law”.... This is the possibility that there might exist in the nuclei electrically neutral particles, which I call neutrons...

In Charles P. Enz

*No Time to Be Brief*

Chapter 6 (p. 215)

Oxford University Press, Inc. Oxford, England. 2002

## NEWTONIAN MECHANICS

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

However much we may feel free, everything that we do is, according to Laplace, completely determined. Indeed the entire cosmos is reduced to a gigantic clock-work mechanism, with each component slavishly and unflinchingly executing its preprogrammed instructions to

mathematical precision. Such is the sweeping implication of Newtonian mechanics.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*  
Chapter 2 (p. 11)  
Simon & Schuster. New York, New York, USA. 1988

## NIGHT

**Ackerman, Diane** 1948–  
American writer

It is nighttime on the planet Earth. But that is only a whim of nature, a result of our planet rolling in space at 1,000 miles per minute. What we call “night” is the time we spend facing the secret reaches of space, where other solar systems and, perhaps, other planetarians dwell. Don't think of night as the absence of day; think of it as a kind of freedom. Turned away from our sun, we see the dawning of far-flung galaxies. We are no longer sun-blind to the star-coated universe we inhabit.

*A Natural History of the Senses*  
Vision, How to Watch the Sky (p. 245)  
Random House, Inc. New York, New York, USA. 1990

### Amaldi, Ginestra Giovene

The night sky looks like a giant fistful of glittering diamonds flung carelessly upon a black carpet.

*Our World and the Universe Around Us* (Volume 1)  
The Universe (p. 13)  
Abradale Press. New York, New York, USA. 1966

**Atwood, Margaret** 1939–  
Canadian poet, novelist, and critic

Night falls. Or has fallen. Why is it that night falls, instead of rising, like the dawn? Yet if you look east, at sunset, you can see night rising, not falling; darkness lifting into the sky, up from the horizon, like a black sun behind cloud cover. Like smoke from an unseen fire, a line of fire just below the horizon, brushfire or a burning city. Maybe night falls because it's heavy, a thick curtain pulled up over the eyes. Wool blanket. I wish I could see in the dark.

*The Handmaid's Tale*  
Chapter 30 (p. 201)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1986

**Beston, Henry** 1888–1968  
American writer

With lights and ever more lights, we drive the holiness and beauty of night back to the forests and the sea; the villages, the crossroads even, will have none of it.

*The Outermost House*  
Chapter VIII (p. 168)  
Rinehart & Company. New York, New York, USA. 1928

For a moment of night we have a glimpse of ourselves and of our world islanded in its stream of stars — pilgrims

of mortality, voyaging between horizons across the eternal seas of space and time.

*The Outermost House*  
Chapter VIII (p. 176)  
Rinehart & Company. New York, New York, USA. 1928

It is dark to-night, and over the plains of ocean the autumnal sky rolls up the winter stars.

*The Outermost House*  
Chapter I (p. 18)  
Rinehart & Company. New York, New York, USA. 1928

...today's civilization is full of people who have never even seen night. Yet to live thus, to know only artificial night, is as absurd and evil as to know only artificial day.

*The Outermost House*  
Chapter VIII (p. 169)  
Rinehart & Company. New York, New York, USA. 1928

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

Night, the beloved. Night, when words fade and things come alive. When the destructive analysis of day is done, and all that is truly important becomes whole and sound again. When man reassembles his fragmentary self and grows with the calm of a tree.

Translated by Bernard Lamotte  
*Flight to Arras*  
Chapter I (p. 23)  
Reynal & Hitchcock. New York, New York, USA. 1942

**Diamond, Neil** 1941–  
American pop/folk singer, composer, and musician

I thank the Lord for the night time  
To forget the day...

*Classics: The Early Years (1966–1967)*  
Thank the Lord for the Nighttime  
Columbia Records #38792. 1983

**Murdin, Paul**  
British astronomer

Astronomers, literally, and human beings in general, figuratively, need the interruption of the night.

In Derek McNally  
*The Vanishing Universe*  
The Aims of Astronomy in Science and the Humanities: Why Astronomy Must Be Protected (p. 19)  
Cambridge University Press. Cambridge, England. 1994

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

Night is a dead monotonous period under a roof; but in the open world it passes lightly, with its stars and dews and perfumes, and the hours are marked by changes in the face of Nature.

*Travels with a Donkey in the Cevennes*  
A Night Among the Pines (p. 79)  
C. Kegan Paul & Company. London, England. 1879



**Tagore, Rabindranath** 1861–1941  
Indian poet and philosopher

The night is like a dark child just born of her mother day. Millions of stars crowding round its cradle watch it, standing still, afraid lest it should wake up.

*Personality*

The World of Personality (p. 57)

The Macmillan Company. New York, New York, USA. 1917

## NOCTURNAL

**Holland, W. J.**

No biographical data available

There are whole armies of living things, which when we go to sleep, begin to awaken; and when we awaken, go to sleep.

*The Moth Book: A Popular Guide to a Knowledge of the Moths of North America*

The World of the Dark (p. 77)

Doubleday, Page & Company. New York, New York, USA. 1904

There are two worlds; the world of sunshine, and the world of the dark. Most of us are more or less familiarly acquainted with the first; very few of us are well acquainted with the latter. Our eyes are well adapted to serve us in the daylight, but they do not serve us as well in the dark, and we therefore fail to know, unless we patiently study them, what wonders this world of the dark holds within itself.

*The Moth Book: A Popular Guide to a Knowledge of the Moths of North America*

The World of the Dark (p. 77)

Doubleday, Page & Company. New York, New York, USA. 1904

## NONSENSE

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

That which in the physical world shadows the nonsense in the mind affords no ground for its condemnation. In a world of aether and electrons we might perhaps encounter nonsense; we could not encounter damned nonsense.

*The Nature of the Physical World*

Conclusion (p. 345)

The Macmillan Company. New York, New York, USA. 1930

## NOTATION

**Brough, J. C.**

No biographical data available

Though Frankland's notation commands admiration,  
As something exceedingly clever,  
And Mr. Kay Shuttleworth praises its subtle worth,  
I give it up sadly for ever:  
Its brackets and braces, and dashes and spaces,

And letters decreased and augmented  
Are grimly suggestive of Lunes to make restive  
A chemical printer demented.  
I've tried hard, but vainly, to realize plainly  
Those bonds of atomic connexion  
Which Crum Brown's clear vision discerns with precision  
Projecting in every direction.

In C.A. Russell

*The History of Valency*

Chapter V (p. 106)

Humanities Press. New York, New York, USA. 1971

**Cajori, Florian** 1859–1930

Swiss-born American educator and mathematician

The miraculous powers of modern calculation are due to three inventions: the Arabic Notation, Decimal Fractions, and Logarithms.

*A History of Mathematics*

Europe During the Sixteenth, Seventeenth and Eighteenth Centuries (p. 149)

The Macmillan Company. London, England. 1919

**Defoe, Daniel** 1660–1731

English pamphleteer, journalist, and novelist

I cut every day a notch with my knife, and every seventh notch was as long again as the rest, and every first day of the month, as long again as that long one; and thus I kept my calendar, or weekly, monthly, and yearly reckoning of time.

*Robinson Crusoe* (p. 46)

Dodd, Mead & Company. New York, New York, USA. 1946

**Dieudonné, Jean** 1906–92

French mathematician and educator

This difficulty lead very gradually to the recognition of the need for a shorthand to make the sequence of operations easily comprehensible: here we have the problem of notation, which crops up again after every introduction of new objects, and which will probably never cease to torment mathematicians.

*Mathematics — The Music of Reason*

Chapter III, Section 7 (p. 49)

Springer-Verlag. Berlin, Germany. 1992

**Frayn, Michael** 1933–

English dramatist

We look at the taciturn, inscrutable universe, and cry,  
“Speak to me!”

*Constructions*

Number 7

Wildwood House. London, England. 1974

**Glaisher, James Whitbread Lee** 1848–1928

English mathematician

I have great faith in the power of well-chosen notation to simplify complicated theories and to bring remote ones near and I think it is safe to predict that the increased

knowledge of principles and the resulting improvements in the symbolic language of mathematics will always enable us to grapple satisfactorily with the difficulties arising from the mere extent of the subject.

Presidential Address, British Association for the Advancement of Science *Nature*, Section A, Volume 42, Number 1089, September 11, 1890 (p. 466)

**Holland, John** 1929–  
American computer scientist

Mathematical notation is for the scientist what musical notation is for the composer.

*Emergence: From Chaos to Order*

Chapter 1 (p. 15)

Addison-Wesley Publishing, Inc. Reading, Massachusetts, USA. 1998

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...for a good notation has a subtlety and suggestiveness which make it seem, at times, like a live teacher. Notational irregularities are often the first sign of philosophical errors, and a perfect notation would be a substitute for thought.

In Ludwig Wittgenstein

*Tractatus Logico-Philosophicus*

Introduction (pp. 17–18)

Routledge & Kegan Paul Ltd. London, England. 1922

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Before the introduction of the Arabic notation, multiplication was difficult, and the division even of integers called into play the highest mathematical faculties. Probably nothing in the modern world could have more astonished a Greek mathematician than to learn that, under the influence of compulsory education, the whole population of Western Europe, from the highest to the lowest, could perform the operation of division for the largest numbers. This fact would have seemed to him a sheer impossibility.... Our modern power of easy reckoning with decimal fractions is the most miraculous result of a perfect notation.

*An Introduction to Mathematics*

Chapter 5 (p. 39)

Oxford University Press, Inc. New York, New York, USA. 1958

## NOVAE

**Gaposchkin, Sergei** 1898–1984  
Russian-born astronomer

When the greatest, the cosmic,  
And the most fascinating explosion  
Has been probed by the fabulous light  
Of the human (but god-like) mind,  
It will be remembered  
That you shouldered the task  
Of exploring the Novae

With intrepid boldness  
And richness of thought.

In Arthur Beer

*Vistas in Astronomy* (Volume 2)

Novae Observed (p. 1506)

Pergamon Press. New York, New York, USA. n.d.

## NUCLEUS

**Cudmore, Lorraine Lee**  
American cell biologist

Despite its comparatively prosaic name, like the unassuming nanny who turns out to be the head of the espionage network, the nucleus is the structural and actual center of the cell.

*The Center of Life: A Natural History of the Cell*

Cellular Evolution (p. 50)

New York Times Book Company. New York, New York, USA. 1977

**Rutherford, Ernest** 1871–1937  
English physicist

It is my personal conviction that if we knew more about the nucleus, we should find it much simpler than we suppose. I am always a believer in simplicity, being a simple fellow.

*Guttingen Lecture*

December 14, 1931

## NULL HYPOTHESIS

**Dunnette, Marvin D.**

...most of us still remain content to build our theoretical castles on the quicksand of merely rejecting the null hypothesis.

Fads, Fashions, and Folderol in Psychology

*American Psychologist*, Volume 21, 1966 (p. 345)

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

In relation to any experiment we may speak of this hypothesis as the “null hypothesis,” and it should be noted that the null hypothesis is never proved or established, but is possibly disproved, in the course of experimentation. Every experiment may be said to exist only in order to give the facts a chance of disproving the null hypothesis.

*The Design of Experiments*

II, 8 (p. 16)

Hafner Publishing Company. New York, New York, USA. 1971

**Tukey, John W.** 1915–2000  
American statistician

The worst, i.e., most dangerous, feature of “accepting the null hypothesis” is the giving up of explicit

uncertainty.... Mathematics can sometimes be put in such black-and-white terms, but our knowledge or belief about the external world never can.

The Philosophy of Multiple Comparisons

*Statistical Science*, Volume 6, Number 1, February 1991 (p. 100–101)

## NUMBER

**Aeschylus** 525 BCE–426 BCE

Greek playwright

...but utterly without knowledge

Moiled, until I the rising of the stars

Showed them, and when they set, Though much obscure.

Moreover, number, the most excellent

Of all inventions, I for them devised,

And gave them writing that retaineth all,

The serviceable mother of the Muse.

In *Great Books of the Western World* (Volume 5)

*The Plays of Aeschylus*

Prometheus Bound, 457

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Archimedes of Syracuse** 287 BCE–212 BCE

Sicilian mathematician

There are some, King Gelon, who think that the number of the sand is infinite in multitude; and I mean by the sand not only that which exists about Syracuse and the rest of Sicily but also that which is found in every region inhabited or uninhabited. Again there are some who, without regarding it as infinite, yet think that no number has been named which is great enough to exceed its multitude.... But I will try to show you by means of geometrical proofs, which you will be able to follow, that, of the numbers named by me, and given in the work which I sent to Zeuxippus, some exceed not only the number of the mass of sand equal in magnitude to the earth, but also that of a mass equal in magnitude to the universe.

*The Works of Archimedes*

The Sand-Reckoner

At The University Press. Cambridge, England. 1897

**Aristotle** 384 BCE–322 BCE

Greek philosopher

...the attributes of numbers are present in a musical scale and in the heavens...

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book XIV, Chapter 3 (p. 622)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Asimov, Isaac** 1920–92

American author and biochemist

Human beings are very conservative in some ways and virtually never change numerical conventions once they

grow used to them. They even come to mistake them for laws of nature.

*Foundation and Earth* (p. 376)

Doubleday & Company, Inc. Garden City, New York, USA. 1986

**Auster, Paul** 1947–

American writer

I've dealt with numbers all my life, of course, and after a while you begin to feel that each number has a personality of its own. A twelve is very different from a thirteen, for example. Twelve is upright, conscientious, intelligent, whereas thirteen is a loner, a shady character who won't think twice about breaking the law to get what he wants. Eleven is tough, an outdoorsman who likes tramping through woods and scaling mountains; ten is rather simpleminded, a bland figure who always does what he's told; nine is deep and mystical, a Buddha of contemplation.... Numbers have souls, and you can't help but get involved with them in a personal way.

*The Music of Chance*

Chapter 4 (p. 73)

Viking Penguin. New York, New York, USA. 1990

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

...insomuch as we see in the schools both of Democritus and of Pythagoras, that the one did ascribe figure to the first seeds of things, and the other did suppose numbers to be the principles and originals of things.

In *Great Books of the Western World* (Volume 30)

*The Advancement of Learning*

Second Book, Chapter VIII, Section 1 (p. 46)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Barrett-Browning, Elizabeth** 1806–61

English poet

How do I love thee?

Let me count the ways.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Sonnets from the Portuguese, XLIII

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Begley, Sharon** 1956–

Science editor

...number theory...is a field of almost pristine irrelevance to everything except the wondrous demonstration that pure numbers, no more substantial than Plato's shadows, conceal magical laws and orders that the human mind can discover after all.

New Answer for an Old Question

*Newsweek*, 5 July, 1993 (p. 53)

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

Roughly it amounts to this: mathematical analysis as it works today must make use of irrational numbers (such

as the square root of two); the sense if any in which such numbers exist is hazy. Their reputed mathematical existence implies the disputed theories of the infinite. The paradoxes remain. Without a satisfactory theory of irrational numbers, among other things, Achilles does not catch up with the tortoise, and the earth cannot turn on its axis. But as Galileo remarked, it does. It would seem to follow that something is wrong with our attempts to compass the infinite.

*Debunking Science*

University of Washington Book Store. Seattle, Washington, USA. 1930

The algebraic numbers are spotted over the plane like stars against a black sky; the dense blackness is the firmament of the transcendentals.

*Men of Mathematics* (p. 569)

Simon & Schuster. New York, New York, USA. 1937

The next fundamental assumption of the Pythagoreans lies much deeper, so deep in fact that civilized man can scarcely hope to fetch it up to the full light of reason. Odd numbers are male; even numbers, female. We can only ask why, expecting no answer except possibly a hesitant allusion to a vestigial phallicism or a forgotten Orphism.

*The Magic of Numbers*

Chapter 14 (p. 155)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1946

The theory of numbers is the last great uncivilized continent of mathematics. It is split up into innumerable countries, fertile enough in themselves, but all the more or less indifferent to one another's welfare and without a vestige of a central, intelligent government. If any young Alexander is weeping for a new world to conquer, it lies before him.

*The Queen of the Sciences*

Chapter VII (p. 91)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

### **Berry, Daniel M.**

No biographical data available

### **Yavne, Moshe**

No biographical data available

In the beginning, everything was void, and J. H. W. H. Conway began to create numbers. Conway said, "Let there be two rules which bring forth all numbers large and small. This shall be the first rule: Every number corresponds to two sets of previously created numbers, such that no member of the left set is greater than or equal to any member of the right set.

And the second rule shall be this: One number is less than or equal to another number if and only if no member of the first number's left set is greater than or equal to the second number, and no member of the second number's right set is less than or equal to the first number." And Conway examined these two rules he had made, and behold! they were very good.

The Conway Stones: What the Original Hebrew May Have Been

*Mathematics Magazine*, Volume 49, Number 4, September 1976 (p. 208)

### **Boethius** ca. 475–524

Roman philosopher and statesman

...in the science of numbers ought to be preferred as an acquisition before all others, because of its necessity and because of the great secrets and other mysteries which there are in the properties of numbers. All sciences partake of it, and it has need of none.

In J Fauvel and J Gray

*The History of Mathematics: A Reader*

Chapter 7

Section 7.B2 (p. 247)

Macmillan Press Ltd. Houndmills, England. 1987

### **Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

One grain of wheat does not constitute a pile, nor do two grains, nor three and so on. On the other hand, everyone will agree that a hundred million grains of wheat do form a pile. What, then, is the threshold number? Can we say that 325,647 grains of wheat do not form a pile, but that 325,648 grains do? If it is impossible to fix a threshold number, it will also be impossible to know what is meant by a pile of wheat; the words can have no meaning, although, in certain extreme cases, everybody will agree about them.

Translated by Douglas Scott

*Probability and Certainty*

Chapter 8 (p. 98)

Walker & Company. New York, New York, USA. 1963

All of mathematics can be deduced from the sole notion of an integer; here we have a fact universally acknowledged today.

*A l'analyse arithmetique du continu*

Oeuvres 3, 1439–1485

Publisher undetermined

### **Borges, Jorge Luis** 1899–1986

Argentine writer

The man who has learned that three plus one are four doesn't have to go through a proof of that assertion with coins, or dice, or chess pieces, or pencils. He knows it, and that's that. He cannot conceive a different sum. There are mathematicians who say that three plus one is a tautology for four, a different way of saying "four"... if three plus one can be two, or fourteen, then reason is madness.

Translated by Andrew Hurley

*Shakespeare's Memory*

Blue Tigers

Penguin. 1999

### **Bridgman, Percy Williams** 1882–1961

American physicist

Nature does not count nor do integers occur in nature. Man made them all, integers and all the rest, Kroneker to the contrary notwithstanding.

*The Way Things Are*

Chapter IV (p. 100)

Harvard University Press. Cambridge, Massachusetts, USA. 1959

**Buchanan, Scott** 1895–1968

American educator and philosopher

Numbers are not just counters; they are elements in a system.

*Poetry and Mathematics*

Chapter III

The University of Chicago Press. Chicago, Illinois, USA. 1975

The theory of number is the epipoem of mathematics.

*Poetry and Mathematics*

Chapter III

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Burke, Edmund** 1729–97

English statesman and philosopher

The starry heaven, though it occurs so very frequently to our view, never fails to excite an idea of grandeur. This cannot be owing to the stars themselves, separately considered. The number is certainly the cause. The apparent disorder augments the grandeur.

*On the Sublime and the Beautiful*

Part II, Sec. XIII (p. 139)

Printed for F.C. and J. Rivington and others. London, England. 1812

**Butterworth, Brian**

Neuroscientist

Although the idea that we have no bananas is unlikely to be a new one, or one that is hard to grasp, the idea that no bananas, no sheep, no children, no prospects are really all the same, in that they have the same numerosity, is a very abstract one.

*The Mathematical Brain*

Macmillan & Company Ltd. London, England. 1999

**Clawson, Calvin C.**

No biographical data available

Numbers, in fact, are the atoms of the universe, combining with everything else.

*Mathematical Mysteries: The Beauty and Magic of Numbers*

Chapter One (p. 22)

Plenum Press. New York, New York, USA. 1996

**Comte, Auguste** 1798–1857

French philosopher

There is no inquiry which is not finally reducible to a question of Numbers; for there is none which may not be conceived of as consisting in the determination of quantities by each other, according to certain relations.

*The Positive Philosophy of Auguste Comte* (Volume 1)

Book I, Chapter I (pp. 42–43)

John Chapman. London, England. 1853

**Dantzig, Tobias** 1884–1956

Russian mathematician

To attempt to apply rational arithmetic to a problem in geometry resulted in the first crisis in the history of mathematics. The two relatively simple problems — the determination of the diagonal of a square and that of the circumference of a circle — revealed the existence of new mathematical beings for which no place could be found within the rational domain.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 44)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

At this stage it might well seem that the infinity of natural numbers really is so big that it cannot be made any bigger, but this is wrong. In a celebrated theorem, Georg Cantor proved the seemingly impossible — that there are infinite sets which are so big that their elements cannot be counted, even with the infinity of natural numbers at one's disposal.

*The Edge of Infinity*

Chapter 2 (p. 30)

Simon & Schuster. New York, New York, USA. 1981

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

You can be moved to tears by numbers — provided they are encoded and decoded fast enough.

*River Out of Eden: A Darwinian View of Life*

Chapter 1 (p. 14)

Basic Books. New York, New York, USA. 1995

**Dedekind, Richard** 1831–1916

German mathematician

I regard the whole of arithmetic as a necessary, or at least natural, consequence of the simplest arithmetical act, that of counting, and counting itself as nothing else than the successive creation of the infinite series of positive integers in which each individual is defined by the one immediately preceding...

Translated by Wooster Woodruff Beman

*Essays on the Theory of Numbers*

Chapter I (p. 4)

The Open Court Publishing Company. Chicago, Illinois, USA. 1901

...numbers are free creations of the human mind; they serve as a means of apprehending more easily and more sharply the difference of things.

Translated by Wooster Woodruff Beman

*Essays on the Theory of Numbers*

The Nature and Meaning of Numbers

Preface to the First Edition (p. 31)

The Open Court Publishing Company. Chicago, Illinois, USA. 1901

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

With numbers you can do anything you like. Suppose I have the sacred number 9 and I want to get a number 1314, date of the execution of Jacques de Molay — a date dear to anyone who, like me, professes devotion to the Templar tradition of knighthood. What do I do? I multiply nine by one hundred and forty-six, the fateful day of destruction of Carthage. How do I arrive at this? I divided thirteen hundred and fourteen by two, by three, *et cetera*, until I found a satisfying date. I could also have divided thirteen hundred and fourteen by 6.28, the double of 3.14, and I would have got two hundred and nine. That is the year Attalus I, king of Pergamon, ascended the throne. You see?

Translated by William Weaver

*Foucault's Pendulum*

Chapter 48 (pp. 288–289)

Harcourt Brace Jovanovich. San Diego, California, USA. 1988

### **Enzensberger, Hans Magnus** 1929–

German writer, poet, translator, and editor

Still in a daze the next morning, Robert said to his mother, “Do you know the year I was born? It was  $6 \times 1$  and  $8 \times 10$  and  $9 \times 100$  and  $1 \times 1000$ .” I don’t know what’s got into the boy lately,” said Robert’s mother, shaking her head. “Here,” she added, handing him a cup of hot chocolate, “maybe this will help. You say the oddest things.” Robert drank his hot chocolate in silence. There are some things you can’t tell your mother, he thought.

*The Number Devil*

The Second Night (p. 46)

Henry Holt & Company. New York, New York, USA. 1998

### **Euler, Leonhard** 1707–83

Swiss mathematician and physicist

...we should take great care not to accept as true such properties of the numbers which we have discovered by observation and which are supported by induction alone. Indeed, we should use such a discovery as an opportunity to investigate more exactly the properties discovered and to prove or disprove them; in both cases we may learn something useful.

In G. Polya

*Induction and Analogy in Mathematics* (Volume 1)

Chapter I (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 1954

### **Euripides** ca. 480 BCE–406 BCE

Greek playwright

Numbers are a fearful thing, and joined to craft a desperate foe.

In *Great Books of the Western World* (Volume 5)

*The Plays of Euripides*

Hecuba, l. 884

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Fabilli, Mary**

No biographical data available

What would I do without numbers?

A 7 there and a 3 here,

days in a month

months in a year

AD and BC

and all such symbols.

In Ernest Robson and Jet Wimp

*Against Infinity*

Numbers (p. 22)

Primary Press. Parker Ford, Pennsylvania, USA. 1979

### **Ferguson, Kitty**

Science writer

Letting numbers take us where we can’t go in person — whether that’s to the top of a windmill or to the origin and borders of the universe — has been and still is one of humankind’s favorite intellectual adventures.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*

Prologue (p. 3)

Walker & Company. New York, New York, USA. 1999

### **Feynman, Richard P.** 1918–88

American theoretical physicist

You know...there are about a hundred billion stars in the galaxy — ten to the eleventh power. That used to be considered a huge number. Today it’s less than the national debt. We ought to call them “economical numbers.”

In David L. Goodstein and Judith R. Goodstein

*Feynman's Lost Lecture: The Motion of Planets Around the Sun*

Chapter 2 (p. 62)

W.W. Norton & Company, Inc. New York, New York, USA. 1996

### **Gass, Fredrick**

No biographical data available

Adam, did you find a good system for naming ordinals?

A: Ordinals? I thought you said “animals.”

Constructive Ordinal Notation Systems

*Mathematics Magazine*, Volume 57, Number 3, May 1984 (p. 131)

### **Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

And he who is versed in the science of numbers can tell of the regions of weight and measures, but he cannot conduct you thither.

For the vision of one man lends not its wings to another man.

*The Prophet*

On Teaching (pp. 56–57)

Alfred A. Knopf. New York, New York, USA. 1969

### **Ginsey, Gurney**

No biographical data available

There are numbers I don’t trust...take

One — too proud, too pointed, much too

Sure that all begins with him — and  
Two, that sits cross-legged on the  
Path and sneers as though he knows all secrets...

Numbers

*Mathematics Magazine*, Volume 38, Number 3, May 1965 (p. 168)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Numbers have undoubted powers to beguile and benumb, but critics must probe behind numbers to the character of arguments and the biases that motivate them.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 8 (p. 144)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

**Hales, Stephen** 1677–1761

English physiologist and clergyman

...since we are assured that the all-wise Creator has observed the most exact proportions, of number, weight, and measure, in the make of all things; the most likely way therefore, to get any insight into the nature of these parts of the creation, which come within our observation, must in all reason be to number, weigh and measure.

*Vegetable Statics*

The Introduction (p. xxxi)

The Scientific Book Guild. London, England. 1961

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

The elementary theory of numbers should be one of the very best subjects for early mathematical instruction. It demands very little previous knowledge; its subject matter is tangible and familiar; the processes of reasoning which it employs are simple, general and few; and it is unique among the mathematical sciences in its appeal to natural human curiosity. A month's intelligent instruction in the theory of numbers ought to be twice as instructive, twice as useful, and at least ten times as entertaining as the same amount of calculus for engineers.

An Introduction to the Theory of Numbers

*Bulletin of the American Mathematical Society*, Volume 35, 1929 (p. 818)

**Henle, James M.**

American mathematician

Belief in a large number is no more daring, I should think, than belief in Tolstoy's *War and Peace*.

The Happy Formalist

*The Mathematical Intelligencer*, Volume 13, Number 1, Winter 1991

(p. 14)

**Hofstadter, Douglas** 1945–

American cognitive scientist and author

People enjoy inventing slogans which violate basic arithmetic but which illustrate “deeper” truths, such as “1 and 1 make 1” (for lovers), or “1 plus 1 plus 1 equals 1” (the

Trinity)... Two raindrops running down a window pane merge; does one plus one make one? A cloud breaks up into two clouds — more evidence for the same? ...Numbers as realities misbehave. However, there is an ancient and innate sense in people that numbers ought not to misbehave. There is something clean and pure in the abstract notion of number...and there ought to be a way of talking about numbers without always having the silliness of reality come in and intrude. The hard-edged rules that govern “ideal” numbers constitute arithmetic, and their more advanced consequences constitute number theory.

*Godel, Escher, Bach: An Eternal Golden Braid*

Part I, Chapter II (p. 56)

Basic Books, Inc. New York, New York, USA. 1979

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Dr. Hooke, the famous English mathematician and philosopher, made a calculation of the number of separate ideas the mind is capable of entertaining, which he estimated as 3,155,760,000.

*Pages from an Old Volume of Life*

Chapter VIII (p. 274, fn a)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Hume, David** 1711–76

Scottish philosopher and historian

...I observe that when we mention any great number, such as a thousand, the mind has generally no adequate idea of it, but only a power of producing such an idea by its adequate idea of the decimals, under which the number is comprehended.

*A Treatise of Human Nature*

Book I, Part I, Section VII (p. 70)

Penguin Books. Baltimore, Maryland, USA. 1969

**Huxley, Aldous** 1894–1963

English writer and critic

A million million spermatozoa,

All of them alive:

Out of their cataclysm but one poor Noah

Dare hope to survive.

And among that billion minus one

Might have chanced to be

Shakespeare, another Newton, a new Donne —

But the One was Me.

*Stories, Essays, and Poems*

Fifth Philosopher's Song (p. 410)

J.M. Dent & Sons Ltd. London, England. 1937

**Jacobi, Karl Gustav Jacob** 1804–51

German mathematician

The God that reigns in Olympus is Number Eternal.

In Tobias Dantzig

*Number: The Language of Science* (4<sup>th</sup> edition)

Chapter 10 (p. 179)

The Macmillan Company. New York, New York, USA. 1954

**Jevons, William Stanley** 1835–82

English economist and logician

Number is but another name for diversity.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter VIII (p. 156)

Macmillan &amp; Company. London, England. 1887

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

Round numbers, she said, are always false.

In Mrs. Piozzi, Richard Cumberland, Bishop Percy and other book

*Johnsoniana*

Apothegms, Sentiment, Opinions, &amp;c

G. Bell. London, England. 1884

**Juster, Norton** 1929–

American architect and writer

“How terribly confusing,” he cried. “Everything here is called exactly what it is. The triangles are called triangles, the circles are called circles, and even the same numbers have the same name. Why, can you imagine what would happen if we named all the twos Henry or George or Robert or John or lots of other things? You’d have to say Robert plus John equals four, and if the four’s name were Albert, things would be hopeless.”

*The Phantom Tollbooth*

Chapter 14 (pp. 173–174)

Alfred A. Knopf. New York, New York, USA. 1989

**Kaminsky, Kenneth**

American mathematics professor, writer, and editor

How poor were we? Why, we were so poor we only had imaginary numbers to play with.

Professor Fogelfro

*Mathematics Magazine*, Volume 69, Number 4, October 1996 (p. 303)**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

When you can measure what you are speaking about and express it in numbers you know something about it; but when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind: it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.

*Popular Lectures and Addresses* (Volume 1)

Lecture, Institution of Civil Engineering

3 May 1883 (p. 73)

Macmillan &amp; Company Ltd. London, England. 1894

**Klein, William**

No biographical data available

Numbers are friends, for me, more or less. It doesn’t mean the same for you, does it — 3,844? For you it’s just a three and an eight and a four and a four. But I say, “Hi! 62 squared.”

In Oliver Sacks

*The Man Who Mistook His Wife for a Hat and Other Clinical Tales*

The Twins (pp. 198–199)

Summit Books. New York, New York, USA. 1985

**Kline, Morris** 1908–92

American mathematics professor and writer

The theory of infinite numbers is only one of the creations of the nineteenth-century critical thinkers. Almost bizarre in its contents it is nevertheless both logical and useful.

*Mathematics in Western Culture*

Chapter XXV (p. 409)

Oxford University Press, Inc. New York, New York, USA. 1953

**Kronecker, Leopold** 1823–91

German mathematician

Number theorists are like lotus-eaters — having once tasted of this food they can never give it up.

In Howard W. Eves

*Mathematical Circles* (Volume 2)

Mathematical Circles Squared

302 (p. 149)

The Mathematical Association of America, Inc. 2003

*Die Ganzen Zahlen hat Gott gemacht, andere ist Menschenwerk.*

God created the natural numbers; everything else is man’s handiwork.

In Sir Arthur Stanley Eddington

*The Nature of the Physical World* (p. 246)

At The University Press. Cambridge, England. 1929

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

There is an old saying that God created everything according to weight, measure and number.

*Philosophical Papers and Letters* (Volume 1)

On the General Characteristic (pp. 339–340)

The University of Chicago Press. Chicago, Illinois, USA. 1956

Some things cannot be weighed, as having no force and power; some things cannot be measured, by reason of having no parts; but there is nothing which cannot be numbered.

In G. Frege

*The Foundations of Arithmetic* (p. 31e)

Northwestern University Press. Evanston, Illinois, USA. 1968...a

miracle of analysis, a monster of the ideal world, almost an amphibian between being and not being.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 7, Section 7.1 (p. 168)

Macmillan &amp; Company Ltd. New York, New York, USA. 1967

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

People don’t like to choose lot #1 in a lottery. “Choose it,” Reason cries loudly. “It has as good a chance of win-



ning the 12,000 thalers as any other.” “In Heaven’s name don’t choose it,” *a je ne sais quoi* whispers. “There’s no example of such little numbers being listed before great winnings.” And actually no one takes it.

*Lichtenberg: Aphorisms & Letters*

Aphorisms (p. 46)

Jonathan Cape. London, England. 1969

### **Locke, John** 1632–1704

English philosopher and political theorist

For number applies itself to men, angels, actions, thoughts; everything that either doth exist, or can be imagined.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book II, Chapter XVI, Section 1 (p. 165)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Longfellow, Henry Wadsworth** 1807–82

American poet

Tell me not, in mournful numbers,  
Life is but an empty dream!

*The Poetical Works of Henry Wadsworth Longfellow*

A Psalm of Life, Stanza 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

### **Maxwell, James Clerk** 1831–79

Scottish physicist

Thus numbers may be said to rule the whole world of quantity, and the four rules of arithmetic may be regarded as the complete equipment of the mathematician.

In E.T. Bell

*Men of Mathematics* (p. xv)

Simon & Schuster. New York, New York, USA. 1937

### **Mazur, Barry** 1937–

American mathematician

In the history of the concept of number, number has been adjective (three cows, three monads) and noun (three, pure and simple), and now . . . , number seems to be more like a verb (to triple).

*Imagining Numbers*

Part II, Chapter 8, Section 37 (p. 138)

Farrar, Straus & Giroux. New York, New York, USA. 2003

### **Parker, F. W.**

No biographical data available

Number was born in superstition and reared in mystery . . . numbers were once made the foundation of religion and philosophy, and the tricks of figures have had a marvelous effect on a credulous people.

*Talks on Pedagogics*

Chapter IV (p. 64)

A.S. Barnes & Company. New York, New York, USA. 1909

### **Paulos, John Allen** 1945–

American mathematician

The mathematician G. H. Hardy was visiting his protégé, the Indian mathematician Ramanujan, in the hospital. To make small talk, he remarked that 1729, the number of the taxi which had brought him, was a rather dull number, to which Ramanujan replied immediately, “No, Hardy! It is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways.

*Innumeracy*

Examples and Principles (p. 6)

Hill & Wang. New York, New York, USA. 1988

### **Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The rudest numerical scales, such as that by which the mineralogists distinguish different degrees of hardness, are found useful. The mere counting of pistils and stamens sufficed to bring botany out of total chaos into some kind of form. It is not, however, so much from counting as a measuring, not so much from the conception of number as from that of continuous quantity, that the advantage of mathematical treatment comes. Number, after all, only serves to pin us down to a precision in our thoughts which, however beneficial, can seldom lead to lofty conceptions, and frequently descends to pettiness.

*Chance, Love and Logic: Philosophical Essays*

The Doctrine of Chances (pp. 61–62)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

### **Philolaus** ca. 480 BCE

Greek philosopher

All things which can be known have number; for it is not possible that without number anything can be either conceived or known.

In Carl B. Boyer

*A History of Mathematics* (p. 60)

John Wiley & Sons, Inc. New York, New York, USA. 1968

### **Plato** 428 BCE–347 BCE

Greek philosopher

SOC: And all arithmetic and calculations have to do with number?

GLAUCON: Yes.

SOC: And they appear to lead the mind towards truth?

GLAUCON: Yes, in a very remarkable manner.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 525 (p. 393)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Pliny (C. Plinius Secundus)** 23–79

Roman savant and writer

Why do we believe that in all matters the odd numbers are more powerful.

*Natural History*

Volume 8, Book XXVIII, sec 23

Harvard University Press. Cambridge, Massachusetts, USA. 1947

**Plotinus** ca. 205–70  
Egyptian-Roman philosopher

Objects of sense are not unlimited and therefore the Number applying to them cannot be so. Nor is an enumerator able to number to infinity; though we double, multiply over and over again, we still end with a finite number...

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Sixth Ennead VI.2 (p. 311)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pope, Alexander** 1688–1744  
English poet

As yet a child, nor yet a fool to fame,  
I lisp'd in numbers, for the numbers came.

*The Complete Poetical Works*

An Epistle to Dr. Arbuthnot, l. 127

Houghton Mifflin Company. New York, New York, USA. 1903

**Proclus** 411–485  
Greek philosopher

Wherever there is number, there is beauty.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 131)

Oxford University Press, Inc. New York, New York, USA. 1972

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

We are the finite numbers.

We are the stuff of the world.

Whatever confusion cumbers

The earth is by us unfurled.

We revere our master Pythagoras

And deeply despise every hag or ass.

Not Endor's witch nor Balaam's mount

We recognize as wisdom's fount.

But round and round in endless baller

We move like comets seen by Halley.

And honored by the immortal Plato

We think no later mortal great-o.

We follow the laws

Without a pause,

For we are the finite numbers.

*The Collected Stories of Bertrand Russell*

Nightmares of Eminent Persons, The Mathematician's Nightmare (p. 43)

George Allen & Unwin Ltd. London, England. 1972

**Sagan, Carl** 1934–96  
American astronomer and author

Hiding between all the ordinary numbers was an infinity of transcendental numbers whose presence you would never have guessed until you looked deeply into mathematics.

Contact: A Novel

Chapter 1 (p. 21)

Simon & Schuster. New York, New York, USA. 1985

**Sandburg, Carl** 1878–1967  
American poet and biographer

He was born to wonder about numbers.

*Complete Poems*

Number Man

Harcourt, Brace. New York, New York, USA. 1950

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

This is the third time; I hope good luck lies in odd numbers.... There is a divinity in odd numbers, either in nativity, chance or death.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

The Merry Wives of Windsor

Act V, Scene i, l. 2–3

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...I am ill at these numbers.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Hamlet, Prince of Denmark

Act II, Scene ii, l. 120

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Smith, Adam (George J. W. Goodman)**

...those who live by numbers can also perish by them and it is a terrifying thing to have an adding machine write an epitaph, either way.

*The Money Game*

Chapter 7 (p. 84)

Random House, Inc. New York, New York, USA. 1968

**Stoney, George Johnstone** 1826–1911  
Irish physicist

When interpreting nature's work, we are obliged frequently to speak of high numbers and small fractions.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*

Survey of That Part of the Range of Nature's Operations Which Man Is Competent to Study (p. 207)

Government Printing Office. Washington, D.C. 1901

**Sukoff, Albert**

No biographical data available

Huge numbers are commonplace in our culture, but oddly enough the larger the number the less meaningful it seems to be.... Anthropologists have reported on the primitive number systems of some aboriginal tribes. The Yancos in the Brazilian Amazon stop counting at three. Since their word for "three" is "*poettarrarorincoaroac*," this is understandable.

Lotsa Hamburgers

*Saturday Review of the Society*, March 1973 (p. 6)

**Syngé, John L.** 1897–1995  
Irish mathematician and physicist

The northern ocean is beautiful, said the Orc, and beautiful the delicate intricacy of the snowflake before it melts and perishes, but such beauties are as nothing to him who delights in numbers, spurning alike the wild irrationality of life and the baffling complexities of nature's laws.

*Kandelman's Krim*

Chapter Six (p. 101)

Jonathan Cape. London, England. 1957

### The Bible

...*Mene, mene, tekel and u-pharsin*

[Numbered, Numbered, Weighed, Divided]

*The Revised English Bible*

Daniel 5:25

Oxford University Press, Inc. Oxford, England. 1989

**Virgil** 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

Uneven numbers are the god's delight.

In *Great Books of the Western World* (Volume 13)

*The Eclogues*

VIII, l. 77

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Waismann, Friedrich** 1896–1959

Austrian mathematician, physicist, and philosopher

Will anyone seriously assert that the existence of negative numbers is guaranteed by the fact that there exist in the world hot assets and cold, and debts? Shall we refer to these things in the structure of arithmetic? Who does not see that thereby an entirely foreign element enters into arithmetic, which endangers the pureness and clarity of its concepts?

*Introduction to Mathematical Thinking: The Formation of Concepts in Modern Mathematics*

Chapter 2 (p. 15)

Frederick Ungar Publishing, Company. New York, New York, USA. 1951

### Williams, Charles

No biographical data available

Nought usually comes at the beginning, Ralph said.

Not necessarily, said Sibyl. It might come anywhere. Nought isn't a number at all. It's the opposite of number.

Nancy looked up from the cards. Got you, aunt, she said. What about ten? Nought's a number there — it's part of ten.

Well, if you say that any mathematical arrangement of one and nought really makes ten — Sibyl smiled. Can it possibly be more than a way of representing ten?

*The Greater Trumps*

Victor Gollancz. London, England. 1932

## NUMBER, FIBONACCI

**Baumel, Judith** 1956–

American poet

Learn the particular strength of the Fibonacci series, a balanced spiraling outward of shapes, those golden numbers which describe dimensions of sea shells, rams' horns, collections of petals and generations of bees.

*The Weight of Numbers*

Fibonacci (p. 21)

Wesleyan University Press, Middletown, Connecticut, USA; 1988

**Lindon, J. A.**

No biographical data available

Each wife of Fibonacci,

Eating nothing that wasn't starchy

Weighed as much as the two before her.

His fifth was some signora!

In Martin Gardner

*Mathematical Circus*

Chapter 13 (p. 152)

Alfred A. Knopf. New York, New York, USA. 1979

## NUMBER THEORY

**Barnett, I. A.**

No biographical data available

...to discover mathematical talent, there is no better course in elementary mathematics than number theory. Any student who can work the exercises in a modern text in number theory should be encouraged to pursue a mathematical career.

The Theory of Numbers as A Required Course in the College Curriculum for Majors

*American Mathematical Monthly*, Volume 73, November 1966 (pp. 1002–1003)

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

The theory of numbers has always occupied a peculiar position among the purely mathematical sciences. It has the reputation of great difficulty and mystery among many who should be competent to judge; I suppose that there is no mathematical theory of which so many well qualified mathematicians are so much afraid.

The Sixth Josiah Willard Gibbs Lecture

*Bulletin of the American Mathematical Society*, Volume 35, 1929

**Hilbert, David** 1862–1943

German mathematician

A problem in number theory is as timeless as a true work of art.

In Legh Wilber Reid

*The Elements of the Theory of Algebraic Numbers*

Introduction

The Macmillan Company. New York, New York, USA. 1910

**Mazur, Barry** 1937–

American mathematician

[Number theory] produces, without effort, innumerable problems which have a sweet, innocent air about them, tempting flowers; and yet...number theory swarms with bugs, waiting to bite the tempted flower-lovers who, once bitten, are inspired to excesses of effort!

Number Theory as Gadfly

*The American Mathematical Monthly*, Volume 98, 1991

## NURSING

**Anderson, Peggy**

No biographical data available

Nurses do whatever doctors and janitors won't do.

*Nurse*

Chapter 2 (p. 31)

Berkley. New York, New York, USA. 1979

The nurse's job is to help the patients get well, or help them to die.

*Nurse*

Chapter 1 (p. 20)

Berkley. New York, New York, USA. 1979

...nurse's play the same role on a regular floor that the electrocardiograph plays in the intensive care unit. They're the monitor.

*Nurse*

Chapter 1 (pp. 20–21)

Berkley. New York, New York, USA. 1979

**Barnes, Djuna** 1892–1982

American writer

The only people who really know anything about medical science are the nurses, and they never tell; they'd get slapped if they did.

*Nightwood*

La Somnambule (p. 40)

Harcourt, Brace & Company. New York, New York, USA. 1937

**Beckett, Samuel** 1906–89

Irish playwright

The patients seeing so much of the nurses and so little of the doctor, it was natural that they should regard the former as their persecutors and the latter as their savior.

*The Collected Works of Samuel Beckett*

Murphy

Chapter 9 (p. 158)

Grover Press, Inc., New York, New York, USA. 1970

**Burns, Olive Ann** 1924–90

Professional writer, journalist, and columnist

They ain't no feelin' in the world like takin' on somebody wilted and near bout gone, and you do what you can, and then all a-sudden the pore thang starts to put out new growth and git well.

*Cold Sassy Tree*

Chapter 3 (p. 12)

Ticknor & Fields. New York, New York, USA. 1984

**Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

A doctor is called in, but a nurse sent for.

*Note-Book of Anton Chekhov* (p. 122)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Cowper, William** 1731–1800

English poet

The nurse sleeps sweetly, hir'd to watch the sick,  
Whom snoring she disturbs.

*The Poetical Works of William Cowper*

The Task

Book I, The Sofa, l. 89–90

John W. Lovell Company. New York, New York, USA. No date

**Di Bacco, Babs Z.**

No biographical data available

Why modern doctors  
Have more leisure time  
For golf and cards  
And things maritime

Than ever before

In history

While nurses don't,

Is a mystery.

Leisure Gap

*American Journal of Nursing*, January 1969 (p. 212)

**Euripides** ca. 480 BCE–406 BCE

Greek playwright

Better be sick than tend the sick; the first is but a single ill, the last unites mental grief with manual toil.

In *Great Books of the Western World* (Volume 5)

*The Plays of Euripides*

Hippolytus, l. 186

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hanson, Elayne Clipper**

No biographical data available

It seems to be a well known fact  
That nurses fairly ooze with tact.  
Their smiles so warm,  
And full of charm,  
Match voices, low  
And movements slow.  
Then why, if I may venture bold

Are nurses' hands so icy cold?

Paradox

*American Journal of Nursing*, March 1969 (p. 672)

**Jewett, Sarah Orne** 1849–1909

American novelist and short story writer

She had no equal in sickness, and knew how to brew every old-fashioned dose and to make every variety of herb-tea, and when her nursing was put to an end by her patient's death, she was commander-in-chief at the funeral.

*Deephaven*

My Lady Brandon and the Widow Jim (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Kipling, Rudyard** 1865–1936

British writer and poet

Let us now remember many honourable women,  
Such as bade us turn again when we were like to die.

*Collected Verse of Rudyard Kipling*

Dirge of Dead Sisters

Doubleday, Page. Garden City, New York, USA. 1915

**Lewis, Lucille**

No biographical data available

The central focus of nursing is to help the person cope with his physiological, psychological, and spiritual reactions to health problems and maintain his integrity in these experiences. To be therapeutic, the nurse must contribute to the wholeness of man, to the interrelationships of the parts to the whole, to the person's here-and-now as well as to his future, to the health of all the parts so that the person may attain and maintain his highest potential. All of these are essential.

This I Believe

*Nursing Outlook*, Volume 15, Number 5, May 1968 (p. 27)

**Lydston, George Frank** 1858–1923

American urologist

How absurd the situation! It is demanded that a woman should slave for three years and go through what would be a fair medical course, were it conscientiously given, for the privilege of finally earning a salary which, were she constantly employed — which, by the way, she never is — would just equal that of a good stenographer.

The Training School Fake and Its Victims

*New York Medical Journal*, Volume 79, 1904

**Manfreda, Margurite Lucy**

No biographical data available

People turn to God in times of crisis, and illness is among those times when people feel the need for spiritual guidance. Nurses, therefore, are in a unique position to bring spiritual aid to their patients and to the patients' families.

In Sharon Fish and Judith Allen Shelly

*Spiritual Care: The Nurse's Role*

Chapter I (p. 17)

InterVarsity Press. Dover Grove, Illinois, USA. 1978

**Matthews, Marian**

No biographical data available

Where are the interns I recall?

Fountains of wisdom, one and all.

Men in white, mature and strong —

They were the Doctors, never wrong.

Something happened to them, or me;

They're not the giants they used to be.

With stethoscopes like shiny toys

They seem to me like little boys.

Excuse me for crying on your shoulder —

They're not younger — I am older.

Interns

*American Journal of Nursing*, November 1968 (p. 2492)

**Mayo, Charles Horace** 1865–1939

American physician

The trained nurse has given nursing the human, or shall we say, the divine touch, and made the hospital desirable for patients with serious ailments regardless of their home advantages.

The Trained Nurse

*Collected Papers of the Mayo Clinic & Mayo Foundation*,

Volume 13, 1921

**Nightingale, Florence** 1820–1910

English nursing pioneer and statistician

For us who Nurse, our Nursing is a thing, which, unless in it we are making progress every year, every month, every week, — take my word for it we are going back.

Address

"Nightingale Fund" School

St Thomas Hospital, 1872

Conceit and Nursing cannot exist in the same person any more than new patches on an old garment.

Address

"Nightingale Fund" School

St. Thomas Hospital, 1872

The most important practical lesson that can be given to nurses is to teach them what to observe — how to observe — what symptoms indicate improvement — what the reverse — which are of importance — which are of none — which are the evidence of neglect — and of what kind of neglect.

*Notes on Nursing: What It Is and What It Is Not*

Chapter XIII (p. 59)

Harrison. London, England. 1859

I use the word nursing for want of a better. It has been limited to signify little more than the administration of medicines and the application of poultices. It ought to signify the proper use of fresh air, light, warmth, cleanliness, quiet, and the proper selection and administration of diet — all at

the least expense of vital power to the patient. It has been said and written scores of times, that every woman makes a good nurse. I believe, on the contrary, that the very elements of nursing are all but unknown.

*Notes on Nursing: What It Is and What It Is Not*  
Notes on Nursing: What It Is and What It Is Not (p. 6)  
Harrison. London, England. 1859

In watching disease, both in private houses and in public hospitals, the thing which strikes the experienced observer most forcibly is this, that the symptoms or the sufferings generally considered to be inevitable and incident to the disease are very often not symptoms of the disease at all, but of something quite different — of the want of fresh air, or of light, or of warmth, or of quiet, or of cleanliness, or of punctuality and care in the administration of diet, of each or of all of these. And this quite as much in private as in hospital nursing.

*Notes on Nursing: What It Is and What It Is Not*  
Notes on Nursing: What It Is and What It Is Not (p. 5)  
Harrison. London, England. 1859

Never to allow a patient to be wakened, intentionally or accidentally, is a sine qua non of all good nursing.

*Notes on Nursing: What It Is and What It Is Not*  
Noise (p. 25)  
Harrison. London, England. 1859

It seems a commonly received idea among men and even among women themselves that it requires nothing but a disappointment in love, the want of an object, a general disgust, or incapacity for other things to turn a woman into a good nurse.

*Notes on Nursing: What It Is and What It Is Not*  
Conclusion (p. 75)  
Harrison. London, England. 1859

A nurse who rustles (I am speaking of nurses professional and unprofessional) is the horror of a patient, though perhaps he does not know why.

*Notes on Nursing: What It Is and What It Is Not*  
Noise (p. 27)  
Harrison. London, England. 1859

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

...the trained nurse has become one of the great blessings of humanity, taking a place beside the physician and the priest, and not inferior to either in her mission.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
Nurse and Patient (p. 156)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Ray, John** 1627–1705  
English naturalist

A nurse's tongue is privileged to talk.  
*A Complete Collection of English Proverbs* (p. 17)  
Printed for G. Cowie. London, England. 1813

**Richardson, Samuel** 1689–1761  
English novelist

Male nurses are unnatural creatures!

*Sir Charles Grandison*  
Part 2, Volume 3, Letter XI (p. 58)  
G. Allen. London, England. 1895

**Roosevelt, Franklin Delano** 1882–1945  
32<sup>nd</sup> president of the United States

...I urge that the Selective Service Act be amended to provide for the induction of nurses into the armed forces...

Annual Message to Congress  
January 6, 1945

**Schmitz, Jacqueline T.**  
No biographical data available

Compressing an hour into a half,  
Busy, yet heedful  
Rushes the nurse  
Bringing earnest solace to the  
Sick and the needful.  
Who must come first? How can she know?  
Inverted scope, focused by Death,  
Grants new perspective as He robs breath.  
Point of View  
*Journal of Nursing*, November 1968 (p. 2492)

## NUTRITION

**Davis, Adelle** 1904–74  
Nutritionist

Nutrition is a young subject; it has long been kicked around like a puppy that cannot take care of itself. Food faddists and crackpots have kicked it pretty cruelly.... They seem to believe that unless food tastes like Socratic hemlock, it cannot build health. Frankly, I often wonder what such persons plan to do with good health in case they acquire it.

*Let's Eat Right to Keep Fit*  
Chapter 1 (p. 3)  
New American Library. New York, New York, USA. 1970

...eat breakfast like a king, lunch like a prince, and dinner like a pauper.

*Let's Eat Right to Keep Fit*  
Chapter 2 (p. 19)  
New American Library. New York, New York, USA. 1970

## O

### OBJECTIVITY

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Objectivity is not an unobtainable emptying of mind, but a willingness to abandon a set of preferences — for or against some view, as Darwin said — when the world seems to work in a contrary way.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 11 (p. 136)

Random House, Inc. New York, New York, USA. 1995

Objectivity cannot be equated with mental blankness; rather, objectivity resides in recognizing your preferences and then subjecting them to especially harsh scrutiny — and also in a willingness to revise or abandon your theories when the tests fail (as they usually do).

*The Lying Stones of Marrakech: Penultimate Reflections in Natural History*

The Proof of Lavoisier's Plates (pp. 104–105)

Harmony Books. New York, New York, USA. 2000

**Schiebinger, Londa** 1952–

American professor and writer of science history

Objectivity in science cannot be proclaimed, it must be built.

*Nature's Body: Gender in the Making of Modern Science*

Chapter 3 (p. 114)

Beacon Press. Boston, Massachusetts, USA. 1993

### OBSCURATIONISM

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

Dawkin's Law of the Conservation of Difficulty states that obscuratationism in an academic subject expands to fill the vacuum of its intrinsic simplicity.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 8)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

### OBSERVATION

**Abbott, Donald Putnam** 1920–86

American marine biologist and professor

Get the experience of looking at fresh things. If you watch live animals, you gain clearer insights in shorter time than you would watching dead animals for much longer.

In Galen Howard Hilgard (ed.)

*Observing Marine Invertebrates: Drawings from the Laboratory*

Author's Preface (p. xvi)

Stanford University Press. Stanford, California, USA. 1987

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

...a scientist must also be absolutely like a child. If he sees a thing, he must say that he sees it, whether it was what he thought he was going to see or not. See first, think later, then test. But always see first. Otherwise you will only see what you were expecting.

*The Ultimate Hitchhiker's Guide to The Galaxy*

So Long and Thanks for All the Fish

Chapter 31 (p. 587)

The Ballantine Book Company. New York, New York, USA. 2002

**Altmann, Jeanne**

Biologist

The true situation may be the opposite of the apparent one.

*Baboon Mothers and Infants*

Introduction (p. 6)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Anscombe, Francis John** 1918–2001

English-born American statistician

No observations are absolutely trustworthy.

Rejection of Outliers

*Technometrics*, Volume 2, Number 2, May 1960 (p. 124)

**Argelander, Friedrich Wilhelm August** 1799–1875

German astronomer

Observations buried in a desk are no observations.

In Harlow Shapley and Helen E. Howarth

*A Source Book in Astronomy*

Argelander (p. 237)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1929

**Arp, Halton Christian** 1927–

American astronomer

Of course, if one ignores contradictory observations, one can claim to have an “elegant” or “robust” theory. But it isn't science.

Letters

*Science News*, Volume 140, Number 4 Jul 27, 1991 (p. 51)

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Consider that everything which happens, happens justly, and if thou observest carefully, thou wilt find it to be so.

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, # 10 (p. 264)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ayres, Clarence Edwin** 1891–1972

No biographical data available

When Moses emerged from the cloudy obscurity of Mount Sinai and stood before the people with the stone

tablets in his hand, he announced that his laws were based on direct observation. It is not recorded that any one doubted him.

*Science: The False Messiah*

Chapter III (p. 42)

The Bobbs-Merrill Company Publishers, Indianapolis, Indiana, USA.

1927

**Baker, Henry** 1698–1774

English naturalist

Beware of determining and declaring your Opinion suddenly on any Object; for Imagination often gets the Start of judgment, and makes People believe they see Things, which better Observations will convince them could not possibly be seen: Therefore assert nothing till after repeated Experiments and Examinations in all Lights and in all Positions.

*The Microscope Made Easy*

Part I, Chapter XV, Cautions in Viewing Objects (p. 62)

Printed for R. Dodsley. London, England. 1743

**Bauer, Georg (Agricola or Georgius**

**Agricola)** 1494–1555

German scholar and scientist

I have omitted all those things which I have not myself seen, or have not read or heard of from persons upon whom I can rely. That which I have neither seen, nor carefully considered after reading or hearing of, I have not written about. The same rule must be understood with regard to all my instruction, whether I enjoin things which ought to be done, or describe things which are usual, or condemn things which are done.

*De Re Metallica*

Preface (pp. xxx–xxxii)

Dover Publications, Inc. New York, New York, USA. 1950

**Bernard, Claude** 1813–78

French physiologist

Only within very narrow boundaries can man observe the phenomena which surround him; most of them naturally escape his senses, and mere observation is not enough.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I (p. 5)

Henry Schuman, Inc. New York, New York, USA. 1927

Observation, then, is what shows facts.; experiment is what teaches about facts and gives experience in relation to anything.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section ii (p. 11)

Henry Schuman, Inc. New York, New York, USA. 1927

Speaking concretely, when we say “making experiments or making observations,” we mean that we devote ourselves to investigation and to research, that we make

attempts and trials in order to gain facts from which the mind, through reasoning, may draw knowledge or instruction.

Speaking in the abstract, when we say, “relying on observation and gaining experience,” we mean that observation is the mind’s support in reasoning, and experience the mind’s support in deciding, or still better, the fruit of exact reasoning applied to the interpretation of facts.

Observation, then, is what shows facts; experiment is what teaches about facts and gives experience in relation to anything.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I, Section ii (p. 11)

Henry Schuman, Inc. New York, New York, USA. 1927

Men sometimes seem to confuse experiment with observation.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I (p. 6)

Henry Schuman, Inc. New York, New York, USA. 1927

**Blake, William** 1757–1827

English poet, painter, and engraver

A fool sees not the same tree that a wise man sees.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell, Proverbs of Hell, l. 8

University of California Press. Berkeley, California, USA. 1982

**Bolles, Edmund Blair**

No biographical data available

...yet there is a difference between scientific and artistic observation. The scientist observes to turn away and generalize; the artist observes to seize and use reality in all its individuality and peculiarity.

*A Second Way of Knowing: The Riddle of Human Perception*

Chapter 11 (p. 150)

Press Hall Press. New York, New York, USA. 1991

**Box, George E. P.** 1919–

English statistician

To find out what happens to a system when you interfere with it you have to interfere with it (not just passively observe it).

Use and Abuse of Regression

*Technometrics*, Volume 8, Number 4, November 1966 (p. 629)

**Brownlee, Donald**

American astronomer

It is no secret that our lives are patterned by personal experience, and by our observations of the experience of others. So it is with the entire human family, staring outward from a place that we know to others that we do not. Our knowledge of home helps us to understand the ways of planets beyond our ken.



In Nigel S. Hey

*Solar System*

How Rare Is the Earth? (p. 156)

Weidenfield & Nicolson. London, England. 2002

**Burroughs, John** 1837–1921

American naturalist and writer

Unadulterated, unsweetened observations are what the real nature-lover craves. No man can invent incidents and traits as interesting as the reality.

*Ways of Nature*

Chapter I (p. 15)

Book for Libraries Press. Freeport, New York, USA. 1971

**Carlyle, Thomas** 1795–1881

English historian and essayist

Shakespeare says, we are creatures that look before and after: the more surprising that we do not look round a little, and see what is passing under our very eyes.

*Sartor Resartus*

Book I, Chapter I (p. 3)

Ginn & Company. Boston, Massachusetts, USA. 1897

**Cohen, Morris Raphael** 1880–1947

American philosopher

Accidental discoveries of which popular histories of science make mention never happen except to those who have previously devoted a great deal of thought to the matter. Observation unilluminated by theoretic reason is sterile.... Wisdom does not come to those who gape at nature with an empty head. Fruitful observation depends not as Bacon thought upon the absence of bias or anticipatory ideas, but rather on a logical multiplication of them so that having many possibilities in mind we are better prepared to direct our attention to what others have never thought of as within the field of possibility.

*Reason and Nature*

Chapter One, Section III (p. 17)

The Free Press, Publishers, Glencoe, Illinois, USA. 1931

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Science is the observation of things possible, whether present or past; prescience is the knowledge of things which may come to pass.

*The Literary Works of Leonardo da Vinci* (Volume 2)

1148 (p. 239)

University of California Press. Berkeley, California, USA. 1977

**Darwin, Charles Robert** 1809–82

English naturalist

Some of my critics have said, “Oh, he is a good observer, but he has no power of reasoning!” I do not think that this can be true, for the “Origin of Species” is one long argument from the beginning to the end, and it has convinced

not a few able men. No one could have written it without having some power of reasoning.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 82)

D. Appleton & Company. New York, New York, USA. 1896

I have an old belief that a good observer really means a good theorist.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 1)

Letter 118, Darwin to Bates, 22 November, 1860 (p. 195)

D. Appleton & Company. New York, New York, USA. 1903

How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service!

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 1)

Letter 133, Darwin to Henry Fawcett, Sept. 18, 1861 (p. 195)

D. Appleton & Company. New York, New York, USA. 1903

I am a firm believer that without speculation there is no good and original observation.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

To Wallace, December 22, 1857 (p. 465)

D. Appleton & Company. New York, New York, USA. 1896

**Davy, Sir Humphry** 1778–1829

English chemist

The grandest as well as the most correct views are those that have been gained by minute observation, and by the application of all the more precise and accurate methods of science.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter III (p. 153)

Smith, Elder & Company. London, England. 1839–1849

**Dickens, Charles** 1812–70

English novelist

The bearings of this observation lays in the application on it.

*The Works of Charles Dickens*

*Dombey and Son* (Part I)

Chapter XXIII (p. 348)

P.F. Collier & Son. New York, New York, USA. 1911

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

You see, but you do not observe. The distinction is clear.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Scandal in Bohemia (p. 349)

Wings Books. New York, New York, USA. 1967

The world is full of obvious things which nobody by any chance ever observes.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)  
The Hound of the Baskervilles, Chapter 3 (p. 18)  
Wings Books. New York, New York, USA. 1967

Never trust impressions, my boy, but concentrate yourself upon details.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
A Case of Identity (p. 411)  
Wings Books. New York, New York, USA. 1967

...it is my business to know things. Perhaps I have trained myself to see what others overlook.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
A Case of Identity (p. 406)  
Wings Books. New York, New York, USA. 1967

**Drake, Daniel** 1785–1852  
American physician

If observation be the soil, reading is the manure of intellectual culture.

*Physician to the West: Selected Writings of Daniel Drake on Science and Society* (p. 307)  
University Press of Kentucky. Lexington, Kentucky, USA. 1970

**du Noüy, Pierre Lecomte** 1883–1947  
French scientist

...I said that an observed fact only becomes a scientific fact when all the observers are in unanimous agreement.

*The Road to Reason*  
Chapter I (pp. 29–30)  
Longmans, Green & Company. London, England. 1949

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

The art of observation and that of experimentation are very distinct. In the first case, the fact may either proceed from logical reasons or be mere good fortune; it is sufficient to have some penetration and a sense of truth in order to profit by it. But the art of experimentation leads from the first to the last link of the chain, without hesitation and without a blank, making successive use of Reason, which suggests an alternative, and of Experience, which decides on it, until, starting from a faint glimmer, the full blaze of light is reached.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter VI (p. 126)  
Macmillan & Company Ltd. London, England. 1918

**Durkheim, Emile** 1858–1917  
French sociologist

Even one well-made observation will be enough in many cases, just as one well-constructed experiment often suffices for the establishment of a law.

Translated by Sarah A. Solovay and John H. Mueller  
*The Rules of Sociological Method*

Chapter IV (p. 80)  
The Free Press. Glencoe, Illinois, USA. 1938

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

We should be unwise to trust scientific inference very far when it becomes divorced from opportunity for observational test.

*The Internal Constitution of the Stars*  
Chapter I (p. 1)  
At The University Press. Cambridge, England. 1930

For the truth of the conclusions of physical science, observation is the supreme Court of Appeal. It does not follow that every item which we confidently accept as physical knowledge has actually been certified by the Court; our confidence is that it would be certified by the Court if it were submitted. But it does follow that every item of physical knowledge is of a form which might be submitted to the Court. It must be such that we can specify (although it may be impracticable to carry out) an observational procedure which would decide whether it is true or not. Clearly a statement cannot be tested by observation unless it is an assertion about the results of observation. Every item of physical knowledge must therefore be an assertion of what has been or would be the result of carrying out a specified observational procedure.

*The Philosophy of Physical Science*  
Chapter I, Section IV (pp. 9–10)  
The Macmillan Company. New York, New York, USA. 1939

Let us suppose that an ichthyologist is exploring the life of the ocean. He casts a net into the water and brings up a fishy assortment. Surveying his catch, he proceeds in the usual manner of a scientist to systematise what it reveals...In applying this analogy, the catch stands for the body of knowledge which constitutes physical science, and the net for the sensory and intellectual equipment which we use in obtaining it. The casting of the net corresponds to observation; for knowledge which has not been or could not be obtained by observation is not admitted into physical science.

*The Philosophy of Physical Science*  
Chapter II, Section I (p. 16)  
The Macmillan Company. New York, New York, USA. 1939

I hope I shall not shock the experimental physicists too much if I add that it is also a good rule not to put overmuch confidence in the observational results that are put forward until they have been confirmed by theory...

*New Pathways In Science*  
Chapter X, Section II (p. 211)  
The Macmillan Company. New York, New York, USA. 1935

**Einstein, Albert** 1879–1955  
German-born physicist

It is the theory which decides what we can observe.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 77)

Harper & Row, Publishers. New York, New York, USA. 1971

A man should look for what is, and not for what he thinks should be...

In Peter Michelmore

*Einstein, Profile of the Man* (p. 20)

Dodd & Mead Publishers. New York, New York, USA. 1962

### **Euler, Leonhard** 1707–83

Swiss mathematician and physicist

It will seem not a little paradoxical to ascribe a great importance to observations even in that part of the mathematical sciences which is usually called Pure Mathematics, since the current opinion is that observations are restricted to physical objects that make impressions on the senses.

In G. Polya

*Induction and Analogy in Mathematics* (Volume 1)

Chapter I (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 1954

...in the theory of numbers, which is still very imperfect, we can place our highest hopes in observations; they will lead us continually to new properties which we shall endeavor to prove afterwards.

In G. Polya

*Induction and Analogy in Mathematics* (Volume 1)

Chapter I (p. 3)

Princeton University Press. Princeton, New Jersey, USA. 1954

### **Fischer, Martin H.** 1879–1962

German-American physician

You must acquire the ability to describe your observations and your experience in such language that whoever observes or experiences similarly will be forced to the same conclusion.

In Howard Fabing and Ray Marr

*Fischerisms* (p. 8)

C.C. Thomas. Springfield, Illinois, USA. 1944

### **Faraday, Michael** 1791–1867

English physicist and chemist

If in such strivings, we...see but imperfectly, still we should endeavor to see, for even an obscure and distorted vision is better than none.

On the Conservation of Force

*Philosophical Magazine*, Volume 13, Number 4, 1857 (p. 238)

### **Feynman, Richard P.** 1918–88

American theoretical physicist

The principle that the observation is the judge imposes a severe limitation to the kind of questions that can be answered. They are limited to questions that you can put this way: "if I do this, what will happen?" There

are ways to try and see. Questions like, "should I do this?" and "what is the value of this?" are not of the same kind.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 16)

Perseus Books. Reading, Massachusetts, USA. 1998

### **Galilei, Galileo** 1564–1642

Italian physicist and astronomer

It is not in ancient tomes, but in close observations and personal consecration that a grain of truth may be found. It is so very easy to seek the significance of things in the papers of this or that man rather than in the works of nature which, ever alive and active, are constantly before our eyes.

In Helen Wright

*Palomar: The World's Largest Telescope*

Origin of the Telescope (p. 9)

The Macmillan Company. New York, New York, USA. 1952

### **Greer, Scott**

No biographical data available

...the link between observation and formulation is one of the most difficult and crucial in the scientific enterprise. It is the process of interpreting our theory or, as some say, of "operationalizing our concepts." Our creations in the world of possibility must be fitted in the world of probability; in Kant's epigram, "Concepts without precepts are empty." It is also the process of relating our observations to theory; to finish the epigram, "Precepts without concepts are blind."

*The Logic of Social Inquiry*

Part III, Chapter 14 (p. 160)

Aldine Publishing Company. Chicago, Illinois, USA. 1969

### **Gregg, Alan** 1890–1957

American medical educator and philosopher

...most of the knowledge and much of the genius of the research worker lie behind selection of what is worth observing. It is a crucial choice, often determining the success or failure of months of work, often differentiating the brilliant discoverer from the...plodder.

*The Furtherance of Medical Research*

Chapter I (p. 8)

Yale University Press. New Haven, Connecticut, USA. 1941

### **Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

An accurate observation remains unaltered throughout the ages. Its scientific value is determined by its truth to Nature; and the more complete the testimony, the less room is there for elaboration by investigators in succeeding generations.

*Discovery; or, The Spirit and Service of Science*

Chapter IV (p. 70)

Macmillan & Company Ltd. London, England. 1918

In the world of natural knowledge, no authority is great enough to support a theory when a crucial observation has shown it to be untenable.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 12)

Macmillan & Company Ltd. London, England. 1918

**Grew, Nehemiah** 1641–1712

Scientific writer and journalist

If...an inquiry into the Nature of Vegetation may be of good Import; It will be requisite to see, first of all, What may offer it self to be enquired of; or to understand, what or Scope is: That so doing, we may take our aim the better in making, and having made, in applying our Observations thereunto.

*The Anatomy of Plants*

An Idea of a Philosophical History of Plants (p. 3)

Printed by W. Rawlins. London, England. 1682

**Hales, Stephen** 1677–1761

English physiologist and clergyman

...it is from long experience chiefly that we are to expect the most certain rules of practice, yet it is withal to be remembered, that observations, and to put us upon the most probable means of improving any art, is to get the best insight we can into the nature and properties of those things which we are desirous to cultivate and improve.

*Vegetable Statics*

The Conclusion (p. 214)

The Scientific Book Guild. London, England. 1961

**Hanson, Norwood Russell** 1924–67

American philosopher of science

The observer may not know what he is seeing: he aims only to get his observations to cohere against the background of established knowledge. This seeing is the goal of observation.

*Patterns of Discovery*

Chapter I (p. 20)

At The University Press. Cambridge, England. 1958

...there is more to seeing than what meets the eyeball.

*Patterns of Discovery*

Chapter I (p. 7)

At The University Press. Cambridge, England. 1958

**Harvey, William** 1578–1657

English physician

...the dull and unintellectual are indisposed to see what lies before their eyes...

In *Great Books of the Western World* (Volume 28)

*An Anatomical Disquisition on the Motion of the Heart and Blood in Animals*

Dedication (p. 268)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

This assumption is not permissible in atomic physics; the interaction between observer and object causes uncontrollable and large changes in the system being observed, because of the discontinuous changes characteristic of atomic processes.

*The Physical Principles of the Quantum Theory*

Introductory (p. 3)

The University of Chicago Press. Chicago, Illinois, USA. 1930

This again emphasizes a subjective element in the description of atomic events, since the measuring device has been constructed by the observer, and we have to remember that what we observe is not nature in itself but nature exposed to our method of questioning.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter III (p. 58)

Harper & Row, Publishers. New York, New York, USA. 1958

The idea that we do observe something already indicates something irreversible. If we draw a pencil line on a paper, for instance, we have established something which cannot be undone, so to speak. Every observation is irreversible, because we have gained information that cannot be forgotten.

In Paul Buckley and F. David Peat

*Glimpsing Reality: Ideas in Physics and the Link to Biology*

Werner Heisenberg (p. 12)

University of Toronto Press. Toronto, Ontario, Canada. 1996

...what we observe is not nature itself, but nature exposed to our method of questioning.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter III (p. 58)

Harper & Row, Publishers. New York, New York, USA. 1958

A real difficulty in the understanding of this interpretation arises, however, when one asks the famous question: But what happens “really” in an atomic event? It has been said before that the mechanism and the results of an observation can always be stated in terms of the classical concepts. But what one deduces from an observation is a probability function, a mathematical expression that combines statements about possibilities or tendencies with statements about our knowledge of facts. So we cannot completely objectify the result of an observation, we cannot describe what “happens” between this observation and the next.

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*

The Copenhagen Interpretation of Quantum Mechanics (pp. 90–91)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

There is scarcely any well-informed person, who, if he has but the will, has not also the power to add something essential to the general stock of knowledge, if he will only observe regularly and methodically some particular class of facts which may most excite his attention...

*A Preliminary Discourse on the Study of Natural Philosophy*  
Part II, Chapter IV, Section 128 (p. 133)  
Printed for Longman, Rees, Orme, Brown & Green. London, England.  
1831

Seeing is in some respects an art which must be learnt. To make a person see with such a power is nearly the same as if I were asked to make him play one of Handel's fugues upon the organ. Many a night I have been practicing to see, and it would be strange if one did not acquire a certain dexterity by such constant practice.

In William Hoyt  
*Planets X and Pluto*  
Chapter 1 (p. 12)  
The University of Arizona Press. Tucson, Arizona, USA. 1981

**Hinshelwood, Sir Cyril** 1897–1967  
English chemist

Again and again, the key to a great discovery has been an unexpected observation.

Science and Scientists  
*Nature*, Volume 207, Number 5001, September 4, 1965 (p. 1057)

**Holton, Gerald** 1922–  
Research professor of physics and science history

**Roller, Duane H. D.** ?–1994  
Science historian

All intelligent endeavor stands with one foot on observation and the other on contemplation.

*Foundations of Modern Physical Science*  
Chapter 13 (p. 218)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA.  
1950

**Hooke, Robert** 1635–1703  
English physicist

The truth is, the Science of Nature has been already too long made only a work of the Brain and the Fancy: It is now high time that it should return to the plainness and soundness of Observations on material and obvious things.

*Micrographia*  
Preface (Fifth page)  
Printed by Jo. Martyn and Ja. Allestry. London, England. 1665

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

You take a number of radioactive nuclei of a particular kind, the number being chosen so that there's an even chance of one of them going off in a certain period of time, say ten seconds. Then for ten seconds you surround them with counters, or any other detecting device you might like to use. At the end of the time the question is, has one of them decayed or not. To decide this you take a look at your counters. The conventional notion is that the state of the counters decides whether a nucleus has gone off or not...my problem now con-

cerns an individual case.... It is perfectly possible to put your counters, or your bubble chamber, your camera, all your gobbledegook in fact, into your calculations — and we know quite definitely that any attempt to get a definite answer out of calculation will prove completely fruitless. The thing that gives the answer isn't the camera or the counter, it's the actual operation of looking yourself at your equipment. It seems that only when we ourselves take a subjective decision can we improve our description of the world, over and above the uncertainty of our theories. I'm talking about quantum theories now.

*October the First Is Too Late*  
Chapter Five (pp. 52–53)  
Harper & Row, Publishers. New York, New York, USA. 1966

**Hubble, Edwin Powell** 1889–1953  
American astronomer

...observation and theory are woven together, and it is futile to attempt their complete separation. Observation always involve theory. Pure theory may be found in mathematics, but seldom in science. Mathematics, it has been said, deals with possible worlds — logically consistent systems. Science attempts to discover the actual world we inhabit. So in cosmology, theory presents an infinite array of possible universes, and observation is eliminating them, class by class, until now the different types among which our particular universe must be included have become increasingly comprehensible.

*The Realm of the Nebulae*  
Chapter I (p. 35)  
Dover Publications, Inc. New York, New York, USA. 1958

**Huxley, Thomas Henry** 1825–95  
English biologist

There is no question in the mind of anyone acquainted with the facts that, so far as observation and experiment can take us, the structure and the functions of the nervous system are fundamentally the same in an ape, or in a dog, and in a man. And the suggestion that we must stop at the exact point at which direct proof fails us, and refuse to believe that the similarity which extends so far stretches yet further, is no better than a quibble. Robinson Crusoe did not feel bound to conclude, from the single human footprint which he saw in the sand that the maker of the impression had only one leg.

*Hume, with Helps to the Study of Berkeley* (p. 123)  
D. Appleton & Company. New York, New York, USA. 1896

**James, William** 1842–1910  
American philosopher and psychologist

Round about the accredited and orderly facts of every science there ever floats a sort of dust-cloud of exceptional observations, of occurrences minute and irregular

and seldom met with, which it always proves more easy to ignore than to attend to...

*The Will to Believe and Other Essays in Popular Philosophy and Human Immortality*

What Psychical Research Has Accomplished (p. 299)

Dover Publications, Inc. New York, New York, USA. 1956

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Each observation destroys the bit of the universe observed, and so supplies knowledge only of a universe which has already become past history...

*The New Background of Science*

Chapter I (p. 2)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

We can only see nature blurred by the clouds of dust we ourselves make; we can still only see the rainbow, but a sun of some sort must exist to produce the light by which we see it.

*The New Background of Science*

Chapter I (p. 4)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

An observation, strictly, is only a sensation. Nobody means that we should reject everything but sensations. But as soon as we go beyond sensations we are making inferences.

*Theory of Probability*

General Questions (p. 412)

Clarendon Press. Oxford, England. 1961

**Jones, Steve**

No biographical data available

Observation and experiment are what count, not opinion and introspection. Few working scientists have much respect for those who try to interpret nature in metaphysical terms. For most wearers of white coats, philosophy is to science as pornography is to sex: it is cheaper, easier, and some people seem, bafflingly, to prefer it. Outside of psychology it plays almost no part in the functions of the research machine.

Review of *How the Mind Works* by Steve Pinker

*The New York Review of Books*, November 6, 1997 (p. 13)

**Jonson, Ben** 1573?–1637

English dramatist and poet

...let me alone to observe, till I turne my selfe into nothing but observation.

*The Poetaster*

Act II, Scene I, l. 193

Henry Holt & Company. New York, New York, USA. 1905

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

The art of science is knowing which observations to ignore and which are the key to the puzzle.

*Blind Watchers of the Sky*

Chapter Seven (p. 189)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Kuhn, Thomas S.** 1922–96

American historian of science

Observation and experience can and must drastically restrict the range of admissible scientific belief, else there would be no science. But they cannot alone determine a particular body of such belief. An apparently arbitrary element, compounded of personal and historical accident, is always a formative ingredient of the beliefs espoused by a given scientific community at a give time.

*The Structure of Scientific Revolutions*

Chapter I (p. 4)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Langer, Susanne Knauth** 1895–1985

American philosopher

The faith of scientists in the power of mathematics is so implicit that their work has gradually become less and less observation, and more and more calculation. The promiscuous collection and tabulation of data have given way to a process of assigning possible meanings, merely supposed real entities, to mathematical terms, working out the logical results, and then staging certain crucial experiments to check the hypothesis against the actual, empirical results. But the facts...accepted by virtue of these tests are not actually observed at all.

*Philosophy in a New Key*

Chapter I (pp. 19–20)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

Observation has become almost entirely indirect; and readings take the place of genuine witness.

*Philosophy in a New Key*

Chapter I (p. 20)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

The men in the laboratory...cannot be said to observe the actual objects of their curiosity at all... They sense data on which the propositions of modern science rest are, for the most part, little photographic spots and blurs, or inky curved lines on paper... What is directly observable is only a sign of the "physical fact"; it requires interpretation to yield scientific propositions.

*Philosophy in a New Key*

Chapter I (p. 20)

Harvard University Press. Cambridge, Massachusetts, USA. 1957

**Lee, Oliver Justin** 1881–1964

American astronomer

Every bit of knowledge we gain and every conclusion we draw about the universe or about any part or feature

of it depends finally upon some observation or measurement. Mankind has had again and again the humiliating experience of trusting to intuitive, apparently logical conclusions without observations, and has seen Nature sail by in her radiant chariot of gold in an entirely different direction.

*Measuring Our Universe: From the Inner Atom to Outer Space*

Chapter 3 (p. 33)

Ronald Press Company. New York, New York, USA. 1950

**Lewis, Gilbert Newton** 1875–1946

American chemist

I claim that my eye touches a star as truly as my finger touches this table.

In George W. Gray

New Eyes on the Universe

*The Atlantic Monthly*, Volume 155, Number 5, May 1935 (p. 608)

**Longair, Malcolm** 1941–

Scottish physicist

Although by now a large amount of observational material is available, the implications of these observations are far from clear.

*Contemporary Physics*

Quasi-Stellar Radio Sources, Volume 8, Number 4, 1967 (p. 357)

**Lonsdale, Dame Kathleen** 1903–71

Irish-born English crystallographer

...observation is not enough, and it seems to me that in science, as in the arts, there is very little worth having that does not require the exercise of intuition as well as of intelligence, the use of imagination as well as of information.

Facts About Crystals

*American Scientist*, Volume 39, Number 4, October 1951 (p. 576)

**Louis, Pierre-Charles-Alexandre** 1787–1872

French physician

It behooves those who devote themselves to observation to be impressed by this truth (*i.e.*, that many “facts” grow old) and to realize that the best work is only good in relation to its time and that it awaits another, more exact and more complete.

*Recherches Anatomiques, Pathologiques et Therapeutiques sur la Maladie Connue Sous les Noms de Gastro-Enterite* (p. vii)

Publisher undetermined

**Lubbock, Sir John** 1834–1913

English banker, author, and scientist

What we do see depends mainly on what we look for. When we turn our eyes to the sky, it is in most cases merely to see whether it is likely to rain. In the same field the farmer will notice the crop, geologists the fossils, botanists the flowers, artists the coloring, sportsmen the cover for game. Though we may all look at the same

things, it does not at all follow that we should see them.

*The Beauties of Nature and the Wonders of the World We Live In*

Introduction (pp. 3–4)

The Macmillan Company. New York, New York, USA. 1893

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Everything which we observe in nature imprints itself uncomprehended and unanalyzed in our percepts and ideas which then, in their turn, mimic the processes of nature in their most general and most striking features.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter I, Part II, Section 2 (p. 36)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Macy, Arthur**

No biographical data available

But I keep no log of my daily grog,

For what's the use o' being bothered? I drink a little

more when the wind's offshore,

And most when the wind's from the no'th'ard.

*Poems*

The Indifferent Mariner

W.B. Clarke Company. Boston, Massachusetts, USA. 1905

**Marschall, Laurence A.**

American astronomer

A first-time deep-sky observer usually sees little more than a fuzzy glow against the blackness of the night.

Thus, to the nonastronomer, once you've seen one celestial object, you've pretty much seen them all.

*The Supernova Story*

Chapter 1 (p. 2)

Plenum Press. New York, New York, USA. 1988

**Marsland, Douglas**

American biologist

The primary basis of all scientific thinking is observation.

*Principles of Modern Biology* (p. 12)

Holt, Rinehart, Winston. New York, New York, USA. 1969

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Innocent, unbiased observation is a myth.

*Induction and Intuition in Scientific Thought*

Chapter II, Section 2 (p. 28)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

It is not methodologically an exaggeration to say that Fleming eventually found penicillin because he had been looking for it. A thousand people might have observed whatever it was that he did observe without making anything of it or building upon the observation in any way; but Fleming had the right slot in his mind, waiting for it. Good luck is almost always preceded by an expectation that it will gratify. Pasteur is well known to have said

that fortune favors the prepared mind, and Fontenelle observed, “*Ces hasards ne sont que pour ceux qui jouent bien!*” (“These strokes of good fortune are only for those who play well!”).

*Advice to a Young Scientist*

Chapter 11 (p. 90)

Basic Books, Inc. New York, New York, USA. 1979

**Meredith, George** 1828–1909

English novelist and poet

Observation is the most enduring of the pleasures of life...

*Diana of the Crossways*

Chapter XI (p. 104)

Charles Scribner’s Sons. New York, New York, USA. 1924

**Minnaert, M.**

No biographical data available

It is indeed wrong to think that the poetry of Nature’s moods in all their infinite variety is lost on one who observes them scientifically, for the habit of observation refines our sense of beauty and adds a brighter hue to the richly coloured background against which each separate fact is outlined. The connection between events, the relation of cause and effect in different parts of a landscape, unite harmoniously what would otherwise be merely a series of detached sciences.

*The Nature of Light and Colour in the Open Air*

Preface (p. v)

Dover Publications. New York, New York, USA. 1954

**Mitchell, Maria** 1818–89

American astronomer and educator

Nothing comes out more clearly in astronomical observations than the immense activity of the universe.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter XI (p. 237)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Morris, Richard** 1939–2003

American physicist and science writer

Simple observation generally gets us nowhere. It is the creative imagination that increases our understanding by finding connections between apparently unrelated phenomena, and forming logical, consistent theories to explain them. And if a theory turns out to be wrong, as many do, all is not lost. The struggle to create an imaginative, correct picture of reality frequently tells us where to go next, even when science has temporarily followed the wrong path.

*The Universe, the Eleventh Dimension, and Everything: What We Know and How We Know It*

Part 3, Chapter 2 (p. 190)

Four Walls Eight Windows. New York, New York, USA. 1999

**Moulton, Lord** 1844–1921

English mathematician

When we are reduced to observation Science crawls.

In Alan Gregg

*The Furtherance of Medical Research*

Chapter I (p. 7)

Yale University Press. New Haven, Connecticut, USA. 1941

**Müller, Johannes** 1801–58

German physiologist

Observation is simple, indefatigable, industrious, upright, without any preconceived opinion. Experiment is artificial, impatient, busy, digressive, passionate, unreliable.

In V.J.E. Kruta

*Purkyně Physiologist: A Short Account of His Contributions to the Progress of Physiology* (p. 20)

Publisher undetermined

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

As in mathematics, so in natural philosophy the investigation of difficult things by the method of analysis ought ever to precede the method of composition. This analysis consists of making experiments and observations, and in drawing general conclusions from them by induction.... By this way of analysis we may proceed from compounds to ingredients, and from motions to the forces producing them; and in general from effects to their causes, and from particular causes to more general ones till the argument end in the most general. This is the method of analysis: and the synthesis consists in assuming the causes discovered and established as principles, and by them explaining the phenomena preceding from them, and proving the explanations.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book III: Part I, Query 31

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**O’Neil, William Matthew**

No biographical data available

It urges the scientist, in effect, not to take risks incurred in moving far from the facts. However, it may properly be asked whether science can be undertaken without taking the risk of skating on the possibly thin ice of supposition. The important thing to know is when one is on the more solid ground of observation and when one is on the ice.

*Fact and Theory: An Aspect of the Philosophy of Science*

Chapter 8 (p. 154)

Sydney University Press. Sydney, Australia. 1969

**Orwell, George (Eric Arthur Blair)** 1903–50

English novelist and essayist

To see what is in front of one’s nose requires a constant struggle.



In Sonia Orwell and Ian Angus (eds.)  
*The Collected Essays, Journalism and Letters of George Orwell: In Front of Your Nose, 1945–1950*  
 1946, 36 (p. 125)  
 Harcourt, Brace & World. New York, New York, USA. 1968

**Osler, Sir William** 1849–1919  
 Canadian physician and professor of medicine

Observation plus thinking has given us the bodies of living creatures in health and disease. There have been two inherent difficulties — to get men to see straight and to get men to think clearly; but in spite of the frailty of the instrument, the method has been one of the most powerful ever placed in the hands of man.

The Pathological Institute of a General Hospital  
*Glasgow Medical Journal*, Volume 76, 1911

Note with accuracy and care everything that comes within your professional ken... Let nothing slip by you; the ordinary hum-drum cases of the morning routine may have been accurately described and pictured, but study each one separately as though it were new — so it is so far as your special experience goes; and if the spirit of the student is in you the lesson will be there.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
 The Army Surgeon (p. 104)  
 The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The whole art of medicine is in observation, as the old motto goes, but to educate the eye to see, the ear to hear and the finger to feel takes time, and to make a beginning, to start a man on the right path, is all that we can do. We expect too much of the student and we try to teach him too much. Give him good methods and a proper point of view, and all other things will be added, as his experience grows.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
 The Hospital as a College (pp. 315–316)  
 The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

Man can do a great deal by observation and thinking, but with them alone he cannot unravel the mysteries of Nature. Had it been possible the Greeks would have done it; and could Plato and Aristotle have grasped the value of experiment in the progress of human knowledge, the course of European history might have been very different.

*Man's Redemption of Man*  
 Address, University of Edinburgh, July 1910 (p. 22)

**Owen, Ed** 1896–1981  
 American geologist

I wandered far and saw many things over a long time. Most of the things which I saw I did not understand. I looked about me and did not see that any others understood the complex pattern either. But as I wandered

I could not escape the feel of things and of places and of the people in them.

In Samuel P. Ellison, Jr., Joseph J. Jones and Mirva Owen (eds.)  
*The Flavor of Ed Owen — A Geologist Looks Back*  
 Introduction (p. 1)  
 Geology Foundation, University of Texas at Austin. Austin, Texas, USA. 1987

**Pavlov, Ivan Petrovich** 1849–1936  
 Russian physiologist

Observation collects whatever nature offers, whereas experimentation takes from nature whatever it requires.

In Ivan Valiela  
*Doing Science: Design, Analysis, and Communication of Scientific Research*  
 Chapter I (p. 11)  
 Oxford University Press, Inc. Oxford, England. 2001

**Planck, Max** 1858–1947  
 German physicist

As long as Natural Philosophy exists, its ultimate highest aim will always be the correlating of various physical observations into a unified system, and, where possible, into a single formula.

Translated by R. Jones and D.H. Williams  
*A Survey of Physics: A Collection of Lectures and Essays*  
 The Unity of the Physical Universe (p. 1)  
 Methuen & Company Ltd. London, England. 1925

**Poincaré, Henri** 1854–1912  
 French mathematician and theoretical astronomer

...to observe is not enough. We must use our observations, and to do that we must generalize.

*The Foundations of Science*  
 Science and Hypothesis, Part IV  
 Chapter IX (p. 127)  
 The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744  
 English poet

To observations which ourselves we make,  
 We grow more partial for th' observer's sake.

*The Complete Poetical Works*  
 Moral Essays, Epis. I, 1. 11–12  
 Houghton Mifflin Company. New York, New York, USA. 1903

**Popper, Karl R.** 1902–94  
 Austrian/British philosopher of science

Some scientists find, or so it seems, that they get their best ideas when smoking; others by drinking coffee or whiskey. Thus there is no reason why I should not admit that some may get their ideas by observing or by repeating observations.

*Realism and the Aim of Science*  
 Part I, Chapter 1 (p. 36)  
 Rowman & Littlefield. Totowa, New Jersey, USA. 1983

**Saxe, John Godfrey** 1816–87  
American poet

It was six men of Indostan  
To learning much inclined,  
Who went to see the Elephant  
(Though all of them were blind),  
That each by observation  
Might satisfy his mind.

*The Poetical Works of John Godfrey Saxe*  
The Parable of the Blind Men and the Elephant  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

**Selye, Hans** 1907–82  
Austrian-American endocrinologist

If a scientist makes no important observation he deserves no credit. But if a significant fact comes his way and he still does not see its importance, he can only blame himself.

*From Dream to Discovery: On Being a Scientist*  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

ARMANDO: How hast thou purchased this experience?

MOTH: By my penny of observation.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
Love's Labour's Lost  
Act III, Scene i, l. 23  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Steinbeck, John** 1902–68  
American novelist

There are good things to see in the tide pools and there are exciting and interesting thoughts to be generated from the seeing. Every new eye applied to the peep hole which looks out at the world may fish in some new beauty and some new pattern, and the world of the human mind must be enriched by such fishing.

In Edward F. Ricketts, Jack Calvin, and Joel W. Hedgpeth  
*Between Pacific Tides*  
Prefaces (p. xi)  
Stanford University Press. Stanford, California, USA. 1968

...one can live in a prefabricated world, smugly and without question, or one can indulge perhaps the greatest human excitement: that of observation to speculation to hypothesis. This is a creative process, probably the highest and most satisfactory we know.

In Edward F. Ricketts, Jack Calvin and Joel W. Hedgpeth  
*Between Pacific Tides*  
Prefaces (p. xi)  
Stanford University Press. Stanford, California, USA. 1968

**Sterne, Laurence** 1713–68  
English novelist and humorist

What a large volume of adventures may be grasped within this little span of life by him who interests his heart in

everything and who, having eyes to see what time and chance are perpetually holding out to him as he journeyeth on his way, misses nothing he can fairly lay his hands on.

*The Life and Opinions of Tristram Shandy, Gentleman and a Sentimental Journey Through France and Italy* (Volume 2)  
In the Street (p. 251)  
Macmillan & Company Ltd. London, England. 1900

**Stewart, Ian** 1945–  
English mathematician and science writer

It's amazing how long it can take to see the obvious. But of course it's only obvious now.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*  
Chapter 3 (pp. 32–33)  
Basic Books, Inc. New York, New York, USA. 1995

**Swift, Jonathan** 1667–1745  
Irish-born English writer

That was excellently observ'd, say I, when I read a Passage in an Author, where his Opinion agrees with mine. When we differ, there I pronounce him to be mistaken.

*Satires and Personal Writings*  
Thoughts on Various Subjects (p. 416)  
Oxford University Press, Inc. New York, New York, USA. 1965

**Sylvester, James Joseph** 1814–97  
English mathematician

Most, if not all, of the great ideas of modern mathematics have had their origin in observation.

A Plea for the Mathematician  
*Nature*, Volume 1, Thursday, December 30, 1869 (p. 238)

**Teale, Edwin Way** 1899–1980  
American naturalist

For observing nature, the best pace is a snail's pace.

*Circle of the Seasons*  
July 14 (p. 150)  
Dodd, Mead & Company. New York, New York, USA. 1953

## The Bible

You have seen much but perceived little...

*The Revised English Bible*  
Isaiah 42:20  
Oxford University Press, Inc. Oxford, England. 1989

**Thiele, T. N.** 1838–1910  
Danish astronomer

An isolated sensation teaches us nothing, for it does not amount to an observation. Observation is a putting together of several results of sensation which are or are supposed to be connected with each other according to the law of causality, so that some represent causes and others their effects.

*Theory of Observations* (p. 2)  
Cahales & Edwin Layton. London, England. 1903

**Thomas, Lewis** 1913–93  
American physician and biologist

The role played by the observer in biological research is complicated but not bizarre: he or she simply observes, describes, interprets, maybe once in a while emits a hoarse shout, but that is that; the act of observing does not alter fundamental aspects of the things observed, or anyway isn't supposed to.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
An Apology (p. 88)  
The Viking Press. New York, New York, USA. 1979

**Thompson, Silvanus P.** 1851–1916  
English physics professor and author

The seemingly useless or trivial observation made by one worker leads on to a useful observation by another; and so science advances, “creeping on from point to point.”

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter XI (p. 292)  
Macmillan & Company Ltd. London, England. 1918

**Thompson, William Robin** 1887–1972  
Canadian entomologist

The mathematical machine works with unerring precision; but what we get out of it is nothing more than a rearrangement of what we put into it. In the last analysis observation — the actual contact with real events — is the only reliable way of securing the data of natural history.

*Science and Common Sense*  
Chapter Six (pp. 114–115)  
Yale University Press. New Haven, Connecticut, USA. 1951

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

The question is not what you look at — but how you look & whether you see.

*Journal* (Volume 3: 1848–1851)  
August 5, 1851 (pp. 354–355)  
Princeton University Press. Princeton, New Jersey, USA. 1981

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

An extremely odd demand is often set forth but never met, even by those who make it; *i.e.*, that empirical data should be presented without any theoretical context, leaving the reader, the student, to his own devices in judging it. This demand seems odd because it is useless simply to look at something. Every act of looking turns into observation, every act of observation into reflection, every act of reflection into the making of associations; thus it is evident that we theorize every time we look carefully at the world.

In Douglas Miller  
*Scientific Studies* (Volume 12)  
Theory of Color  
Preface (p. 159)  
Suhrkamp. New York, New York, USA. 1988

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

True cosmical views are the result of observation and ideal combination, and of a long-continued communion with the external world; nor are they a work of a single people, but the fruits yielded by reciprocal communication, and by a great, if not general, intercourse between different nations.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 2)  
Physical Contemplation of the Universe (p. 116)  
Harper & Brothers. New York, New York, USA. 1869

**von Liebig, Justus** 1803–73  
German organic chemist

However numerous our observations may be, yet, if they only bear on one side of a question, they will never enable us to penetrate the essence of a natural phenomenon in its full significance.

*Animal Chemistry*  
Preface (p. xxxii)  
Johnson Reprint Corporation. New York, New York, USA. 1964

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

...nothing destroys the powers of general observation quite so much as a life of experimental science.

*Seven Famous Novels by H.G. Wells*  
The Food of the Gods  
Chapter 2 (p. 540)  
Alfred A. Knopf. New York, New York, USA. 1934

**Westaway, Frederic William**  
Science writer

It is the essence of good observation that the eye shall not only see a thing itself, but of what parts that thing is composed. And if an observer is to become a successful investigator in any department of Science, he must have an extreme acquaintance with what has already been done in that particular department. Only then will he be prepared to seize upon any one of those minute indications which often connect phenomena apparently quite remote from each other. His eyes will thus be struck with any occurrence which, according to received theories, ought not to happen; for these are the facts which serve as clues to new discoveries.

*Scientific Method: Its Philosophy and Its Practice*  
Chapter XVI, Section 3 (p. 196)  
Blackie & Sons Ltd. London, England. 1919

**Wheeler, John Archibald** 1911–  
American physicist and educator

Only by the analysis and interpretation of observations as they are made, and the examination of the larger implications of the results, is one in a satisfactory position to pose new experimental and theoretical questions of the greatest significance.

Elementary Particle Physics

*American Scientist*, Spring, April 1947 (p. 189)

**Wheeler, John Archibald** 1911–

American physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

May the universe in some strange sense be “brought into being” by the participation of those who participate?... [T]he vital act is the act of participation. “Participant” is the incontrovertible new concept given by quantum mechanics. It strikes down the term “observer” of classical theory, the man who stands safely behind the thick glass wall and watches what goes on without taking part. It can’t be done, quantum mechanics says.

*Gravitation* (p. 1273)

W.H. Freeman and Company, New York, New York, USA. 1973

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

We habitually observe by the method of difference. Sometimes we see an elephant, and sometimes we do not. The result is that an elephant, when present, is noticed.

*Process and Reality: An Essay in Cosmology*

Part I, Chapter I, Section II (p. 6)

The Macmillan Company, New York, New York, USA. 1929

**Wilson, Jr., E. Bright** 1908–92

American physical chemist

Observations are useless until they have been interpreted.

*An Introduction to Scientific Research*

Chapter 8 (p. 169)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

**Wöhler, Friedrich** 1800–82

German chemist

My imagination is pretty active, but in thinking I am very slow. No one is less made to be a critic than I. The organ for philosophical thought I lack completely, as you well know, as completely as that for mathematics. Only for observing, do I possess, or at least I believe I do, a passable arrangement in my brain. A kind of instinct that allows me to become aware of relations among data may well be connected with [this arrangement].

In O. Theodor Benfey

*From Vital Force to Structural Formulas*

Chapter 3 (p. 18)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1964

**Wright, R. D.**

No biographical data available

Whatever happened to the terms probability and observation? Are statements of high probability now to be deified by calling them truths? Does a set of consistent observations become fact? When I teach biology to the college student, the nature of information mandates that the class and I preserve a healthy skepticism regarding both the broad generalizations and the specific statements of the discipline. Fact and truth are terms we almost never use. There is nothing shameful in describing what we know as having a certain probability, following from observations that have a degree of imprecision. That’s the nature of science, including the science of evolution.

Letters

*BioScience*, Volume 31, Number 11, December 1981 (p. 788)

**Zinsser, Hans** 1878–1940

American bacteriologist

The scientist takes off from the manifold observations of predecessors, and shows his intelligence, if any, by his ability to discriminate between the important and the negligible, by selecting here and there the significant stepping-stones that will lead across the difficulties to new understanding. The one who places the last stone and steps across the terra firma of accomplished discovery gets all the credit. Only the initiated know and honor those whose patient integrity and devotion to exact observation have made the last step possible.

*As I Remember Him: The Biography of R.S.*

Chapter XX (p. 332)

Little, Brown & Company, Boston, Massachusetts, USA. 1940

## OBSERVATORY

**Cerf, Bennett** 1898–1971

American publisher and editor

Some weeks later the Einsteins were taken to the Mt. Wilson Observatory in California. Mrs. Einstein was particularly impressed by the giant telescope.

*Try and Stop Me: A Collection of Anecdotes and Stories, Mostly Humorous*

On the Telescope (p. 163)

Simon & Schuster, New York, New York, USA. 1944

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

What is so good in a college as an observatory? The sublime attaches to the door and to the first stair you ascend; — and this is the road to the stars...

*Journals of Ralph Waldo Emerson 1864–1876*

November 14, 1865 (p. 118)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1911

**Lowell, Percival** 1855–1916

American astronomer

A steady atmosphere is essential to the study of planetary detail; size of instrument being a very secondary matter. A large instrument in poor air will not begin to show what a smaller one in good air will. When this is recognized, as it eventually will be, it will become the fashion to put up observatories where they can see rather than be seen.

*Mars*

Preface (p. v)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

### **Mitchell, Maria** 1818–89

American astronomer and educator

There is no observatory in this land, nor in any land, probably, of which the question is not asked, “Are they doing anything? Why don’t we hear from them? They should make discoveries, they should publish.”

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter XI (p. 223)

Lee & Shepard. Boston, Massachusetts, USA. 1896

### **Rosseland, Svein** 1894–1985

Norwegian astronomer

...an astronomical observatory of today looks more like a factory plant than an abode for philosophers. The poetry of constellations has given way to the lure of plate libraries, and the angel of cosmogenic speculation has been caught in a cobweb of facts insistently clamoring for explanations.

*Theoretical Astrophysics: Atomic Theory and the Analysis of Stellar Atmospheres and Envelopes*

Introduction (p. xi)

At The Clarendon Press. Oxford, England. 1936

### **Russell, Henry Norris** 1877–1957

American astronomer

The good spectroscopist — to parody the old jest — might perhaps be permitted to go, when he died, instruments and all, and set up an observatory on the moon.

Where Astronomers Go When They Die

*Scientific American*, Volume 149, Number 3, September 1933 (p. 112)

## **OBSERVER**

### **Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

He is lost, as an observer, who believes that he can, with impunity, affirm that for which he can adduce no evidence.

In Burt G. Wilder

Louis Agassiz, Teacher

*The Harvard Graduate's Magazine*, June, 1907

### **Cuvier, Georges** 1769–1832

French zoologist and statesman

The observer listens to nature; the experimenter questions and forces her to unveil herself.

In Claude Bernard

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter I (p. 6)

Henry Schuman, Inc. New York, New York, USA. 1927

### **de Chambaud, J. J. Ménuret**

No biographical data available

The name of observer has been given to the physicist who is content to examine the phenomena just as nature presents them to him; he differs from the experimental physicist who combines...and who sees only the result of his own combinations. This latter one never sees nature as it is in fact; he pretends by his labor to render nature more accessible to the senses, to raise the mask which conceals it from our eyes, but often he disfigures it and renders it unintelligible. Nature is always unveiled and bare for him who has eyes — or it is covered only by a slight gauze which the eye and reflection easily pierce — and the pretended mask exists only in the imagination, usually quite limited, of the manipulator of experiments.

In D. Diderot and J.L. d'Alembert (eds.)

Observateur

*Encyclopédie, ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers*, Volume 23 (p. 287D)

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Let the observer place himself so that he is, to the best of his knowledge, at rest. If he is a normal human being, he will seat himself in an arm-chair; if he is an astronomer, he will place himself on the sun or at the centre of the stellar universe.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter II (p. 38)

At The University Press. Cambridge, England. 1921

## **OBSTETRICS**

### **Hosmer, William**

No biographical data available

The present practice of medicine, especially obstetrics, must be set down not only as having an immoral tendency, but as, in itself, a gross, abusive, and shameless immorality.

*Young Lady's Book: Or, Principles of Female Education*

Chapter V (p. 191)

Miller, Orton & Mulligan. Buffalo, New York, USA. 1854

## **OCCAM'S RAZOR**

### **Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

It is unfortunate that we try to solve the simplest questions cleverly, and therefore make them unusually complicated. We should seek a simple solution.

*Note-Book of Anton Chekhov* (p. 20)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

While Occam's razor is a useful tool in the physical sciences, it can be a very dangerous implement in biology. It is thus very rash to use simplicity and elegance as a guide in biological research.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 13 (p. 138)

Basic Books, Inc. New York, New York, USA. 1988

**Dixon, Malcom**

No biographical data available

God doesn't always shave with Occam's razor.

In David Hall

Letters, God's Razor

*New Scientist*, Volume 142, Number 1922, April 23, 1994 (p. 51)

**Gettings, Fred**

No biographical data available

*Simplex sigillum veri*

Cut causes, be merry

Slash 'em and dock 'em

Said William of Ockham

Wiping his razor

On the sleeve of his blazer.

In Renee Haynes

Signs of Secrecy

*Times Literary Supplement*, June 18, 1981 (p. 688)

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

When two hypotheses are possible, we provisionally choose that which our minds adjudge to be the simpler, on the supposition that this is more likely to lead in the direction of the truth. It includes as a special case the principle of Occam's razor — *Entia non multiplicanda praeter necessitatem*.

*Physics and Philosophy*

Chapter VII (p. 183)

Dover Publications, Inc. New York, New York, USA. 1981

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.

*The Mathematical Principles of Natural Philosophy*

Book Three, Rule 1 (p. 270)

Printed for H.D. Symonds. London, England. 1803

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

We cannot in any sense be both the observers and the actors in any specific instance, or we shall fail properly to be either one or the other; yet we know that our life is built of these two modes, is part free and part inevitable, is part creation and part discipline, is part acceptance and part effort.

*Science and the Common Understanding*

Chapter 6 (p. 88)

Simon & Schuster. New York, New York, USA. 1954

**Stenger, Victor J.** 1935–

American physicist

The use of Occam's razor, along with the related critical, skeptical view toward any speculations about the unknown, is perhaps the most misunderstood aspect of the scientific method. People confuse doubt with denial. Science doesn't deny anything, but it doubts everything not required by the data. Note, however, that doubt does not necessarily mean rejection, just an attitude of disbelief that can be changed when the facts require it.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 1 (p. 26)

Prometheus Books. Buffalo, New York, USA. 1990

## OCEAN

**Aeschylus** 525 BCE–426 BCE

Greek playwright

Ye waves

That o'er th' interminable ocean wreath

Your crisped smiles.

*Prometheus Bound*, l. 95

Heritage Press. New York, New York, USA. 1966

**Beebe, William** 1877–1962

American ornithologist

The eternal one, the one most worthy and which will not pass from mind, the only other place comparable to these marvelous regions, must surely be naked space itself, out far beyond atmosphere, between the stars, where sunlight has no grip upon the dust and rubbish of planetary air, where the blackness of space, the shining planets, comets, suns, and stars must really be closely akin to the world of life as it appears to the eyes of an awed human being, in the open ocean, one half mile down.

*Half Mile Down*

Chapter 11 (p. 225)

Harcourt, Brace & Company. New York, New York, USA. 1934

**Beston, Henry** 1888–1968

American writer

The seas are the heart's blood of the earth.

*The Outermost House*

Chapter III (p. 47)

Rinehart & Company. New York, New York, USA. 1928

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

OCEAN, n. A body of water occupying about two-thirds of a world made for man — who has no gills.

*The Enlarged Devil's Dictionary* (p. 207)  
Doubleday. Garden City, New York, USA. 1967

**Bishop Joseph Hall** 1574–1656  
English bishop and satirist

There is many a rich stone laid up in the bowels of the earth, many a fair pearle in the bosome of the sea, that never was seene nor never shall bee.

*The Works of the Right Reverend Father in God, Joseph Hall* (Volume 1) Contemplations (p. 115)  
Printed by C. Whittingham. London, England. 1808

**Browning, Robert** 1812–89  
English poet

The sea heaves up, hangs loaded o'er the land,  
Breaks there, and buries its tumultuous strength.

*The Poems and Plays of Robert Browning*  
Luria  
Act I  
The Modern Library. New York, New York, USA. 1934

**Bryant, William Cullen** 1794–1878  
American poet

That make the meadows green; and, poured round all,  
Old Ocean's gray and melancholy waste, — Are but the solemn decorations all  
Of the great tomb of man.

*Poems*  
Thanatopsis  
D. Appleton. New York, New York, USA. 1874

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
English Romantic poet and satirist

Time writes no wrinkle on thine azure brow,  
Such as Creation's dawn beheld, thou rollest now.

*The Complete Poetical Works of Byron*  
Childe Harold  
Canto IV, Stanza 182  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

Roll on, thou deep and dark blue Ocean — roll!  
Ten thousand fleets sweep over thee in vain;  
Man marks the earth with ruin — his control  
Stops with the shore.

*The Complete Poetical Works of Byron*  
Childe Harold  
canto IV, Stanza 179  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Carson, Rachel** 1907–64  
American marine biologist and author

There is no drop of water in the ocean, not even in the deepest parts of the abyss, that does not know and

respond to the mysterious forces that create the tide. No other force that affects the sea is so strong.

*The Sea Around Us*  
Part II, Chapter 3 (p. 149)  
Oxford University Press, Inc. New York, New York, USA. 1989

Unmarked and trackless though it may seem to us, the surface of the ocean is divided into definite zones, and the pattern of the surface water controls the distribution of its life.

*The Sea Around Us*  
Part I, Chapter 2 (p. 20)  
Oxford University Press, Inc. New York, New York, USA. 1989

The ocean is the earth's greatest storehouse of minerals.

*The Sea Around Us*  
Part III, Chapter 2 (p. 185)  
Oxford University Press, Inc. New York, New York, USA. 1989

The edge of the sea is a strange and beautiful place. All through the long history of Earth it has been an area of unrest where waves have broken heavily against the land, where the tides have pressed forward over the continents, receded, and then returned. For no two successive days is the shore line precisely the same. Not only do the tides advance and retreat in their eternal rhythms, but the level of the sea itself is never at rest. It rises or falls as the glaciers melt or grow, as the floor of the deep ocean basins shift under its increasing load of sediments, or as the earth's crust along the continental margins warps up or down in adjustment to strain and tension. Today a little more land may belong to the sea, tomorrow a little less. Always the edge of the sea remains an elusive and indefinable boundary.

*The Edge of the Sea*  
Chapter I (p. 1)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

The face of the sea is always changing. Crossed by colors, lights, and moving shadows, sparkling in the sun, mysterious in the twilight, its aspects and its moods vary hour by hour.

*The Sea Around Us*  
Part I, Chapter 3 (p. 29)  
Oxford University Press, Inc. New York, New York, USA. 1989

The continents themselves dissolve and pass to the sea, in grain after grain of eroded land...

*The Sea Around Us*  
Part III, Chapter 14 (p. 212)  
Oxford University Press, Inc. New York, New York, USA. 1989

Every living thing of the ocean, plant and animal alike, returns to the water at the end of its own life span the materials that had been temporarily assembled to form its body. So there descends into the depths a gentle never-ending rain of the disintegrating particles of what once were living creatures of the sunlit surface waters, or of those twilight regions beneath.

Undersea  
*Atlantic Monthly*, September 1937

**Cornwall, Barry (Bryan Waller Procter)** 1787–1874

English author

The sea! the sea! the open sea!  
 The blue, the fresh, the ever free!  
 Without a mark, without a bound,  
 It runneth the earth's wide regions round;  
 It plays with the clouds; it mocks the skies;  
 Or like a cradled creature lies.

In Richard Green Parker and J. Madison Watson (eds)  
*The National Fourth Reader*  
 The Sailor's Song (p. 156)  
 Bams & Burr. New York, New York, USA. 1864

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The seas perhaps hold the highest hopes for continued life. Yet, what does man do to the seas? Not only does he grab with greed the creatures of the sea, he turns nature's cradle for life into a receptacle for garbage and filth. This is man whose life blood contains sodium, potassium, and calcium in almost the same proportions as they still exist in the environment of mother sea which encouraged his birth.

In Maurice F. Strong (ed.)

*Who Speaks for Earth?*

Unity Through Diversity (p. 44)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1973

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Behold the Sea,  
 The opaline, the plentiful and strong,  
 Yet beautiful as is the rose in June,  
 Fresh as the trickling rainbow of July;  
 Sea full of food, the nourisher of kinds,  
 Purger of earth, and medicine of men;  
 Creating a sweet climate by my breath,  
 Washing out harms and griefs from memory,  
 And, in my mathematic ebb and flow,  
 Giving a hint of that which changes not.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

Seashore (p. 242)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Forbes, Edward** 1815–54

English naturalist

Moreover it is becoming the Britons, whether scientific or unscientific, who boast at all fitting occasions of their aptitude to rule the waves, should know something of the population of their saline empire, especially of those parts of it immediately in contact with their terrestrial domain, and the coasts of the Continent to which our United Kingdom appertains.

*The Natural History of the European Seas*

Chapter I (p. 3)

John Van Voorst. London, England. 1859

...beneath the waves there are many dominions yet to be visited, and kingdoms to be discovered; and he who venturously brings up from the abyss enough of their inhabitants to display the physiognomy of the country, will taste that cup of delight, the sweetness of whose draught those only who have made a discovery know.

*The Natural History of the European Seas*

Chapter I (p. 11)

John Van Voorst. London, England. 1859

**Gould, Hannah Flagg** 1789–1865

American poet

Alone I walked on the ocean strand,  
 A pearly shell was in my hand;  
 I stooped, and wrote upon the sand  
 My name, the year, the day.  
 As onward from the sport I passed,  
 One lingering look behind I cast,  
 A wave came rolling high and fast,  
 And washed my lines away.

*Poems*

A Name in the Sand

Hilliard, Gray &amp; Company. Boston, Massachusetts, USA. 1839

**Gray, Thomas** 1716–71

English poet

Full many a gem of purest ray serene,  
 The dark unfathomed caves of ocean bear.

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*

Elegy in a Country Churchyard

Stanza 14

J. Blackwood. London, England. 1800

**Henderson, Lawrence** 1878–1942

American biochemist

No philosopher's or poet's fancy, no myth of a primitive people has ever exaggerated the importance, the usefulness, and above all the marvelous beneficence of the ocean for the community of living things.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*

Chapter V, Section III (p. 190)

The Macmillan Company. New York, New York, USA. 1913

The regulatory devices of our modern laboratories have not yet succeeded in rivaling the oceans. Singly, certain conditions, for example, temperature, alkalinity, and concentration, may be more accurately regulated by man, though on a small scale only; but the regulation of all such properties together is not yet possible. The only known improvement upon the ocean is the body of a higher warm-blooded animal. Here, however, the processes of organic evolution have begun with the ocean, and in several respects merely perfected existing arrangements.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*



Chapter V, Section III (p. 186)  
The Macmillan Company. New York, New York, USA. 1913

### Hess, Harry

No biographical data available

The birth of the oceans is a matter of conjecture, the subsequent history is obscure, and the present structure is just beginning to be understood. Fascinating speculation on these subjects has been plentiful, but not much of it predating the last decade holds water.

In A.E.J. Engel, Harold L. James, and B.F. Leonard (eds.)  
*Petrologic Studies — A Volume in Honor of A.F. Buddington*  
History of the Ocean Basins (p. 599)  
The Geological Society of America. 1962

### Heyerdahl, Thor 1914–2002

Norwegian ethnographer and adventurer

...bear in mind that the ocean currents circulate with no regard for political borderlines, and that nations can divide the land, but the revolving ocean, indispensable and yet vulnerable, will forever remain a common human heritage.

In Maurice F. Strong (ed.)  
*Who Speaks for Earth?*  
How Vulnerable Is the Ocean? (p. 63)  
W.W. Norton & Company, Inc. New York, New York, USA. 1973

### Horsfield, Brenda

No biographical data available

### Stone, Peter Bennet

No biographical data available

...there is on the other hand some encouragement in the reflection that Oceanography has usually only ruined the reputations of people who dared to speculate too little and thought on too small a scale. She has smiled most benignly on those who backed the most daring and outrageous possibility...

*The Great Ocean Business*  
Chapter 7 (p. 150)  
Coward, McCann & Geoghegan. New York, New York, USA. 1972

### Ingelow, Jean 1820–97

English poet and novelist

Quoth the Ocean, "Dawn! O fairest, clearest,  
Touch me with thy golden fingers bland;  
For I have no smile till thou appearest  
For the lovely land."

*The Poetical Works of Jean Ingelow*  
Winstanley  
The Apology  
John B. Alden, Publisher. New York, New York, USA. 1883

### Kennedy, John F. 1917–63

35<sup>th</sup> president of the United States

Knowledge of the oceans is more than a matter of curiosity. Our very survival may hinge upon it.

*General Government Matters: Department of Commerce, and Related Agencies Appropriations for 1862*  
Letter to the President of the Senate on Increasing the National Effort, in  
Oceanography, March 29, 1961 (p. 549)  
U.S. Government Printing Office. Washington, D.C. 1961

### Landor, Walter Savage 1775–1864

English poet and essayist

Past are three summers since she first beheld  
The ocean; all around the child await  
Some exclamation of amazement here:  
She coldly said, her long-lasht eyes abased,  
Is this the mighty ocean? is this all?

*Gebir*  
Book V, l. 133–137  
Woodstock Books. Oxford, England. 1993

But I have sinuous shells of pearly hue;

....  
Shake one, and it awakens; then apply  
Its polished lips to your attentive ear,  
And it remembers its august abodes,  
And murmurs as the ocean murmurs there.

*Gebir*  
Book I, l. 169, 173–176  
Woodstock Books. Oxford, England. 1993

### Larcom, Lucy 1824–93

American writer

The land is dearer for the sea,  
The ocean for the shore.

*The Poetical Works of Lucy Larcom*  
On the Beach  
Stanza 11  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1884

### Lee-Hamilton, Eugene J. 1845–1907

English poet

The hollow sea-shell, which for years hath stood  
On dusty shelves, when held against the ear  
Proclaims its stormy parent, and we hear  
The faint, far murmur of the breaking flood.  
We hear the sea. The Sea? It is the blood  
In our own veins, impetuous and near.

*Sea-Shell Murmurs*  
*The Living Age*, Volume CLVI, January, February, March 1883 (p. 322)

### Longfellow, Henry Wadsworth 1807–82

American poet

Would'st thou, — so the helmsman answered,  
Learn the secret of the sea?  
Only those who brave its dangers  
Comprehend its mystery!

*The Seaside and the Fireside*  
The Secret of the Sea  
Stanza 8  
Ticknor, Reed & Fields. Boston, Massachusetts, USA. 1850

**Melville, Herman** 1819–91

American novelist

Not only is the sea such a foe to man who is an alien to it, but it is also a fiend to its own offspring; worse than the Persian host who murdered his own guests; sparing not the creatures which itself hath spawned. Like a savage tigress that tossing in the jungle overlays her own cubs, so the sea dashes even the mightiest whales against the rocks, and leaves them there side by side with the split wrecks of ships. No mercy, no power but its own controls it. Panting and snorting like a mad battle steed that has lost its rider, the masterless ocean overruns the globe.

In *Great Books of the Western World* (Volume 48)*Moby Dick*

Chapter 58 (p. 204)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...that same image [of Narcissus] we ourselves see in all rivers and oceans. It is the image of the ungraspable phantom of life: and this is the key to it all.

In *Great Books of the Western World* (Volume 48)*Moby Dick*

Chapter 1 (pp. 2–3)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Milton, John** 1608–74

English poet

...a dark

Illimitable ocean without bound,  
Without dimension, where length, breadth, and height  
And time and place are lost...

In *Great Books of the Western World* (Volume 32)*Paradise Lost*

Book II, l. 891–894

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mishima, Yukio** 1925–70

Japanese writer

Down beneath the spray, down beneath the whitecaps, that beat themselves to pieces against the prow, there were jet-black invisible waves, twisting and coiling their bodies. They kept repeating their patternless movements, concealing their incoherent and perilous whims.

*The Sound of Waves*

Chapter 14 (p. 125)

Berkeley Publishing Group. New York, New York, USA. 1961

**Montgomery, Robert**

No biographical data available

And Thou, vast Ocean! on whole awful face  
Time's iron feet can print no ruin trace.

*Notes and Queries*

The Omnipresence of the Deity

Part I, Stanza 20

Oxford University Press. London, England. 1849

**Rossetti, Christina Georgina** 1830–94

English poet

Why does the sea moan evermore?  
Shut out from heaven it makes its moan,  
It frets against the boundary shore;  
All earth's full rivers cannot fill  
The sea, that drinking thirsteth still.

In William Michael Rossetti

*The Poetical Works of Christina Georgina Rossetti*

By the Sea

Stanza 1

Macmillan &amp; Company Ltd. London, England. 1911

**Shelley, Percy Bysshe** 1792–1822

English poet

There the sea I found  
Calm as a cradled child in dreamless slumber bound.

*The Poems of Percy Bysshe Shelley*

The Revolt of Islam, Canto I, Stanza 15

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Stoddard, Richard Henry** 1825–1903

American critic and poet

Thou wert before the Continents, before  
The hollow heavens, which like another sea  
Encircles them and thee, but whence thou wert,  
And when thou wast created, is not known,  
Antiquity was young when thou wast old.

In Anna Ward (ed.)

*Surf and Wave: The Sea as Sung by the Poets*

Hymn to the Sea, l. 104

Thomas Y. Crowell &amp; Company. New York, New York, USA. 1883

**Taylor, Bayard** 1825–78

American journalist and author

We follow and race  
In shifting chase,  
Over the boundless ocean-space!  
Who hath beheld when the race begun?  
Who shall behold it run?

In Anna Ward (ed.)

*Surf and Wave: The Sea as Sung by the Poets*

The Waves

Thomas Y. Crowell &amp; Company. New York, New York, USA. 1883

**Tennyson, Alfred (Lord)** 1809–92

English poet

Break, break, break,  
On thy cold gray stones, O sea!  
And I would that my tongue could utter  
The thoughts that arise in me.

*Alfred Tennyson's Poetical Works*

"Break, Break, Break"

Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The ocean is a wilderness reaching round the globe,  
wilder than a Bengal jungle, and fuller of monsters,

washing the very wharves of our cities and the gardens  
of our seaside residences.

*Cape Cod*

Chapter IX (p. 148)

Princeton University Press. Princeton, New Jersey, USA. 2004

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The sea is flowing ever,

The land retains it never.

The Works of Johann Wolfgang von Goethe

*Hikmet Nameh*

Book of Proverbs (p. 395)

J.H. Moore. Philadelphia, Pennsylvania, USA. 1901

**Webb, Charles Henry** 1834–1905

American writer

I send thee a shell from the ocean-beach;  
But listen thou well, for my shell hath speech.  
Hold to thine ear

And plain thou'lt hear

Tales of ships.

*Vagrom Verse*

With a Nantucket Shell

Ticknor & Company. Boston, Massachusetts, USA. 1889

**Weisz, Paul B.** 1919–

German-born American chemical engineer and biomedical researcher

The Pacific. You don't comprehend it by looking at a  
globe, but when you're traveling at four miles a second  
and it still takes you twenty-five minutes to cross it, you  
know it's big.

In Kevin W. Kelley

*The Home Planet*

With Plate 64

Addison-Wesley. Reading, Massachusetts, USA. 1988

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

To me the sea is a continual miracle,  
The fishes that swim — the rocks — the motion of the  
waves — the ships with men in them,  
What stranger miracles are there?

*Complete Poetry and Collected Prose*

Miracles

The Library of America. New York, New York, USA. 1982

**Wordsworth, William** 1770–1850

English poet

I have seen

A curious child, who dwelt upon a tract  
Of inland ground, applying to his ear  
The convolutions of a smooth-lipped shell;  
To which, in silence hushed, his very soul  
Listened intensely; and his countenance soon  
Brightened with joy; for from within were heard  
Murmurings, whereby the monitor expressed  
Mysterious union with its native sea.

*Poems By William Wordsworth*

Excursions, Book IV

Ginn and Company. Boston, Massachusetts, USA. 1897

## OCEANOGRAPHY

**Spilhaus, Athelstan** 1911–78

South-African born American geophysicist and oceanographer

The science of oceanography is not a discipline but an  
adventure wherein any discipline or combination of dis-  
ciplines may be focused on understanding and using the  
sea and all that is in it.

*Annual Report of the Board of Regents of the Smithsonian Institution,  
1964*

The Future of Oceanography (p. 361)

Government Printing Office. Washington, D.C. 1965

## ODDS

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Choose a point in space at random and the odds against it  
being occupied by a star are enormous.

*The Universe Around Us*

Chapter I (p. 102)

The Macmillan Company. New York, New York, USA. 1929

**Stoppard, Tom** 1937–

Czech-born English playwright

Life is a gamble at terrible odds — if it was a bet you  
wouldn't take it.

*Rosencrantz and Guildenstern Are Dead*

Act Three (p. 115)

Grove Press, Inc. New York, New York, USA. 1967

## OMEGA POINT

**Barrow, John D.** 1952–

English theoretical physicist

**Tipler, Frank** 1947–

American physicist

If life evolves in all of the many universes in a quantum  
cosmology, and if life continue to exist in all of these  
universes, then all of these universes, which include all  
possible histories among them, will approach the Omega  
Point. At the instant the Omega Point is reached, life will  
have gained control of all matter and forces not only in  
a single universe, but in all universes whose existence  
is logically possible; life will have spread into all spa-  
tial regions in all universes which could locally exist,  
and will have stored an infinite amount of information,  
including all bits of knowledge which it is logically  
possible to know.

*The Anthropic Cosmological Principle*

Chapter 10 (p. 676)  
Clarendon Press. Oxford, England. 1986

## OPINION

**Adams, George** 1750–95  
English instrument maker

Mankind are always ready to adopt or reject what accords with pre-conceived opinions, to make reason subservient to prejudice, and to reject without examination, whatever is discordant with a received system; thus closing the door of science, and excluding themselves from the benefit of light.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture II (p. 27)  
Printed by R. Hindmarsh. London, England. 1794

**Bernard, Claude** 1813–78  
French physiologist

...no man's opinion, formulated in a theory or otherwise, may be deemed to represent the whole truth in the sciences. It is a guide, a light, but not an absolute authority. The revolution which the experimental method has effected in the sciences is this: it has put a scientific criterion in the place of personal authority. The experimental method is characterized by being dependent only on itself, because it includes within itself its criterion — experience.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter II, Section IV (p. 40)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Bourne, William** 1535–82  
English mathematician

...for that my opinion doth differ from some of the ancient writers in natural Philosophy, it is possible that it may be utterly disliked of and condemned to be of no truth.

*The Treasure for Travelers*  
The Fyfh Booke, To The Reader (p. 3)  
Publisher undetermined

**Browne, Sir Thomas** 1605–82  
English author and physician

Where we desire to be informed, 'tis food to contest with men above ourselves; but, to confirm and establish our opinions, 'tis best to argue with judgments below our own, that the frequent spoils and victories over their reasons may settle in ourselves an esteem and confirmed opinion of our own.

In Charles Sayle (ed.)  
*The Works of Sir Thomas Browne* (Volume 1)  
Religio Medici  
The First Part, Section 6 (p. 12)  
John Grant. Edinburgh, Scotland. 1912

**Crum, H. A.**  
No biographical data available

Let us also remember that plants vary and opinions vary. One man's fish is another man's poison. One man's moss is another man's mess.

*The Bryologist*  
Traditional Make-Do Taxonomy, Volume 88, 1985 (p. 22)

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

It is never worth a first class man's time to express a majority opinion. By definition there are plenty of others to do that.

*A Mathematician's Apology*  
Foreword (p. 46)  
Cambridge University Press. Cambridge, England. 1967

**Heinlein, Robert A.** 1907–88  
American science fiction writer

Oh, I have strong opinions, but a thousand reasoned opinions are never equal to one case of diving in and finding out.

*Time Enough for Love*  
Prelude, Chapter I (p. 31)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Hering, Constantine** 1800–80  
Father of American homeopathy

Among men of deliberate and acute reflection, no difference of opinion can exist relative to the truth of a discovery which rests upon the basis of actual experiment.

In S. Hahnemann  
*Organon of Homoeopathic Medicine*  
Preface (p. xii)  
W. Radde. New York, New York, USA. 1843

**Joubert, Joseph** 1754–1824  
French moralist

Our opinions are clouds between us and the clear skies of truth.

Translated by H.P. Collins  
*Pensées and Letters of Joseph Joubert*  
Chapter X (p. 83)  
Books for Libraries Press, Freeport, New York, USA. 1972

**Lippmann, Walter** 1889–1974  
American journalist and author

True opinions can prevail only if the facts to which they refer are known; if they are not known, false ideas are just as effective as true ones, if not a little more effective.

*Liberty and the News*  
Liberty and the News (pp. 64–65)  
Transaction Publishers. New Brunswick, New Jersey, USA. 1995

**Locke, John** 1632–1704  
English philosopher and political theorist

New opinions are always suspected, and usually opposed, without any other reason but because they are not already common.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Dedicatory Epistle (p. 85)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Milton, John 1608–74

English poet

...opinion in good men is but knowledge in the making.

In *Great Books of the Western World* (Volume 32)

*Areopagitica* (p. 406)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Pearson, Karl 1857–1936

English mathematician

We never think of taking the opinion of the man in the street on the reasons why the moon does not keep her calculated times; we do not ask his opinion on the value of the opsonic index; we recognise that these are problems which require special training and analysis wholly beyond his grasp, but we still think he is quite capable of expressing an opinion on whether the employment of women is good for her infants or not, although he may be in possession of no data, and although, if he were, he would be quite incapable of interpreting them.

*Eugenics Laboratory Lecture Series*

The Academic Aspect of the Science of National Eugenics, 7, 1911

(p. 20)

### Terence 190 BCE–158 BCE

Roman comic dramatist

...as many men, so many opinions...

In T. A. Blythe

*A Literal Translation of the Phormio by Terence*, (p. 22)

Simkin, Marshall & Company. London, England. 1880

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

Our opinions do not really blossom into fruition until we have expressed them to someone else.

In Opie Read

*Mark Twain and I*

Five Quarts of Moonlight Juice (p. 38)

Reilly & Lee. Chicago, Illinois, USA. 1940

Opinions based upon theory, superstition, and ignorance are not very precious.

In Albert Bigelow Paine

*Mark Twain's Letters* (Volume 2)

Letter to J. H. Twitchell, 1/27/1900 (p. 695)

Harper & Brothers. New York, New York, USA. 1917

### Young, Thomas 1773–1829

English polymath

The object of the present dissertation is not so much to propose any opinions which are absolutely new, as to refer some theories, which have been already advanced, to their original inventors, to support them by additional evidence, and to apply them to a great number of diversified facts, which have hitherto been buried in obscurity. Nor is it absolutely necessary in this instance to produce a single new experiment; for of experiments there is already an ample store.

On the Theory of Light and Colours

*Philosophical Transactions of the Royal Society of London*, Volume 92,

1802 (p. 12)

## OPIUM

### De Quincey, Thomas 1785–1859

English essayist

Oh! just, subtle, and mighty opium! that to the hearts of poor and rich alike, for the wounds that will never heal, and for “the pangs that tempt the spirit to rebel,” bringest an assuaging balm; eloquent opium!

*The Collected Writings of Thomas De Quincey* (Volume 3)

*Confessions of an English Opium Eater*

Part II (p. 396)

A. & C. Black. London, England. 1897

### Melville, Herman 1819–91

American novelist

... whenever my hypos get such an upper hand of me, that it requires a strong moral principle to prevent me from deliberately stepping into the street, and methodically knocking people's hats off — then, I account it high time to get to sea as soon as I can.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 1 (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## OPTICS

### Day, Roger E.

No biographical data available

I wish I were a crystal lens,  
With aplanatic face,  
And lived at Number Seven Ten,  
Illumination Place,  
City of Glass.

Fantasy of Glass

*The Physics Teacher*, Volume 3, Number 6, September 1965 (p. 288)

### Digges, Leonard ca. 1520–59

English mathematician

But marvelous are the conclusions that may be performed by glasses concave and convex of Circulare and parabolical formes, using for multiplication of beames sometime

the aide of Glasses transparent, which by fraction should unite or dissipate the images or figures presented by the reflection of other. By these kinde of Glasses or rather frames of them, placed in due Angles, yee may not only set out of the proportion of an whole region, ye may represent before your eye the lively image of every Towne, Village, &c and that in as little or great space or place as ye will prescribe, but also augment and dilate any parcell thereof.

*A Geometrical Practical Treatise Named Pantometria, Divided into Three Bookes, Longimetra, Planimetra, and Stereometria*  
Chapter 21  
Publisher undetermined

**Grosseteste, Robert** 1175–1253  
English statesman

This part of Perspectiva, when well understood, shows us how we may make things a very long distance off appear as if placed very close, and larger near things appear very small, and how we may make small things placed at a distance appear any size we want, so that it may be possible for us to read the smallest letters at incredible distances, or to count sand, or grains, or seeds, or any sort of minute objects...

In A.C. Crombie  
*Science, Optics, and Music in Medieval and Early Modern Thought*  
Chapter 9, Section II (p. 198)  
The Hambledon Press. London, England. 1990

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

As happens in all the sciences in which Geometry is applied to matter, the demonstrations concerning Optics are founded on truths drawn from experiences.

*A Treatise on Light*  
Chapter I (p. 1)  
Macmillan & Company Ltd. London, England. 1912

**Joyce, James** 1882–1941  
Irish-born author

He faced about and, standing between the awnings, held out his right arm at arm's length toward the sun. Wanted to try that often. Yes; completely. The tip of his little finger blotted out the sun's disc. Must be the focus where the rays cross.

*Ulysses* (p. 164)  
Random House, Inc. New York, New York, USA. 1946

**Marton, Ladislaus**  
No biographical data available

“Electron optics I believe,”  
He often gravely said,  
“Concern a branch of knowledge  
That is way above my head.”

Alice in Electronland  
*American Scientist*, Volume 31, Number 3, July 1943 (p. 251)

## ORBIT

**Kepler, Johannes** 1571–1630  
German astronomer

The testimony of the ages confirm that the motions of the planets are orbicular.

*New Astronomy*  
Part I, 1 (p. 115)  
At the University Press. Cambridge, England. 1992

## ORDER

**Anaxagoras** ca. 500 BCE–428 BCE  
Greek philosopher of nature

Mind orders all things.

In Fabre  
*The Glow-Worm* (p. 234)  
Hodder & Stoughton Ltd. London, England. 1919

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The human understanding is of its own nature prone to abstractions, and gives a substance and reality to things which are fleeting.

In John M. Robinson (ed)  
*The Philosophical Woks of Francis Bacon*  
*Novum Organon*  
LI (p. 267)  
George Routledge & Sons, Ltd. London, England. 1905

**Birkhoff, Garrett** 1911–96  
American mathematician

...there is hidden order in Nature, to be found only by patient search.

*Hydrodynamics: A Study in Logic, Fact, and Simulation*  
Conclusion (p. 179)  
Princeton University Press. Princeton, New Jersey, USA. 1950

**Brown, Thomas**  
No biographical data available

Even the rudest wanderer in the fields...finds that the profusion of blossoms around him — in the greater number of which he is able himself to discover many striking resemblances — may be reduced to some order of arrangement.

Quoted in Hugh Miller  
*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*  
Lecture First (p. 37)  
Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Browne, Sir Thomas** 1605–82  
English author and physician

All things begin in order, so shall they end, and so shall they begin again; according to the ordainer of order, and the mysticall mathematicks of the City of Heaven.

In John Carter (ed.)  
*Urne Buriall and The Garden of Cyrus*  
 The Garden of Cyrus, Chapter V (p. 114)  
 Cassell. London, England. 1932

**Darwin, Charles Robert** 1809–82  
 English naturalist

An organic being is a microcosm — a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars of heaven.

*The Variation of Animals and Plants Under Domestication* (Volume 2)  
 Chapter XXVII (p. 399)  
 D. Appleton & Company. New York, New York, USA

**Davies, Paul Charles William** 1946–  
 British-born physicist, writer, and broadcaster

The universe contains vastly more order than Earth-life could ever demand. All those distant galaxies, irrelevant for our existence, seem as equally well ordered as our own.

In Eugene F. Mallove  
*The Quickening Universe: Cosmic Evolution and Human Destiny* (p. 61)  
 St. Martin's Press. New York, New York, USA. 1987

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

If you take a pack of cards as it comes from the maker and shuffle it for a few minutes, all trace of the original systematic order disappears. The order will never come back however long you shuffle. Something has been done which cannot be undone, namely, the introduction of a random element in place of the arrangement.

*The Nature of the Physical World*  
 Chapter IV (p. 63)  
 The Macmillan Company. New York, New York, USA. 1930

**Frankel, Felice** 1945–  
 Science photographer

**Whitesides, George M.**  
 American chemist

Order is repetition, regularity, symmetry, simplicity. It forms the spine of our efforts to measure, control, and understand.

*On the Surface of Things: Images of the Extraordinary in Science*  
 Order (p. 63)  
 Chronicle Books. San Francisco, California, USA. 1997

**Huntington, Edward V.** 1874–1952  
 Mathematician

The fundamental importance of the subject of order may be inferred from the fact that all the concepts required in geometry can be expressed in terms of the concept of order alone.

*The Continuum, and Other Types of Serial Order*  
 Introduction (p. 2)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1917

**Huxley, Thomas Henry** 1825–95  
 English biologist

...the man of science knows that here, as everywhere, perfect order is manifested; that there is not a curve of the waves, not a note in the howling chorus, not a rainbow glint on a bubble which is other than a necessary consequence of the ascertained laws of nature; and that with sufficient knowledge of the conditions competent physico-mathematical skill could account for, and indeed predict, every one of those 'chance' events.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter XIV (p. 554)  
 D. Appleton & Company. New York, New York, USA. 1896

**Kline, Morris** 1908–92  
 American mathematics professor and writer

Is there a law and order in this universe or is its behavior merely the working of chance and caprice? Will the Earth and other planets continue their motions around the sun or will some unknown body, coming from great distances, rush through our planetary system and alter the course of every planet? Cannot the sun some day explode, as other suns are doing daily, and burn us all to a crisp? Was man deliberately planted on a planet especially prepared for his existence or is he merely an insignificant concomitant of accidental cosmic circumstances?

*Mathematics in Western Culture*  
 Chapter XXIV (p. 374)  
 Oxford University Press, Inc. New York, New York, USA. 1953

**Lewis, C. S. (Clive Staples)** 1898–1963  
 British author, scholar, and popular theologian

To the modern man it seems simply natural that an ordered cosmos should emerge from chaos, that life should come out of the inanimate, reason out of instinct, civilization out of savagery, virtue out of animalism. This idea is supported in his mind by a number of false analogies: the oak coming from the acorn, the man from the spermatozoon, the modern steamship from the primitive coracle. The supplementary truth that every acorn was dropped by an oak, every spermatozoon derived from a man, and the first boat by something so much more complex than itself as a man of genius, is simply ignored. The modern mind accepts as a formula for the universe in general the principle "almost nothing may be expected to turn into almost everything" without noticing that the parts of the universe under our direct observation tell a quite different story.

*Present Concerns: Essays by C.S. Lewis*  
 Modern Man and His Categories of Thought (p. 63)  
 Harcourt Brace Jovanovich. New York, New York, USA. 1986

**Lucretius** ca. 99 BCE–55 BCE  
Roman poet

For verily not by design did the first-beginnings of things station themselves each in its right place guided by keen intelligence, nor did they bargain sooth to say what motions each should assume, but because many in number and shifting about in many ways throughout the universe they are driven and tormented by blows during infinite time past, after trying motions and unions of every kind at length they fall into arrangements such as those out of which our sum of things has been formed...

In *Great Books of the Western World* (Volume 12)

*Lucretius: On the Nature of Things*

Book One, l. 1020 (p. 13)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mann, Thomas** 1875–1955  
German-born American novelist

...order and simplification are the first steps toward the mastery of a subject — the actual enemy is the unknown.

*The Magic Mountain*

Chapter V

Encyclopædic (pp. 245–246)

Alfred A. Knopf. New York, New York, USA. 1966

**Miller, Jr., G. Tyler**  
No biographical data available

Man continually engages in attempts to create order, but only at the expense of greater disorder in the surroundings.

*Energetics, Kinetics, and Life: An Ecological Approach* (p. 200)

Wadsworth Publishing Company. Belmont, California, USA. 1971

**Moulton, Forest Ray** 1872–1952  
American astronomer

To an astronomer the most remarkable and interesting thing about that part of the physical universe with which he has become acquainted is not its vast extent in space, nor the number and great masses of its stars, nor the violent forces that operate in the stars, nor in the long periods of astronomical time, but that which holds him awestruck is the perfect orderliness of the universe and the majestic succession of the celestial phenomena.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 30)

The University of Chicago Press. Chicago, Illinois, USA. 1927

Now we find ourselves a part of a Universal Order of which we did not dream and whose alphabet we are just beginning to learn. Instead of shrinking it to our measure, we contemplate its infinite orderliness and set no limits to the goal our race may hope to attain.

*Astronomy*

Chapter XVI (p. 533)

The Macmillan Company. New York, New York, USA. 1931

The orderliness of the universe is the supreme discovery in science; it is that which gives us hope that we shall be able to understand not only the exterior world but also our own bodies and our own mind.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 30)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

We cannot make much progress without a faith that in this bewildering field of human experience, which is so new and so much more complicated than we thought even five years ago, there is a unique and necessary order: not an order that we can tell a priori, not an order that we can see without experience, but an order which means that the parts fit into a whole and that the whole requires the parts.

*The Constitution of Matter* (p. 37)

Oregon State System of Higher Education. Eugene, Oregon, USA. 1956

One may only hope that what is at the moment just a picture of chaos will ultimately reveal again that deep harmony and order which one has always found in the physical world when one has pushed hard, and which is very beautiful indeed.

In Lincoln Barnett

*Writing on Life: Sixteen Close-Ups*

Physicist Oppenheimer (p. 358)

William Sloane Associates, Publishers. New York, New York, USA.

1951

**Picard, Charles Emile** 1856–1941  
French mathematician

We no longer pretend to be able to grasp reality in a physical theory; we see in it rather an analytic or geometric mold useful and fertile for a tentative representation of phenomena, no longer believing that the agreement of a theory with experience demonstrates that the theory expresses the reality of things. Such statements have sometimes seemed discouraging; we ought rather to marvel that, with representations of things more or less distant and discolored, the human spirit has been able to find its way through the chaos of so many phenomena and to derive from scientific knowledge the ideas of beauty and harmony. It is no paradox to say that science puts order, at least tentative order, into nature.

In Lucienne Felix

*The Modern Aspect of Mathematics* (p. 31)

Basic Books, Inc. New York, New York, USA. 1960

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

To obtain a result of real value, it is not enough to grind out calculations or to have a machine to put things in



order; it is not order alone, it is unexpected order, which is worth while. The machine may gnaw on the crude fact; the soul of the fact will always escape it.

*The Foundations of Science*

Science and Method, Book I

Chapter II (pp. 373–374)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

Where order in variety we see,  
And where, though all things differ, all agree.

*The Complete Poetical Works*

Windsor Forest, l. 15–16

Houghton Mifflin Company. New York, New York, USA. 1903

**Reichenbach, Hans** 1891–1953

German philosopher of science

...whereas inorganic nature was seen to be controlled by the laws of cause and effect, organic nature appeared to be governed by the law of purpose and means.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 192)

University of California Press. Berkeley, California, USA. 1951

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Dimensions, in geometry, are a development of order. The conception of a limit, which underlies all higher mathematics, is a serial conception. There are parts of mathematics which do not depend upon the notion of order, but they are very few in comparison with the parts in which this notion is involved.

*Introduction to Mathematical Philosophy*

Chapter IV (p. 29)

Dover Publications, Inc. New York, New York, USA. 1993

The notion of continuity depends upon that of order, since continuity is merely a particular type of order.

*Mysticism and Logic and Other Essays*

Chapter V (p. 91)

Longmans, Green & Company. London, England. 1925

**Sarton, May** 1912–95

American poet and novelist

I see a certain order in the universe and math is one way of making it visible.

*As We Are Now* (p. 38)

W.W. Norton & Company, Inc. New York, New York, USA. 1973

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

The heavens themselves, the planets, and this centre,  
Observe degree, priority, and place,  
Insisture, course, proportion, season, form,  
Office, and custom, in all line of order.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Troilus and Cressida

Act I, Scene iii, l. 85–88

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

In the first place, there can be no living science unless there is a widespread instinctive conviction in the existence of an Order of Things, and, in particular, of an Order of Nature.

*Science and the Modern World*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1929

**Wöhler, Friedrich** 1800–82

German chemist

**von Liebig, Justice** 1803–73

German organic chemist

When in the dark province of organic nature, we succeed in finding a light point, appearing to be one of those inlets whereby we may attain to the examination and investigation of this province, then we have reason to congratulate ourselves, although conscious that the object before us is unexhausted.

*American Journal of Science and Arts*, Volume 26, 1834 (p. 261)

**Yang, Chen Ning** 1922–

Chinese-born American theoretical physicist

Nature possesses an order that one may aspire to comprehend.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1957

The Law of Parity Conservation and Other Symmetry Laws of Physics (p. 394)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## ORGAN TRANSPLANT

**Carrel, Alexis** 1873–1944

French surgeon and biologist

Thus, while the problem of the transplantation of organs has been solved from a surgical point of view, we see that this by no means suffices to render such operations of definite surgical practicability, and it will only be through a more fundamental study of the biological relationships existing between living tissues that the problems involved will come to be solved and thereby render possible the benefits to humanity which we hope to see accomplished in the future.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1912

Suture of Blood-Vessels and Transplantation of Organs (p. 464)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## ORGANIC CHEMISTRY

**Berzelius, Jöns Jacob** 1779–1848  
Swedish chemist

We have reached a point where we are beginning to see a theory of organic compounds; but if, instead of letting this develop as our experience grows, we want to base it on isolated facts, considered without regard for their relations with the general system of our knowledge, and by giving explanations which do not harmonise with the principles of the science, and if, moreover, we want to conclude that this lack of agreement must lead us to reject as erroneous principles which are already well established on other grounds, then we shall never succeed in finding the truth.

*Annals de chemie et de physique*, Volume 71, 1839

**Cram, Donald J.** 1919–2001  
American chemist

**Cram, Jane M.**

No biographical data available

No other profession is endowed with such a rich landscape, draws inspiration from so many fields of science, exercises the hand and mind in so many different ways, offers such opportunities to employ creative instincts, and mixes ideas, theory, and experiment on a daily basis. Hurrah for the science of organic chemistry, and for the joy it brings those who play the research game.

*Container Molecules and Their Guests*

Preface (p. vi)

Royal Society of Chemistry. Cambridge, England. 1994

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Drops of deliquescence glistened on his forehead,  
Whitened round his feet the dust of efflorescence,  
'Till one Monday morning when the flow suspended,  
There was no De Sauty.

Nothing but a cloud of elements organic  
C.O.H.N. Ferrum, Chlor. Flu. Sil. Potassa,  
Calc. Sod. Phosph. Mag. Sulphur, Mang.? Alumin.?  
Caprum?

Such as man is made of.

*The Professor at the Breakfast Table*

Chapter I

De Sauty (p. 33)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Hopkins, Frederick Gowland** 1844–89  
English biochemist

A very distinguished organic chemist long since dead, said to me in the late eighties: "The chemistry of the living? That is the chemistry of protoplasm; that is superchemistry; seek, my young friend, for other ambitions."

In Joseph Needham and Ernest Baldwin (eds.)

*Hopkins & Biochemistry*

Report of the British Association

Some Chemical Aspects of Life

1933 (p. 245)

**Kekulé, Friedrich August** 1829–96  
German chemist

We define organic chemistry as the chemistry of carbon compounds. In doing this, we see no opposition between organic and inorganic compounds. What has been known for a long time as organic chemistry and which more usefully may be called the chemistry of carbon compounds, is rather only a special section of pure chemistry which is dealt with separately because the large number and special importance of carbon compounds seems to make a special field of study necessary.... It must be emphasized that organic chemistry does not deal with the study of the chemical processes in the organs of plants and animals.

*Lehrbuch der Organischen Chemie* (Volume 1) (p. 10)

Publisher undetermined

**Thompson, Sir D'Arcy Wentworth** 1860–1948  
Scottish zoologist and classical scholar

The mysteries of organic chemistry are great, and the differences between its processes or reactions as they are carried out in the organism and in the laboratory are many; the actions, catalytic and other, which go on in the living cell, are of extraordinary complexity. But the contention that they are different in kind from ordinary chemical operations... would seem to be no longer tenable.

*On Growth and Form* (Volume 2)

Chapter IX (p. 652)

At The University Press. Cambridge, England. 1951

**Thudichum, J. L. W.** 1829–1901  
Chemist

Organic chemistry is the child of medicine, and however far it may go on its way, with its most important achievements, it always returns to its parent.

On the Discoveries and Philosophy of Leibig

*Journal of the Royal Society of Arts*, Volume 24, 1876 (p. 141)

**Ure, Andrew** 1778–1857  
Scottish physician

All of the elementary principles of organic nature may be considered as deriving the peculiar delicacy of their chemical equilibrium, and the consequent facility with which it may be subverted and new modeled, to the multitude of atoms grouped together in a compound. On this view, none of them should be expected to consist of a single atom of each component.

On the Ultimate Analysis of Vegetable and Animal Substances

*Philosophical Transactions of the Royal Society of London*, Volume 112, 1822 (pp. 468–469)

**Wöhler, Friedrich** 1800–82  
German chemist

Organic chemistry just now is enough to drive one mad. It gives one the impression of a primeval, tropical forest full of the most remarkable things, a monstrous and boundless thicket, with no way of escape, into which one may well dread to enter.

In Edward Franklin Degering  
*An Outline of Organic Nitrogen Compounds*  
Letter to Berzelius, 28 January 1835 (p. 5)  
University Lithoprinters. Ypsilanti, Michigan, USA. 1945

## ORGANISM

**Bernard, Claude** 1813–78  
French physiologist

We may, of course strike a balance between what a living organism takes in as nourishment and what it gives out in excretions.... This would be like trying to tell what happens inside a house by watching what goes in by the door and what comes out by the chimney.

*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter II, Section IX  
The Macmillan Company. New York, New York, USA. 1927

**Evans, Howard Ensign** 1919–2002  
Entomologist

It has been said that for every problem concerning living things there is an organism ideal for its solution. It is probable that there are still undiscovered species living that hold the answers to problems that face us now or will in the future.

*Pioneer Naturalist: The Discovery and Naming of North American Plants and Animals*  
Naturalists, Then and Now (p. 267)  
Henry Holt & Company. New York, New York, USA. 1993

**Hess, Walter** 1881–1973  
Swiss physiologist

A recognized fact which goes back to the earliest times is that every living organism is not the sum of a multitude of unitary processes, but is, by virtue of interrelationships and of higher and lower levels of control, an unbroken unity.

*Nobel Lectures, Physiology or Medicine 1942–1962*  
Nobel lecture for award received in 1949  
The Central Control of the Activity of Internal Organs (p. 247)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Jacob, François** 1920–  
French biologist

And one of the deepest, one of the most general functions of living organisms is to look ahead, to produce future as Paul Valéry put it.

*The Possible and the Actual*

Time and the Invention of the Future (p. 66)  
Pantheon Books. New York, New York, USA. 1982

**Jones, J. S.**  
No biographical data available

**Ebert, D.**  
No biographical data available

No organism can do everything. Every creature is restricted by constraints of various kinds. Many of these arise from the facts of history and the nature of evolution, both of which can proceed only from where they left off.

In R.J. Berry, T.J. Crawford and G.M. Hewitt (eds.)  
*Genes in Ecology*  
Life History and Mechanical Constraints on Reproduction in Genes, Cells and Waterfleas (p. 393)  
Blackwell Scientific Publications. Oxford, England. 1992

**Price, P. W.**  
No biographical data available

Visually stimulating organisms, the large, the colorful, the active, the aggressive, command our attention, while the secretive and insidious remain largely ignored.

*Evolutionary Biology of Parasites*  
Chapter Eight (p. 171)  
Princeton University Press. Princeton, New Jersey, USA. 1980

**Savage-Rumbaugh, Sue**  
American psychologist

**Lewin, Roger Amos**  
Anthropologist

All organisms with complex nervous systems are faced with the moment-by-moment question that is posed by life: What shall I do next?

*Kanzi: The Ape at the Brink of the Human Mind*  
Chapter 10 (p. 255)  
John Wiley & Sons, Inc. New York, New York, USA. 1994

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

The hosts of living organisms are not random creatures, they can be classified in battalions and regiments. Neither are they isolated creatures, for every thread of life is inter-twined with others in a complex web.

*The System of Animate Nature (Volume 1)*  
Lecture II (p. 58)  
William & Norgate. London, England. 1920

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Basic characteristics of an individual organism: to divide, to unite, to merge into the universal, to abide in the particular, to transform itself, to define itself, and as living things tend to appear under a thousand conditions,

to arise and vanish, to solidify and melt, to freeze and flow, to expand and contract. Since these effects occur together, any or all may occur at the same moment.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 303–304)

Suhrkamp. New York, New York, USA. 1988

## ORGANIZATION

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

There is no doubt that the scheme of physics as it has stood for the last three-quarters of a century postulates a data at which either the entities of the universe were created in a state of high organization, or pre-existing entities were endowed with that organization, which they have been squandering ever since. Moreover, this organization is admittedly the antithesis of chance. It is something which could not occur fortuitously.

*The Nature of the Physical World*

Chapter IV (pp. 84–85)

The Macmillan Company. New York, New York, USA. 1930

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Men talk much of matter and energy, of the struggle for existence that molds the shape of life. These things exist, it is true; but more delicate, elusive, quicker than fins in water, is that mysterious principle known as “organization,” which leaves all other mysteries concerned with life stale and insignificant by comparison. For that without organization life does not persist is obvious. Yet this organization itself is not strictly the product of life, nor of selection. Like some dark and passing shadow within matter, it cups out the eyes’ small windows or spaces the notes of a meadow lark’s song in the interior of a mottled egg.

*The Immense Journey*

The Flow of the River (p. 26)

Vintage Books. New York, New York, USA. 1957

**Huxley, Thomas Henry** 1825–95

English biologist

Not only are all animals existing in the present creation organized to one of these five plans; but paleontology tends to show that in the myriad of past ages of which the earth’s crust contains the records, no other plan of animal life made its appearance on our planet. A marvelous fact and one which seems to present no small obstacle in the way of the notion of the possibility of fortuitous development of animal life.

In Michael Foster and E. Ray Lankester (eds)

*Scientific Memoirs of Thomas Huxley*

Volume 1, On Natural History as Knowledge, Discipline and Power (p. 306)  
Publisher undetermined. 1901

**Needham, Joseph** 1900–95

English biochemist and sinologist

Organization and Energy are the two fundamental problems which all science has to solve.

*Time: The Refreshing River*

The Naturalness of the Spiritual World (p. 33)

The Macmillan Company. New York, New York, USA. 1943

...organization is not something fundamentally mystical and unamenable to scientific attack, but rather the basic problem confronting the biologist.... It is for us to investigate the nature of this biological organization, not to abandon it to the metaphysicians because the rules of physics do not seem to apply to it.

*Order and Life*

Chapter I (pp. 7, 17–18)

Yale University Press. New Haven, Connecticut, USA. 1936

**Simpson, George Gaylord** 1902–84

American paleontologist

The point about explanation in biology that I would particularly like to stress is this: to understand organisms one must explain their organization. It is elementary that one must know what is organized and how it is organized, but that does not explain the fact or the nature of the organization itself. Such explanation requires knowledge of how an organism came to be organized and what function the organization serves. Ultimate explanation in biology is therefore necessarily evolutionary.

*This View of Life: The World of an Evolutionist*

Chapter Six (p. 113)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

One of the most basic principles of biology is organization, which means that two things put together in a specific way form a new unit, a system, the properties of which are not additive and cannot be described in terms of the properties of the constituents. As points may be connected to letters, letters to words, words to sentences, etc., so atoms can join to molecules, molecules to organelles, organelles to cells, etc., every level of organization having a new meaning of its own and offering exciting vistas and possibilities.

*Bioenergetics*

Chapter 6 (p. 39)

Academic Press. New York, New York, USA. 1957

**Woodger, Joseph Henry** 1894–1981

English biologist

The failure to take organization seriously is perhaps but another consequence of the rapid development of physics and chemistry as compared to other sciences, and the consequent dazzling effect this had on biological vision.

*Biological Principles: A Critical Study*

Part II, Chapter VI, B, 5 (p. 291)  
Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1929

If the concept of organization is of such importance as it appears to be it is something of a scandal that we have no adequate conception of it. The first duty of the biologist would seem to be to try and make clear this important concept. Some biochemists and physiologists...express themselves as though they really believed that if they concocted a mixture with the same chemical composition as what they call "protoplasm" it would proceed to "come to life." This is the kind of nonsense which results from forgetting or being ignorant of organization.

*Biological Principles: A Critical Study*

Part II, Chapter VI, B, 5 (p. 291)  
Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1929

## ORGANS

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

...We have also here an acting cause to account for that balance so often observed in nature, — a deficiency in one set of organs always being compensated by an increased development of some others — powerful wings accompanying weak feet, or great velocity making up for the absence of defensive weapons; for it has been shown that all varieties in which an unbalanced deficiency occurred could not long continue their existence. The action of this principle is exactly like that of the centrifugal governor of the steam engine, which checks and corrects any irregularities almost before they become evident; and in like manner no unbalanced deficiency in the animal kingdom can ever reach any conspicuous magnitude, because it would make itself felt at the very first step, by rendering existence difficult and extinction almost sure soon to follow.

*Journal of the Proceedings of the Linnean Society, Zoology*, Volume 3, 1858 (pp. 61–62)

## ORIGIN OF LIFE

**Goldanskii, Vitalii** 1923–2001

Soviet physicist and chemist

Two properties of living systems that are unique from the standpoint of physics, namely, self-replication and homochirality, may serve as Ariadne's thread in the labyrinth of hypotheses concerning this [origin-of-life] problem.

In J. and K. Tran Thon Van, J. C. Mounolou, J. Schneider and C. McKay (eds.)

*Frontiers of Life*

Chirality, Origin of Life, and Evolution  
Publisher undetermined

**Oparin, Alexander Ivanovich** 1894–1980

Russian biochemist

...when I began to be interested in the problem of the origin of life, in the early 1920s, the whole topic was in a state of crisis. It appeared as if it was a forbidden subject in the world of science. The problem was generally felt to be insoluble in principle using objective scientific research methods. It was felt that it belonged more to the sphere of faith than knowledge, and that, for this reason, serious scientists should not waste their time and effort on hopeless attempts to solve the problem.

Jubilee for Heterogenesis Research

*New Scientist*, Volume 142, 1974

**Sagan, Carl** 1934–96

American astronomer and author

Every human community has somehow or other tried to understand...deep questions of origins. Origin of our group, whatever it is, origin of our species, origin of life, origin of Earth, origin of the universe. I think you have to be made out of wood not to be interested in these questions. And there's no way to understand even the questions, much less the answers, without understanding science.

Speech

National meeting of the American Astronomical Society (January 5, 1993)

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

To push anything back into the past is equivalent to reducing it to its simplest element. Traced as far as possible in the direction of their origins, the last fibers of the human aggregate are lost to view and are merged in our eyes with the very stuff of the universe.

*The Phenomenon of Man*

Book One, Chapter I (p. 39)

Harper & Brothers. New York, New York, USA. 1959

**Wächtershäuser, Günter**

International patent lawyer

The chemist strives to explain the inanimate world by reference to mechanistic laws. The historian strives to understand the world of human culture by reference to a fabric of plans and purposes.... Nowhere is this encounter in sharper focus than in the problem of the origin of life.

The Origin of Life and Its Methodological Challenge

*Journal of Theoretical Biology*, Volume 187, 1997

## ORIGINALITY

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Those theories to which we ascribe originality are not so easily grasped, not so quickly epitomized and systematized. An author tends toward this or that way of thinking; but it is modified by his individuality, indeed,

often simply by his presentation, by the peculiarity of the idiom in which he speaks and writes, by the change in times, by various considerations.

In Karl J. Fink

*Goethe's History of Science*

Chapter 9 (p. 115)

Cambridge University Press. Cambridge, England. 1991

## ORNITHOLOGY

**Audubon, John James** 1785–1851

West Indian-born American ornithologist and artist

To render more pleasant the task you have imposed upon yourself, of following an author through the mazes of descriptive ornithology, permit me, kind reader, to relieve the tedium which may be apt now and then to come upon you, by presenting you with occasional descriptions of the scenery and manners of the land which has furnished the objects that engage your attention.

*Ornithological Biography* (Volume 1)

The Ohio (p. 29)

Adam Black. Edinburgh, Scotland. 1831

### Author undetermined

...the philosophy of science is just about as useful to scientists as ornithology is to birds.

In S. Weinberg

Newtonianism, Reductionism and the Art of Congressional Testimony

*Nature*, Volume 330, Number 6147, 3–9 December 1987 (p. 433)

**Darwin, Charles Robert** 1809–82

English naturalist

I took much pleasure in watching the habits of birds, and even made notes on the subject. In my simplicity I remember wondering why every gentleman did not become an ornithologist.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter II (p. 32)

D. Appleton & Company. New York, New York, USA. 1896

**Vidal, Gore** 1925–

American essayist, novelist, and social/political commentator

To a man, ornithologists are tall, slender, and bearded so that they can stand motionless for hours, imitating kindly trees, as they watch for birds.

*Armageddon? Essays 1983–1987*

Mongolia (p. 131)

Vintage Books. New York, New York, USA. 1990

**White, Gilbert** 1720–93

English naturalist and cleric

A good ornithologist should be able to distinguish birds by their air [manner] as well as by their colours and shape; on the ground as well as on the wing, and in the bush as well as in the hand.

*The Natural History of Selborne*

Letter XLII

To Dianas Barrington

August 7, 1778

Robert M. McBride & Company. New York, New York, USA. 1925

## OSMOTIC PRESSURE

**van't Hoff, Jacobus Henricus** 1852–1911

Dutch physical and organic chemist

In an investigation, whose essential aim was a knowledge of the laws of chemical equilibrium in solutions, it gradually became apparent that there is a deep-seated analogy — indeed, almost an identity — between solutions and gases, so far as their physical relations are concerned; provided that with solutions we deal with the so-called osmotic pressure, where with gases we are concerned with the ordinary elastic pressure.

*Zeitschrift für physikalische Chemie*

The Role of Osmotic Pressure in the Analogy between Solutions and Gasses, Volume 1, 1887

## OSTEOPATH

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Osteopath — One who argues that all human ills are caused by the pressure of hard bone on soft tissue. The proof of his theory is to be found in the heads of those who believe it.

*A Mencken Chrestomathy*

Chapter XXX (p. 625)

Alfred A. Knopf. New York, New York, USA. 1949

## OTHER WORLDS

**Abbey, Henry** 1842–1911

Author

When from the vaulted wonder of the sky  
The curtain of the light is drawn aside,  
And I behold the stars in all their wide  
Significance and glorious mystery,  
Assured that those more distant orbs are suns  
Round which innumerable worlds revolve,  
My faith grows strong, my day-born doubts dissolve,  
And death, that dread annulment which life shuns,  
Or fain would shun, becomes to life the way,  
The thoroughfare to greater worlds on high,  
The bridge from star to star. Seek how we may,  
There is no other road across the sky;  
And, looking up, I hear star-voices say:  
“You could not reach us if you did not die.”

*The Poems of Henry Abbey*

Faith's Vista

Kingston. New York, New York, USA. 1895

**Jackson, Helen Hunt** 1830–85

American writer and poet

Who knows what myriad colonies there are  
Of fairest fields, and rich, undreamed-of gains  
Thick planted in the distant shining plains  
Which we call sky because they lie so far?  
Oh, write of me, not “Died in bitter pains,”  
But “Emigrated to another star!”

*Helen Jackson's Poems*

Emigravit

Robert Brothers. Boston, Massachusetts, USA. 1888

**Magnus, Albertus** 1206–1280

Scientist, philosopher, and theologian

Do there exist many worlds, or is there but a single world?  
This is one of the most noble and exalted questions in the  
study of Nature.

In G. McColley

The Seventeenth-Century Doctrine of a Plurality of Worlds

*Annals of Science*, Volume 1, Number 4, October 15, 1936 (p. 385)**Oersted, Hans Christian** 1777–1851

Danish physicist and chemist

Dost thou perceive naught but machinery  
In laws which guide the course along heaven's paths?  
Look with a larger view around; behold  
The unity of living thoughts, displayed  
In countless varying forms. The mighty sun  
Is but a twinkling star amidst the space  
Infinite filled with worlds, whose suns, heaven's lamps,  
Shine in our night.... Look

Upon the spangled heav'ns, there to discover  
Thousands of blazing suns, encircled by  
Companions numerous.... A race of beings behold  
Struggling for mental power, knowledge divine.

*The Soul in Nature: With Supplementary Contributions*

The Balloon

H.G. Bohn. London, England. 1852

**Tennyson, Alfred (Lord)** 1809–92

English poet

The Moon's white cities, and the opal width  
Of her small glowing lakes, her silver heights  
Unvisited with dew of vagrant cloud,  
And the unsounded, undescended depth  
Of her black hollows. The clear galaxy  
Shorn of its hoary lustre, wonderful,  
Distinct and vivid with sharp points of light,  
Blaze within blaze, an unimagined depth  
And harmony of planet-girded suns  
And moon-encircled planets, wheel in wheel,  
Arch'd the wan sapphire. Nay — the hum of men,  
Or other things talking in unknown tongues  
And notes of busy life in distant worlds  
Beat like a far wave on my anxious ear.

*Alfred Tennyson's Poetical Works*

Timbuctoo

Oxford University Press, Inc. London, England. 1953

And the suns of the limitless universe sparkled and  
shone in the sky,  
Flashing with fires as of God, but we knew that their  
light was a lie —  
Bright as with deathless hone — but, however they  
sparkled and shone,  
The dark little worlds running round them were worlds  
of woe like our own.

*Alfred Tennyson's Poetical Works*

Despair, Stanza III

Oxford University Press, Inc. London, England. 1953

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Let your soul stand cool and composed before a million  
universes.

*Complete Poems and Collected Prose*

Song of Myself

Section 48

The Library of America. New York, New York, USA. 1982

I was thinking this globe enough, till there sprang out so  
noiseless

around me myriads of other globes.

Now, while the great thoughts of space and eternity fill  
me, I will

measure myself by them;

And now, touch'd with the lives of other globes, arrived  
as far

along as those of the earth,

Or waiting to arrive, or pass'd on farther than those of  
the earth,

I henceforth no more ignore them, than I ignore my own  
life,

Or the lives of the earth arrived as far as mine, or  
waiting to arrive.

*Complete Poetry and Collected Prose*

Night on the Prairies

The Library of America. New York, New York, USA. 1982

**OUTER SPACE****Hey, Nigel S.** 1936–

American science writer

Human minds are being pulled into outer space by a  
thin, strong filament of neural energy called wonder.  
And this, to me, is a very good thing. As more of us let  
our sense of wonder expand into the cosmos — so that  
we comprehend the delicate smallness of our planet in  
the scheme of things — we are gaining a special kind  
of wisdom. My dream is that, with the blessing of good  
fortune, this wisdom will eventually enable us to trans-  
cend the dangerous confusion of civilizations that are  
maintained by coercion and misbelief. All sane persons

will comprehend their innate unity with the supernovas of which we are made. There will be no need for Utopia, for then we will have become meta-humans, siblings to all things that exist with and among the planets and the teeming stars. And then, perhaps, there will be peace at last.

*Why People Need Space*

Lecture, National Space Center, October 2002

**MacLeod, Ken** 1954–

Scottish science fiction writer

Outer space is, fundamentally, familiar. It's only the night sky, without the earth beneath your feet.

*The Engines of Light*

Cosmonaut's Keep (p. 1)

Tom Doherty Associates, LLC. New York, New York, USA. 2002

**United Nations Treaty on the Exploration and Use of Space**

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

January 27, 1967

**Webb, Jimmy** 1946–

American music composer

I'll fly a starship, across the universe divine,

And when I reach the other side  
I'll find a place to rest my spirit if I can  
Perhaps I may become a highwayman again  
Or I may simply be a single drop of rain  
But I will remain, and I'll be back again  
And again, and again, and again.

*Ten Easy Pieces*

Highwayman

CM Angel. 1996

**OUTLIER**

**Green, Celia** 1935–

English philosopher and psychologist

The fact that something is far-fetched is no reason why it should not be true; it cannot be as far-fetched as the fact that something exists.

*The Decline and Fall of Science*

Aphorisms (p. 1)

Hamilton. London, England. 1976

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

I don't see the logic of rejecting data just because they seem incredible.

In D.O. Edge and M.J. Mulkey

*Astronomy Transformed: The Emergence of Radio Astronomy in Britain*

Notes: Chapter 3 (p. 432, fn j)

John Wiley & Sons, Inc. New York, New York, USA. 1976



## P

### PAIN

**Bell, Sir Charles** 1774–1842  
Scottish anatomist and surgeon

Pain is the necessary contrast to pleasure; it ushers us into existence or consciousness: it alone is capable of exciting the organs into activity: it is the compassion and the guardian of human life.

*The Hand, Its Mechanism and Vital Endowments as Evincing Design*  
Chapter 7 (p. 211)  
John Murray. London, England. 1852

**Burney, Fanny** 1752–1840  
English novelist and diarist

When the dreadful steel was plunged into the breast — cutting through veins — arteries — flesh — nerves — I needed no more injunctions not to restrain my cries. I began a scream that lasted unintermittingly during the whole time of the incision — & I almost marvel that it rings not in my Ears still! so excruciating was the agony.

In A. Dally  
*Women Under the Knife: A History of Surgery*  
Letter to Esther Burney, 1811  
Hutchinson Radius. London, England. 1991

**Coates, Florence Earle** 1850–1927  
American poet

Ah, me! the Prison House of Pain! —  
what lessons there are bought! —  
Lessons of a sublimer strain  
Than any elsewhere taught.

*Poems* (Volume 2)  
The House of Pain  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

**Dickinson, Emily** 1830–86  
American lyric poet

Pain has an element of blank;  
It cannot recollect  
Where it began, or if there were  
A day when it was not.

*The Complete Poems of Emily Dickinson*  
No. 650 (p. 323)  
Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

He has seen but half the universe who never has been  
shewn the House of Pain.

*The Complete Works of Ralph Waldo Emerson* (Volume 12)  
Natural History of Intellect  
The Tragic (p. 405)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Hilton, John** 1804–78  
English surgeon

Pain the monitor, and Rest the cure, are starting points for contemplation which should ever be present to the mind of the surgeon in reference to his treatment.

*Rest and Pain: A Course of Lectures on the Influence of Mechanical and Physiological Rest In the Treatment of Accidents and Surgical Diseases, and the Diagnostic Value of Pain* (p. 500)  
George Bell & Sons. London, England. 1892

Every pain has its distinct and pregnant signification, if we will but carefully search for it.

*Rest and Pain: A Course of Lectures on the Influence of Mechanical and Physiological Rest In the Treatment of Accidents and Surgical Diseases, and the Diagnostic Value of Pain* (p. 499)  
George Bell & Sons. London, England. 1892

**Hood, Thomas** 1582–98  
English poet and editor

Of all our pains, since man was curst,  
I mean of body, not the mental,  
To name the worst, among the worst,  
The dental sure is transcendental;  
Some bit of masticating bone,  
That ought to help to clear a shelf:  
But lets its proper work alone,  
And only seems to gnaw itself.

*The Complete Poetical Works of Thomas Hood*  
A True Story  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Johnson, Samuel** 1696–1772  
English critic, biographer, and essayist

...those who do not feel Pain, seldom think that it is felt...  
*The Rambler* (Volume 1)  
No. 48, September 1, 1750 (p. 335)  
Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Latham, Peter Mere** 1789–1875  
English physician

It would be a great thing to understand Pain in all its meanings.

In William B. Bean  
*Aphorisms from Latham* (p. 71)  
Prairie Press. Iowa City, Iowa, USA. 1962

**Mather, Cotton** 1663–1728  
American minister and religious writer

WHAT is Pain? Tis a Sensation produced on the Tension of a Nerve.

*The Angel of Bethesda*  
Capsula IX (p. 54)  
American Antiquarian Society and Barre Publishers. Barre, Massachusetts, USA. 1972

**Robinson, Victor** 1886–1947  
Physician

The first cry of pain through the primitive jungle was the first call for a physician.

*The Story of Medicine*

Chapter I (p. 1)

The New York Home Library. New York, New York, USA. 1943

**Schweitzer, Albert** 1875–1965

Alsation-German theologian and philosopher

Whosoever is spared personal pain must feel himself called to help in diminishing the pain of others.

Recalled on his death

September 4, 1965

Source undetermined

**Thompson, Francis** 1859–1907

English writer

Nothing begins, and nothing ends,

That is not paid with a moan;

For we are born in other's pain,

And perish in our own.

*Complete Poetical Works of Francis Thompson*

Daisy, Stanza 15

Boni & Liveright, Inc., Publishers. New York, New York, USA. 1923

**Watson, Sir William** 1858–1935

English author of lyrical and political verse

Pain with the thousand teeth.

*The Poems of William Watson*

The Dream of Man (p. 127)

Macmillan & Company. New York, New York, USA. 1893

## PALEONTOLOGIST

**Bracker, Milton**

No biographical data available

Consider the sages who pulverize boulders,  
And burrow for elbows and shinbones and shoulders,  
And shovel the loot from a hill or a dale of it,  
And lovingly carry off pail after pail of it.

P Is for Paleontology

*Journal of Geological Education*, Volume 19, Number 4, September 1971 (p. 192)

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

The paleontologist watching the rise and fall of races sees, with only actors and setting changed, one drama repeated. Thus like the jaded critic he knows the end before the final curtain. He sees that death is the penalty for life.

*Parade of the Living*

Part III, Chapter XVII (pp. 237–238)

Coward-McCann, Inc. New York, New York, USA. 1930

**Brett-Surman, Michael** 1950–

American paleontologist

Being a paleontologist is like being a coroner except all the witnesses are dead and all the evidence has been left out in the rain for 65 million years.

In Louie Psihoyos

*Hunting Dinosaurs* (p. vii)

Random House, Inc. New York, New York, USA. 1994

**Colbert, Edwin H.** 1905–2001

American vertebrate paleontologist

Any paleontologist worth his or her salt takes a great deal of pleasure in thinking of the discoveries he has made in the field and laboratory, but true satisfaction is in the publications that describe and interpret the fossils.

*Digging into the Past: An Autobiography*

Chapter VII (p. 126)

Dembner Books. New York, New York, USA. 1989

**Cousteau, Jacques-Yves** 1910–77

French naval officer and ocean explorer

A paleontologist holds the thread of evolution in his hands by combining the biological and geological evidence in fossils.

*The Ocean World of Jacques Cousteau: The Adventure of Life*

Chapter I (p. 13)

The World Publishing Company. New York, New York, USA. 1973

**Gaudry, Jean-Albert** 1827–1908

French paleontologist

It is the proper function of paleontologists to supply some proofs to the doctrine of evolution; it does not fall to them to explain the process by which the author of the world has produced the modifications. That study of processes is what is called Darwinism.... Assuredly it is a subject quite worthy of the attention of those naturalists that study the causes of the modifications of beings; but it is up to the physiologists, who experiment on living creatures, to teach us how the changes are produced today, and must have been produced formerly.... On this subject a paleontologist can avow his ignorance. All that he can say is that the discovery of vestiges buried in the bowels of the earth teach us that a constant harmony has presided at the transformation of the organic world.

Les Enchaenements

*Revue des Deux Mondes*, 9<sup>th</sup> Series, Volume 23, 1877 (p. 183)

**Matthew, William Diller** 1871–1930

Canadian-American paleontologist

...evolution is only one aspect of the order of nature, of the relations of cause and effect, of continuity of space and time, which pervade the universe and enable us to comprehend its simplicity of plan, its complexity of detail. The paleontologist, engaged in adding year by year to the mass of documents which record the history of life, in deciphering their meaning and interpreting their significance, has no more occasion to doubt

its continuity and orderly development than the historian has to doubt the continuity and consecutive evolution of human history, or the student of current affairs to doubt that the events of tomorrow.

*Natural History*, Volume 25, Number 2, 1925

**Morris, Simon Conway** 1951–  
English paleontologist

As well as being lumps of patterned stone, fossils are also historical documents. History per se has had a bit of bad press recently.... There is a tension between the documentation of history (famously referred to as “one bloody thing after another”), and the search for universal principles that are ahistoric and possibly timeless. After a period in the doldrums, the bearers of the historical tidings, the paleontologists, are making tentative movements toward the legendary High Table where, just visible through the clouds of incense (and rhetoric), the high priests of evolutionary theory smile benignly.

*The Phylogeny of Life and the Accomplishments of Phylogenetic Biology*  
Symposium at the University of Arizona. Tucson, Arizona, USA  
October 11–13, 1996

Early Metazoan Radiations: What the Fossil Record Can and Cannot Tell Us

**Simpson, George Gaylord** 1902–84  
American paleontologist

Not long ago paleontologists felt that a geneticist was a person who shut himself in a room, pulled down the shades, watched small flies disporting themselves in milk bottles, and thought that he was studying nature. A pursuit so removed from the realities of life, they said, had no significance for the true biologist. On the other hand, the geneticists said that paleontology had no further contributions to make to biology, that its only point has been the completed demonstration of the truth of evolution, and that it was a subject too purely descriptive to merit the name “science.” The paleontologist, they believed, is like a man who undertakes to study the principles of the internal combustion engine by standing on a street corner and watching the motor cars whizz by.

*Tempo and Mode in Evolution*

Introduction (p. xv)

Columbia University Press. New York, New York, USA. 1944

**Turney, John**  
No biographical data available

Take a complete, illustrated catalogue of London’s National Gallery. Shred it into tiny pieces and cast them into the wind from the gallery’s steps above Trafalgar Square. Wait a few weeks, then scour the square for surviving scraps of paper. Now try to reconstruct the history of painting from your haul. If you manage to produce a coherent story — schools, styles, genres, named painters and all — you are probably a paleontologist.

Review of “In Search of Deep Time”  
*New Scientist*, 25 March 2000

## PALEONTOLOGY

**Grassé, Pierre P.** 1895–1985  
French zoologist

Naturalists must remember that the process of evolution is revealed only through fossil forms. A knowledge of paleontology is, therefore, a prerequisite; only paleontology can provide them with the evidence of evolution and reveal its course or mechanisms. Neither the examination of present beings, nor imagination, nor theories can serve as a substitute for paleontological documents. If they ignore them, biologists, the philosophers of nature, indulge in numerous commentaries and can only come up with hypotheses. That is why we constantly have recourse to paleontology, the only true science of evolution. From it we learn how to interpret present occurrences cautiously; it reveals that certain hypotheses considered certainties by their authors are in fact questionable or even illegitimate.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*

An Introduction to the Study of Evolution (p. 4)

Academic Press. New York, New York, USA. 1977

**Bakker, Robert T.** 1945–  
American paleontologist

Paleontology is a very visual inquiry.... All paleontologists scribble on napkins at coffee breaks, making sketches to explain their thinking.

Brushing Up On Dinosaurs

*Science News*, October 4, 1986

**Crawford, Osbert Guy Stanhope** 1886–1957  
English archaeologist

If archaeology is humanity revealed by its works, paleontology is life revealed by its own remains.

*Man and His Past*

Chapter VI (p. 70)

Oxford University Press, Inc. London, England. 1921

**Dunbar, Carl O.**  
No biographical data available

If they stink, the remains belong to zoology, but if not, to paleontology.

In Alan M. Cvancara

*Sleuthing Fossils: The Art of Investigating Past Life*

Chapter 1 (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1990

**Hillery, Herbert**  
No biographical data available

There is no end to paleontology, there is no end to geology; and when the morning of the resurrection shall come,

some paleontologist will be searching for some previously undiscovered species of extinct beings, and some geologist will be pecking away at the rocks to find some characteristics which have never been before ascertained. There is no end to it.

*Congressional Record*, Volume 23, 1892 (p. 4626)

**Herzen, Aleksandr** 1812–70

Russian political author

The small buds of organic chemistry, geology, paleontology, comparative anatomy have grown in our century into huge branches and borne fruit exceeding our wildest hopes. The world of the past, obedient to the mighty voice of science, has left the tomb to bear witness to the upheavals which accompany the evolution of the surface of the globe; the soil on which we live, this tombstone of the past life, is growing transparent, as it were; the stone vaults have opened, the interior of the rocks could not retain their secrets. Not only do the half-decayed, half-petrified vestiges again assume flesh, paleontology also strives to discover the law of the relation between geologic epochs and their complete flora and fauna. Then everything that ever lived will be resurrected in the human mind, will be saved from the sad fate of utter oblivion, and those whose bones have been completely decayed, whose phenomenal existence has been utterly obliterated, will be restored in the bright sanctuary of science where the temporal finds its repose and is perpetuated.

*Selected Philosophical Works*

Letters on the Study of Nature, Letter One (pp. 99–100)

Foreign Languages Publishing House. Moscow, Russia. 1956

**Howard, Robert West**

No biographical data available

The three volumes of [Lyell's] Principles of Geology, published between 1829 and 1833, became the essential textbook of the profession. In its discussion of fossils and the vital role they had played in the development of geology as an exact science, Lyell urged adoption of a Greek-rooted word, meaning "the science of early beings," as the professional name for research of the types of plant and animal fossils embedded in the Earth's layered crust. His suggestion was adopted throughout Europe and the Americas. Thus, three centuries after the curiosities of Leonardo da Vinci, the dawnseekers' science was given the name of paleontology.

*The Dawnseekers: The First History of American Paleontology*

Chapter 9 (p. 126)

Harcourt Brace Jovanovich. New York, New York, USA. 1975

**Huxley, Thomas Henry** 1825–95

English biologist

That application of the sciences of biology and geology, which is commonly known as palaeontology, took its origin in the mind of the first person who, finding

something like a shell, or a bone, naturally imbedded in gravel or rock, indulged in speculations upon the nature of this thing which he had dug out — this "fossil" — and upon the causes which had brought it into such a position.

*Collected Essays* (Volume 4)

The Rise and Progress of Paleontology (p. 24)

Macmillan & Company Ltd. London, England. 1904

**Kielan-Jaworowska, Zofia** 1925–

Polish paleontologist

No scientist familiar with the intellectual adventure of studying animals from times long past will have any hesitation in affirming that to travel millions of years into the past, which is what paleontological study amounts to, is much more fascinating than the most exotic geographical travel we are able to undertake today. The study of animals that lived on Earth millions of years ago is not merely a study of their anatomy, but first and foremost a study of the course of evolution on earth and of the laws that govern it.

Translated by the Israel Translation Society

*Hunting for Dinosaurs*

Chapter 15 (p. 176)

The MIT Press. Cambridge, Massachusetts, USA. 1969

**Kitts, David B.**

Evolutionist and paleontologist

Despite the bright promise that paleontology provides a means of "seeing" evolution, it has presented some nasty difficulties for evolutionists, the most notorious of which is the presence of "gaps" in the fossil record. Evolution requires intermediate forms between species and paleontology does not provide them...

*Evolution*, Volume 28, September 1974 (p. 467)

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

It may seem that palaeontology is a science of pure speculation or inquisitiveness, and the palaeontologist the most unreal and useless of researchers; a man dedicated to retrospection, plunged living into the past, where he spends his days collecting the debris of dead things.

*The Future of Man*

Chapter IV, Part I, Section 3 (p. 66)

Harper & Row, Publishers. New York, New York, USA. 1964

**Miller, Hugh** 1802–56

Scottish geologist and theologian

Paleontology, or the science of ancient organisms, deals, as its subject, with all the plants and animals of all the geologic periods. It bears nearly the same sort of relation to the physical history of the past that biography does to the civil and political history of the past.

*The Testimony of the Rocks; of, Geology in Its Bearings on the Two Theologies, Natural and Revealed*

Lecture First (p. 33)

Gould & Lincoln. Boston, Massachusetts, USA. 1857

**Osborn, Henry Fairfield** 1857–1935  
American paleontologist and geologist

Paleontology is the zoology of the past.  
*The Age of Mammals in Europe, Asia and North America*  
Chapter I (p. 1)  
The Macmillan Company. New York, New York, USA. 1910

The preservation of extinct animals and plants in the rocks is one of the fortunate accidents of time, but to mistake this position as indicative of affinity [with zoology and botany] is about as logical as it would be to bracket the Protozoa, which are principally aquatic organisms, under hydrology, or the Insecta, because of their aerial life, under meteorology. No, this is emphatically a misconception which is still working harm in some museums and institutions of learning. Paleontology is not geology, it is zoology ; it succeeds only so far as it is pursued in the zoological and biological spirit.

The Present Problems of Paleontology  
*Popular Science Monthly*, 1905 (p. 226)

**Rudwick, Martin J. S.**  
Science historian

As paleontology now prepares for a great leap forward into a computerised age there is perhaps a danger that it may lose sight of its historic origins in the “steam age” of science and before.

*The Meaning of Fossils, Episodes in the History of Paleontology*  
Chapter Five, Section XII (p. 266)  
Macdonald. London, England. 1972

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

What a noble science is paleontology! And what really startling sagacity its votaries exhibit!

*Collected Tales, Sketches, Speeches & Essays 1852–1890* (Volume 1)  
A Brace of Brief Lectures on Science (p. 528)  
The Library of America. New York, New York, USA. 1992

**van der Gracht, W. A.** 1873–1943  
Dutch petroleum geologist

There are few subjects where there exists greater diversity of opinions regarding practically everything than in paleontology.

In C.G. Simpson  
Mammals and the Nature of Continents  
*American Journal of Science*, Volume 241, 1943 (p. 1)

**von Buch, L.**  
No biographical data available

...through knowledge of [paleontology] we obtain not only the history of the Earth but also the history of life.

In Rudolf Daber and Jochen Helms (eds.)  
*Fossils: The Oldest Treasures that Ever Lived*  
Only a Slab of Transitional Limestone (p. 40)  
T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

Palaeontological studies have brought charm and variety to the science of the rigid structures of this Earth. Petrified strata show us, preserved in their graves, the flora and fauna of past millennia. We climb upwards in time when, noting the spatial stratification conditions, we penetrate downwards from one stratum to the next. Long-vanished plant and animal life emerges before our eyes.

In Jochen Helms  
*Fossils: The Oldest Treasures that Ever Lived*  
Knowledge and Museums (p. 9)  
T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

## PANSPERMIA

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Should the time come when this earth comes into collision with another body, comparable in dimensions to itself...many great and small fragments carrying seeds of living plants and animals would undoubtedly be scattered through space. Hence, and because we all confidently believe that there are at present, and have been from time immemorial, many worlds of life besides our own, we must regard it as probable in the highest degree that there are countless seed-bearing meteoric stones moving about through space. If at the present instance no life existed upon this earth, one such stone falling upon it might, by what we blindly call natural causes, lead to its becoming covered with vegetation.

*Popular Lectures and Addresses* (Volume 2)  
Presidential Address to the British Association, Edinburgh, 1871  
British Association for the Advancement of Science, Volume 4, Number 262, 1871 (p. 201)  
Macmillan & Company Ltd. London, England. 1894

## PARABOLA

**Allen, Woody** 1935–  
American film director and actor

She wore a short skirt and a tight sweater and her figure described a set of parabolas that could cause cardiac arrest in a yak.

*Getting Even*  
Mr. Big (p. 139)  
Random House, Inc. New York, New York, USA. 1971

**Frere, John Hookham** 1769–1846  
British diplomat and man of letters

And first, the fair PARABOLA behold,  
Her timid arms, with virgin blush, unfold!  
Though, on one focus fixed, her eyes betray  
A heart that glows with love’s resistless sway...  
In Charles Edmonds

*Poetry of the Anti-Jacobin*

The Loves of the Triangle, Canto II, l. 107–108

Printed for J. Wright, by W. Bulmer &amp; Company. London, England. 1801

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

It has been observed that missiles and projectiles describe a curved path of some sort; however no one has pointed out the fact that this path is a parabola. But this and other facts, not few in number or less worth knowing, I have succeeded in proving; and what I consider more important, there have been opened up to this vast and most excellent science, of which my work is merely the beginning, ways and means by which other minds more acute than mine will explore its remote corners.

In *Great Books of the Western World* (Volume 28)*Dialogues Concerning the Two New Sciences*

Third Day (p. 197)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

KNELLER:...take a sugar loaf and cut it slantwise, and you will get hyperbolas and parabolas, ellipses and ovals...

*The Complete Plays of Bernard Shaw*

In Good King Charles's Golden Days, Act I (p. 1358)

Odham's Press. London, England. 1950

**PARADIGM****Barnes, Barry**

Sociologist

...paradigms, the core of the culture of science, are transmitted and sustained just as is culture generally: scientists accept them and become committed to them as a result of training and socialization, and the commitment is maintained by a developed system of social control.

In Quentin Skinner (ed.)

*The Return of Grand Theory in the Human Sciences*

Thomas Kuhn (p. 89)

Cambridge University Press. Cambridge, England. 1985

**Kuhn, Thomas S.** 1922–96

American historian of science

The operations and measurements that a scientist undertakes in the laboratory are not “the given” of experience but rather “the collected with difficulty.” They are not what the scientist sees — at least not before his research is well advanced and his attention focused.... Science does not deal in all possible laboratory manipulations. Instead, it selects those relevant to the juxtaposition of a paradigm with the immediate experience that that paradigm has partially determined.

*The Structure of Scientific Revolutions*

Chapter X (p. 126)

The University of Chicago Press. Chicago, Illinois, USA. 1970

Normal science does not aim at novelties of fact or theory and, when successful, finds none. New and unsuspected phenomena are, however, repeatedly uncovered by scientific research, and radical new theories have again and again been invented by scientists. History even suggests that the scientific enterprise has developed a uniquely powerful technique for producing surprises of this sort. If this characteristic of science is to be reconciled with what has already been said, then research under a paradigm must be a particularly effective way of inducing a paradigm change. That is what fundamental novelties of fact and theory do. Produced inadvertently by a game played under one set of rules, their assimilation requires the elaboration of another set. After they have become parts of science, the enterprise, at least of those specialists in whose particular field the novelties lie, is never quite the same again.

*The Structure of Scientific Revolutions*

Chapter VI (p. 52)

The University of Chicago Press. Chicago, Illinois, USA. 1970

A paradigm is what members of the scientific community share, and, conversely a scientific community consists of men who share a paradigm.

*The Structure of Scientific Revolutions*

Postscript (p. 176)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**PARADISE****Abbey, Edward** 1927–89

American environmentalist and nature writer

When I write “paradise” I mean not only apple trees and golden women but also scorpions and tarantulas and flies, rattlesnakes and Gila monsters, sandstorms, volcanoes and earthquakes, bacteria and bear, cactus, yucca, bladderweed, ocotillo and mesquite, flash floods and quicksand, and yes — disease and death and the rotting of the flesh.

*Desert Solitaire*

Down the River (p. 190)

Ballantine Books. New York, New York, USA. 1968

**Hilbert, David** 1862–1943

German mathematician

No one...will drive us out of this paradise that Cantor has created for us!

*Hilbert — Courant*

Hilbert

Chapter XX (p. 177)

Springer-Verlag. New York, New York, USA. 1986

**PARADOX****Bohr, Niels Henrik David** 1886–1962

Danish physicist

How wonderful that we have met with a paradox. Now we have some hope of making progress.

In L.I. Ponomarev

*The Quantum Dice* (p. 75)

Institute of Physics Publishing. Bristol, England. 1993

**Bourbaki, Nicholas**

Mathematical discussion group

There is no sharply drawn line between those contradictions which occur in the daily work of every mathematician, beginner or master of his craft, as a result of more or less easily detected mistakes, and the major paradoxes which provide food for logical thought for decades and sometimes centuries.

In Bryan H. Bunch

*Mathematical Fallacies and Paradoxes*

Chapter 2 (p. 38)

Van Nostrand Reinhold Company. New York, New York, USA. 1982

**Cudmore, Lorraine Lee**

American cell biologist

It is a bizarre paradox we are facing, for we find that experimental scientists (who are supposed to be fair) at times make the Spanish Inquisition a model of fair hearings and unbiased judgment.

*The Center of Life: A Natural History of the Cell*

Cellular Evolution (p. 55)

New York Times Book Company. New York, New York, USA. 1977

**de Morgan, Augustus** 1806–71

English mathematician and logician

If I had before me a fly and an elephant, having never seen more than one such magnitude of either kind; and if the fly were to endeavour to persuade me that he was larger than the elephant, I might possibly be placed in a difficulty. The apparently little creature might use such arguments about the effect of distance, and might appeal to such laws of sight and hearing as I, if unlearned in those things, might be unable wholly to reject. But there were a thousand flies, all buzzing, to appearance, about the great creature and, to a fly, declaring, each one for himself, that he was bigger than the quadruped; and all giving different and frequently contradictory reasons; and each one despising and opposing the reasons of the others — I should feel quite at my ease...[to] say, My little friends, the case of each one of you is destroyed by the rest.

A Budget of Paradoxes

Introduction

The Open Court Publishing Company. Chicago, Illinois, USA. 1915

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Play not with paradoxes. That caustic which you handle in order to scorch others may happen to sear your own fingers and make them dead to the quality of things.

*Felix Holt, the Radical*

Chapter XIII (p. 151)

Wm. L. Allison Company. New York, New York, USA. No date

**Falletta, Nicholas**

No biographical data available

A paradox is truth standing on its head to attract attention.

*The Paradoxicon* (p. xvii)

Doubleday &amp; Company, Inc. New York, New York, USA. 1983

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

RUTH: A paradox?

KING: A paradox!

A most ingenious paradox!

We've quips and quibbles heard in flocks,

But none to beat this paradox!

*The Complete Plays of Gilbert and Sullivan*

Pirates of Penzance

Act II (p. 142)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1976

How quaint the ways of paradox

At common sense she gaily mocks.

*The Complete Plays of Gilbert and Sullivan*

Pirates of Penzance

Act II (p. 168)

Random House, Inc. New York, New York, USA. 1936

**Humphries, W. J.** 1862–1949

American meteorologist and atmosphere scientist

The scientific paradox is only an exception to some familiar but too inclusive generalization. It, therefore, has both the appeal of the riddle and the charm of surprise — the surprise, the instant the truth is seen, of a sudden and unexpected discovery....

A Bundle of Meteorological Paradoxes

*Annual Report of the Board of Regents of the Smithsonian Institution,*

1920 (p. 183)

Government Printing Office. Washington, D.C. 1922

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

Perhaps the greatest paradox of all is that there are paradoxes in mathematics...because mathematics builds on the old but does not discard it, because its theorems are deduced from postulates by the methods of logic, in spite of its having undergone revolutionary changes we do not suspect it of being a discipline capable of engendering paradoxes.

*Mathematics and the Imagination*

Paradox Lost and Paradox Regained (p. 193)  
Simon & Schuster. New York, New York, USA. 1940

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Paradoxes have no place in science. Their removal is the substitution of true for false statements and thoughts.

*Popular Lectures and Addresses* (Volume 1)  
On Sun's Heat  
Lecture  
Royal Institution of Great Britain  
January 21, 1887 (pp. 372–373)  
Macmillan & Company Ltd. London, England. 1894

**Rapport, Anatol** 1911–2007  
Russian-born mathematician and biologist

Paradoxes have played a dramatic part in intellectual history, often foreshadowing revolutionary developments in science, mathematics, and logic. Whenever, in any discipline, we discover a problem that cannot be solved within the conceptual framework that supposedly should apply, we experience an intellectual shock. The shock may compel us to discard the old framework and adopt a new one. It is to this process of intellectual molting that we owe the birth of many of the major ideas in mathematics and science.

Escape from Paradox  
*Scientific American*, Volume 217, Number 1, July 1967 (p. 50)

**Rogers, Jr., Hartley**  
American mathematician

It is a paradox in mathematics and physics that we have no good model for the teaching of models.

In Lynn Arthur Steen  
*Mathematics Tomorrow*  
Physics and Mathematics (p. 232)  
Springer-Verlag. New York, New York, USA. 1981

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

Books on paradoxes in statistics are similar to mystery books. They have a faithful readership, and they follow a rigorous sequence in their presentation, like Greek tragedies.

*Indiscrete Thoughts*  
Chapter XX (p. 224)  
Birkhäuser. Boston, Massachusetts, USA. 1997

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Although this may seem a paradox; all exact science is dominated by the idea of approximation.

In Jefferson Hane Weaver  
*The World of Physics* (Volume 2)  
K.2 (p. 22)  
Simon & Schuster. New York, New York, USA. 1987

**Schild, Alfred** 1921–77  
Physicist

Consider a pair of twins. Immediately after birth they are separated. One of them, the first one, remains on earth, the second one is put in a rocket ship and flown to Alpha Centauri at a pretty high speed, 99% that of light. Alpha Centauri is the nearest star; it is about four light-years away from us. As soon as the second twin gets to Alpha Centauri, he turns around and flies back to earth at the same high speed. When the two twins meet again, the first one, the one who stayed behind on earth, will be eight years old...he will be able to talk quite well and read a little bit. He may have finished second grade and be about to enter third. The second twin, the one who took the journey, on his return will be approximately one year old.... He will still need diapers, he will be barely able to walk, and he won't be able to talk much.

The Clock Paradox in Relativity Theory  
*The American Mathematical Monthly*, Volume 66, Number 1, January 1959 (p. 1)

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

Attention had recently (A. Einstein, B. Podolsky, and N. Rosen, *Phys. Rev.* 47 (1935) 777) been called to the obvious but very disentangling measurement to one system, the representative obtained for the other system is by no means independent of the particular choice of observations which we select for that purpose and which by the way are entirely arbitrary. It is rather discomfiting that the theory should allow a system to be steered or piloted into one or the other type of state at the experimenter's mercy in spite of his having no access to it.

*Proceedings of the Cambridge Philosophical Society*, Volume 11, 1935 (p. 555)

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Paradoxes are the only truths.

*Misalliance* (p. 142)  
Samuel French, Inc. London, England. 1957

**Shimony, Abner** 1928–  
American physicist and philosopher of science

I hope that the rigor and beauty of the argument of EPR [Einstein–Podolsky–Rosen paradox] is apparent. If one does not recognize how good an argument it is — proceeding rigorously from premises which are thoroughly reasonable — then one does not experience an adequate intellectual shock when one finds out that the experimental evidence contradicts their conclusions. This shock should be as great as the one experienced by Frege when he read Russell's theoretical paradox and said, "Alas, arithmetic totters!"



Quoted by Franco Seller

*Quantum Mechanics Versus Local Realism: The Einstein–Podolsky–Rosen Paradox*

Chapter 1, Section 2 (p. 19)

Plenum Press. New York, New York, USA. 1988

**Smith, E. E.** 1890–1965

No biographical data available

With sufficient knowledge, any possible so-called paradox can be resolved.

*Masters of the Vortex*

Chapter 11 (p. 109)

Pyramid. New York, New York, USA. 1968

**Sylvester, James Joseph** 1814–97

English mathematician

As lightning clears the air of impalpable vapours, so an incisive paradox frees the human intelligence from the lethargic influence of latent and unsuspected assumptions. Paradox is the slayer of Prejudice.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

A Lady's Fan on Parallel Motion, and on an Orthogonal Web of Jointed Rods (p. 36)

University Press. Cambridge, England. 1904–1912

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

The way of paradoxes is the way of truth. To test Reality we must see it on the tight-rope. When the Verities become acrobats we can judge them.

*The Picture of Dorian Gray*

Chapter 3 (p. 44)

The Modern Library. New York, New York, USA. 1992

## PARASITE

### Bishop of Birmingham

...the loathsome parasite is a result of the integration of mutations: it is both an exquisite example of adaptation to environment and ethically revolting.

Heredity and Predestination

*Nature*, Volume 126, Number 3187, November 29, 1930 (p. 842)

**Brooks, Daniel R.** 1951–

American evolutionary biologist

**McLennan, Deborah A.** 1955–

Canadian evolutionary biologist

Parasites are an enigma. To some people they are an unpleasant but unavoidable fact of life. To others they are, like Victorian ankles, an embarrassing topic to be avoided in polite conversation.

*Parascript: Parasites and the Language of Evolution*

Chapter 1 (p. 1)

Smithsonian Institution Press. Washington, D.C. 1993

**Elton, Charles S.** 1900–91

English biologist

The difference between the methods of a carnivore and a parasite is simply the difference between living upon capital and upon income; between the habits of the beaver, which cuts down a whole tree a hundred years old, and the bark-beetle, which levies a daily toll from the tissues of the tree; between the burglar and the black-mailer.

*Animal Ecology*

Chapter VI (pp. 72–73)

Sidgwick & Jackson, Ltd. London, England. 1927

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

...each man, like each plant, has his parasites.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

The Conduct of Life

Chapter 1 (p. 45)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Frost, Robert** 1874–1963

American poet

Will the blight end the chestnut?

The farmers rather guess not.

It keeps smoldering at the roots

And sending up new shoots

Till another parasite

Shall come to end the blight.

*Complete Poems of Robert Frost*

Evil Tendencies Cancel

Henry Holt & Company. New York, New York, USA. 1949

**Mayr, Ernst** 1904–2005

German-born American biologist

Parasitologists have accumulated, during the past decades, an amount of information that is truly formidable. This information is not only valuable for the parasitologist, but is also a potential gold-mine for the evolutionist and general biologist. Yet, much of this information is hidden away in a widely scattered and highly technical literature.

In J. G. Baer (ed.)

*Premier Symposium sur la spécificité parasitaire des parasites des Vertébrés*

Evolutionary Aspects of Host Specificity Among Parasites of Vertebrates

Université de Neuchâtel. Neuchâtel, Switzerland, 1957

**Mr. Spock**

Fictional character

A truly successful parasite is commensal, living in amity with its host, or even giving it positive advantages....

A parasite that regularly and inevitably kills its host cannot survive long, in the evolutionary sense, unless it multiplies with tremendous rapidity.... It is not pro-survival.

*Star Trek II: The Wrath of Khan*  
Film (1982)

**Noble, Elmer R.** 1909–2001  
American protozoologist and parasitologist

**Noble, Glenn A.** 1909–?  
American biologist

Parasites as a whole are worthy examples of the inexorable march of evolution into blind alleys.

*Parasitology: The Biology of Animal Parasites* (3<sup>rd</sup> edition)  
Section X, Chapter 25 (p. 572)  
Lea & Febiger. Philadelphia, Pennsylvania, USA. 1971

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Unbidden guests

Are often welcomest when they are gone.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The First Part of King Henry the Sixth  
Act II, Scene ii, l. 55–56  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**van Beneden, P. J.**  
No biographical data available

In the ancient as well as the new world, more than one animal resembles somewhat the sharper leading the life of a great nobleman; and it is not rare to find, by the side of the humble pickpocket, the audacious brigand of the high road, who lives solely on blood and carnage. A great proportion of these creatures always escape, either by cunning, by audacity, or by superior villainy, from social retribution.

*Animal Parasites and Messmates* (p. xvii)  
Henry S. King. London, England. 1876

**Wilson, Edward O.** 1929–  
American biologist and author

Leishmaniasis, schistosomiasis, malignant tertian malaria, filariasis, echinococcosis, onchocerciasis, yellow fever, amoebic dysentery, bleeding bot-fly cysts... evolution has devised a hundred ways to macerate livers and turn blood into a parasite's broth.

*Biophilia*  
Bernhardsdorp (pp. 12–13)  
Harvard University Press. Cambridge, Massachusetts. 1984

## PARKINSON'S DISEASE

**Parkinson, James** 1755–1824  
English physician and paleontologist

The disease, respecting which the present inquiry is made, is of a nature highly afflictive.... The unhappy sufferer has considered it as an evil, from the domination of which he had not prospect of escape.

An Essay on the Shaking Palsy  
*Medical Classics*, Volume 10, Number 10, June 1938

So slight nearly imperceptible are the first inroads of this malady, and so extremely slow its progress, that it rarely happens, that the patient can form any recollection of the precise period of its commencement. The first symptoms perceived are, a slight sense of weakness, with a proneness to trembling in some particular part, sometimes in the head, but most commonly in one of the hands and arms.

An Essay on the Shaking Palsy  
*Medical Classics*, Volume 2, Number 10, June 1938

## PARTICLE

**Davy, Sir Humphry** 1778–1829  
English chemist

...the different bodies in nature are composed of particles or minute parts, individually imperceptible to the senses. When the particles are similar, the bodies they constitute are denominated simple, and when they are dissimilar, compound. The chemical phenomena result from the different arrangements of the particles of bodies; and the powers that produce these arrangements are repulsion, or the agency of heat, and attraction.

*Syllabus of a Course of Lectures at the Royal Institution* (p. 2)  
Publisher undetermined. London, England. 1802

**Fermi, Enrico** 1901–54  
Italian-born American physicist

If I could remember the names of all these particles, I'd be a botanist.

In A. Zee  
*Fearful Symmetry*  
Chapter 11 (p. 168)  
Macmillan Publishing Company. New York, New York, USA. 1986

**Feynman, Richard P.** 1918–88  
American theoretical physicist

We seem gradually to be groping toward an understanding of the world of sub-atomic particles, but we really do not know how far we have yet to go in this task.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*  
Basic Physics (p. 45)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

One of the consequences is that things which we used to consider as waves also behave like particles, and particles behave like waves; in fact everything behaves the same way. There is no distinction between a wave and a particle. So quantum mechanics unifies the idea of the field and its waves, and the particles, all into one.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Basic Physics (p. 36)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

Quantum mechanics has many aspects. In the first place, the idea that a particle has a definite location and a definite speed is no longer allowed; that is wrong.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2–3 (p. 2–6)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Glashow, Sheldon L.** 1932–  
American physicist

Tapestries are made by many artisans working together. The contributions of separate workers cannot be discerned in the complete work, and the loose and false threads have been covered over. So it is in our picture of particle physics.

*Nobel Lectures, Physics 1971–1980*

Nobel lecture for award received in 1979

Towards a Unified Theory — Threads in a Tapestry (p. 494)

World Scientific Publishing Company. Singapore. 1992

**Gleick, James** 1954–  
American author, journalist, and essayist

Quantum mechanics taught that a particle was not a particle but a smudge, a traveling cloud of possibilities...

*Genius: The Life and Science of Richard Feynman*

M. I. T. (p. 89)

Pantheon Books. New York, New York, USA. 1992

**Hein, Piet** 1905–96  
Danish poet and scientist

Nature, it seems is the popular name for milliards and milliards and milliards of particles playing their infinite game of billiards and billiards and billiards.

*Grooks II*

Atomyriades

Doubleday & Company, Inc. Garden City, New York, USA. 1969

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

We can not longer speak of the behavior of the particle independently of the process of observation. As a final consequence, the natural laws formulated mathematically in quantum theory no longer deal with the elementary particles themselves but with our knowledge of them.

Nor is it any longer possible to ask whether or not these particles exist in space and time objectively...

*The Physicist's Conception of Nature*

Chapter I (p. 15)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

The mathematically formulated laws of quantum theory show clearly that our ordinary intuitive concepts cannot be unambiguously applied to the smallest particles. All the words or concepts we use to describe ordinary physical objects, such as position, velocity, color, size, and so on, become indefinite and problematic if we try to [apply them to] elementary particles.

*Across the Frontiers*

Chapter IX (p. 114)

Harper & Row, Publishers. New York, New York, USA. 1974

In the light of quantum theory these elementary particles are no longer real in the same sense as objects of daily life, trees or stones, but appear as abstractions derived from the real material of observation in the true sense.

*On Modern Physics*

Philosophical Problems (p. 13)

C.N. Potter. New York, New York, USA. 1961

**Johnson, George** 1952–  
American science writer

In science's great chain of being, the particle physicists place themselves with the angels, looking down from the heavenly spheres on the chemists, biologists, geologists, meteorologists — those who are applying, not discovering, nature's most fundamental laws. Everything, after all, is made from subatomic particles. Once you have a concise theory explaining how they work, the rest should just be filigree.

New Contenders for a Theory of Everything

*The New York Times*, F1, Column 1, Tuesday, December 4, 2001

**Regnault, Noël** 1702–62  
Jesuit mathematician

The Imagination is lost here. Rather than the Minds; for if you divide a Particle into the most inconceivably minute Parts, the Mind will always find therein something that regards the West, and something that regards the East; and what regards the West, is not that which regards the East.

*Philosophical Conversations* (Volume 1)

Conversation I (p. 9)

Printed for W. Innys, C. Davis, and N. Prevost. London, England. 1731

**Stewart, Ian** 1945–  
English mathematician and science writer

**Cohen, Jack**

Reproductive biologist

They ask wavy questions to decide whether it's a wave, and particle questions to decide whether it's a particle.

*The Collapse of Chaos: Discovering Simplicity in a Complex World*  
Chapter 8 (p. 276)  
The Viking Press. New York, New York, USA. 1994

**Weinberg, Steven** 1933–  
American nuclear physicist

As a scientist, you're probably not going to get rich. Your friends and relatives probably won't understand what you're doing. And if you work in a field like elementary particle physics, you won't even have the satisfaction of doing something that is immediately useful. But you can get great satisfaction by recognizing that your work in science is a part of history.

Scientist: Four Golden Lessons  
*Nature*, Volume 426, 2003 (p. 389)

**Whitman, Walt** 1819–92  
American poet, journalist, and essayist

Oh amazement of things — even the least particle!

*Complete Poems and Collected Prose*  
Song at Sunset

The Library of America. New York, New York, USA. 1982

## PAST

### Author undetermined

“Hands off the Past!” he cried. “No man is fit  
To see or touch it till I’ve sieved each bit.  
The Past is mine!” Well, now he’s part of it.

Epitaph on an Archaeologist  
*Punch*, February 12, 1986 (p. 63)

**Ayer, Alfred Jules** 1910–89  
English philosopher

In practice, speculations about the past, if they are not to be entirely idle, must relate to the traces which the past has left.

*The Central Questions of Philosophy*  
Chapter II (p. 25)

Weidenfeld & Nicolson. London, England. 1973

**Barrow, John D.** 1952–  
English theoretical physicist

Things are as they are because they were as they were.

*The Origin of the Universe*  
Chapter 1 (p. 17)

Basic Books. New York, New York, USA. 1994

**Colbert, Edwin H.** 1905–2001  
American vertebrate paleontologist

The past is mysterious, ever so the farther we look back from our vantage point in the twentieth-century world. As we follow the procession of the year back through time the earth and its inhabitants seem to us less real and

less substantial the more distantly they are removed from this age in which we live.

*The Age of Reptiles*

Chapter 1 Time, Tetrapods and Fossils (p. 1)

W.W. Norton & Company, Inc. New York, New York, USA. 1965

**Crawford, Osbert Guy Stanhope** 1886–1957  
English archaeologist

The archaeologist who tries to re-create the past is like a craftsman at work upon a great building. At first he sees but dimly the plan of the whole, but as he warms to his work it gradually unfolds itself before him.

*Man and His Past*

Chapter XIX (p. 225)

Oxford University Press, Inc. London, England. 1921

**Elton, G. R.**

No biographical data available

The future is dark, the present burdensome; only the past, dead and finished, bears contemplation.

*The Beaver*, Volume 72, Number 4, Aug./Sept. 1992 (p. 4)

**Gorky, Maxim** 1868–1938

Soviet/Russian writer

You can't drive anywhere in a carriage of the past!

*The Lower Depths*

Act Four (p. 80)

Brentano's Publishers. New York, New York, USA. 1923

**Hartley, L. P.** 1895–1972

English writer

The past is a foreign country; they do things differently there.

*The Go-Between*

Prologue (p. 3)

Alfred A. Knopf. New York, New York, USA. 1954

**Hawking, Stephen William** 1942–

English theoretical physicist

...the light that we see from distant galaxies left them millions of years ago, and in the case of the most distant object we have seen, the light left some eight billions years ago. Thus, when we look at the universe, we are seeing it as it was in the past.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 2 (p. 28)

Bantam Books. Toronto, Ontario, Canada. 1988

**Horn, Alfred Aloysius** 1854–1927

Traveler, trader, and adventurer

There's places in Africa where you get visions of primeval force...in Africa the Past has hardly stopped breathing.

*Trader Horn: Being the Life and Works of Alfred Aloysius Horn*

Chapter XXIII (pp. 257, 258)

Simon & Schuster. New York, New York, USA. 1927

## Inscription

What is past is prologue.

Entrance to National Archives, Washington, D.C.

**Koestler, Arthur** 1905–83

Hungarian-born English writer

...man cannot inherit the past; he has to recreate it.

*The Act of Creation*

Book One, Part Two, Chapter XI (p. 266)

The Macmillan Company. New York, New York, USA. 1964

**Kohl, Philip L.** 1946–

American anthropologist

A real past, although blurred, can be glimpsed through archaeological materials.

Symbolic Cognitive Archaeology

*Dialectical Anthropology*, Volume 9, 1985 (p. 115)

**Kubler, George** 1912–96

American art historian

Knowing the past is as astonishing a performance as knowing the stars.

*The Shape of Time: Remarks on the History of Things*

Chapter 1 (p. 19)

Yale University Press. New Haven, Connecticut, USA. 1962

**Leakey, Mary** 1913–96

English archaeologist

Man's early tools and any insights we can get into the lifestyles and activities in succeeding stages of human evolution have been the aspects of the past that I have found the most absorbing, more so than the anatomical features linking or separating one fossil hominoid from another...

*Disclosing the Past: An Autobiography*

Chapter 16 (p. 211)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Lipe, William D.**

American archaeologist

...consideration of the past removes us from the immediate concerns of the here and now...[and] plunges us directly into the larger common world which exists in the stream of time and hence bridges the mortality of generations.

In H. Cleere (ed.)

*Approaches to the Archaeological Heritage: A Comparative Study of World Cultural Resource*

Management Systems Value and Meaning in Cultural Resources (p. 10)

Cambridge University Press. London, England. 1984

**Longfellow, Henry Wadsworth** 1807–82

American poet

Let me review the scene,

And summon from the shadowy Past

The forms that once have been.

*The Poetical Works of Henry Wadsworth Longfellow*

A Gleam of Sunshine

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Mann, Thomas** 1875–1955

German-born American novelist

Very deep is the well of the past. Should we not call it bottomless?

Translated by H. T. Lowe-Porter

*Joseph and His Brothers*

Prelude (p. 3)

Alfred A. Knopf. New York, New York, USA. 1939

**Newton, Sir Charles Thomas** 1816–94

British archaeologist

The record of the Human Past is not all contained in printed books. Man's history has been graven on the rocks of Egypt, stamped on the bricks of Assyria, enshrined in the marble of the Parthenon — it rises before us a majestic Presence in the piled-up arches of the Coliseum — it lurks an unsuspected treasure amid the oblivious dust of archives and monasteries — it is embodied in all the heirlooms of religions, of races, of families; in the relics which affection and gratitude, personal or national, pride of country or pride of lineage, have preserved for us...

*Essays on Art and Archaeology*

Chapter I (p. 1)

Macmillan & Company Ltd. London, England. 1880

**Orwell, George (Eric Arthur Blair)** 1903–50

English novelist and essayist

Who controls the past controls the future: who controls the present controls the past.

*Nineteen Eighty-Four*

Part Three, Chapter II (p. 251)

Buccaneer Books. Cutchogue, New York, USA. 1949

**Sandburg, Carl** 1878–1967

American poet and biographer

I tell you the past is a bucket of ashes.

*Complete Poems*

Prairie

Harcourt, Brace. New York, New York, USA. 1950

**Sir Joseph Whemple**

Fictional character

We didn't come to Egypt to dig for medals! Much more is to be learned from studying bits of broken pottery than from all the sensational finds. Our job is to increase the sum of human knowledge of the past, not to satisfy our own curiosity.

*The Mummy*

Film (1940)

**Toulmin, Stephen** 1922–

Anglo-American philosopher

**Goodfield, June**

Science writer and historian

...no transformation in men's attitude to Nature — in their "common sense" — has been more profound than the change in perspective brought about by the discovery of the past. Rather than take this discovery for granted, it is almost preferable to exaggerate its significance.

*The Discovery of Time*

Introduction (pp. 17–18)

Harper &amp; Row, Publishers. New York, New York, USA. 1965

**Weigall, Arthur Edward** 1880–1934

English Egyptologist and author

Man is by nature a creature of the present. It is only by an effort that he can consider the future, and it is often quite impossible for him to give any heed at all to the past.

*The Glory of the Pharaohs*

Chapter II (p. 35)

G.P. Putnam's Sons. New York, New York, USA. 1923

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian and sociologist

[The] restoration of the past is one of the most astonishing adventures of the human mind.

The Grisly Folk

*Storyteller Magazine*, April 1921

Could anything be more dead, more mute and inexpressive to the inexperienced eye than the ochreous fragments of bone and the fractured lumps of flint that constitute the first traces of something human in the world?

The Grisly Folk

*Storyteller Magazine*, April 1921**Whitman, Walt** 1819–92

American poet, journalist, and essayist

The past, the infinite greatness of the past!

For what is the present, after all, but a growth out of the past.

*Complete Poetry and Collected Prose*

Leaves of Grass

Passage to India

The Library of America. New York, New York, USA. 1982

**PATENT****O'Malley, John R.**

No biographical data available

Almost every engineer is affected by the patent system.

Patents and the Engineer

*Engineering Facts from Gatorland*, Volume 4, Number 5, December 1967**Proverb**

A patent is merely a title to a lawsuit.

In Frank Lewis Dyer

*Edison. His Life and Inventions* (Volume 2)

Chapter XXVIII (p. 700)

Harper &amp; Brothers. New York, New York, USA. 1929

**Roosevelt, Franklin Delano** 1882–194532<sup>nd</sup> president of the United States

Patents are the key to our technology; technology is the key to production.

In Robert A. Buckles

*Ideas, Inventions, and Patents: How to Develop and Protect Them*

Chapter 1 (p. 1)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1957

**PATENT MEDICINE****Adams, Samuel Hopkins** 1871–1958

American author

With a few honorable exceptions the press of the United States is at the beck and call of the patent medicine. Not only do the newspapers modify news possibly affecting these interests, but they sometimes become their agents.

The Great American Fraud

*Collier's Weekly*, Volume 36 October 7, 1905 (p. 14)**PATHOLOGY****Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

Pathology would remain a lovely science, even if there were no therapeutics, just as seismology is a lovely science, though no one knows how to stop earthquakes.

*A Mencken Chrestomathy*

Chapter XXX (pp. 625–626)

Alfred A. Knopf. New York, New York, USA. 1949

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

Pathology has been released from the anomalous and isolated position which it has occupied for thousands of years. Through the application of its doctrines not only to diseases of man, but also to those of even the smallest and lowest of animals, and to those of plants, it helps to deepen biological knowledge, and to light up still further that region of the unknown which still envelops the intimate structure of living matter. It is no longer merely applied physiology — it has become physiology itself.

Translated by Leland J. Rathner

*Disease, Life, and Man, Selected Essays*

The Place of Pathology Among the Biological Sciences (p. 169)

Stanford University Press. Stanford, California, USA. 1958

Pathology also has its place in the science of biology, certainly a very honorable one, for to pathology we owe the realization that the contrast between health and disease is not to be sought in a fundamental difference of two

kinds of life, nor in an alteration of essence, but only in an alteration of conditions.

Translated by Lelland J. Rather

*Disease, Life, and Man, Selected Essays*

The Place of Pathology Among the Biological Sciences (p. 169)  
Stanford University Press. Stanford, California, USA. 1958

## PATIENT

**Abernethy, John** 1680–1740

Irish Presbyterian minister, theologian, and dissenter

Private patients, if they do not like me, can go elsewhere, but the poor devils in the hospital I am bound to take care of.

*Memoirs of John Abernethy*

Chapter V (p. 37)

Harper & Brothers. New York, New York, USA. 1853

**Armour, Richard** 1906–89

American poet

The perfect patient let us praise:  
He's never sick on Saturdays,  
In fact this wondrous, welcome sight  
Is also never sick at night.

In waiting rooms he does not burn  
But gladly sits and waits his turn,  
And even, I have heard it said,  
Begs others, "Please go on ahead."  
He takes advice, he does as told,  
He has a heart of solid gold.

He pays his bills, without a fail,  
In cash, or by the same day's mail.  
He has but one small fault I'd list:  
He doesn't (what a shame!) exist.

*The Medical Muse*

Ideal Patient

McGraw-Hill Book Company, Inc. New York, New York, USA. 1963

**Cushing, Harvey** 1869–1939

American neurosurgeon

Every patient, he said, provided two questions — firstly what can be learnt from him and secondly what can be done for him.

In Robert Coope

*The Quiet Art* (p. 103)

E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**de Madariaga, Salvador** 1886–1978

Spanish writer and statesman

There are no diseases, there are only patients.

*Essays with a Purpose*

On Medicine (p. 174)

Hollis & Carter. London, England. 1954

**Drake, Daniel** 1785–1852

American physician

[There is no era in the life of a physician] in which his self-complacency is so exalted, as the time which passes between receiving his diploma with its blue ribbon, and receiving crepe and gloves, to wear at the funeral of his first patient.

*Western Journal of Medicine and Surgery*, New Series, II:355, October 1844

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American-born British poet and playwright

REILLY: Most of my patients begin, Miss Coplestone, by telling me exactly what is the matter with them. And what I am to do about it.

*The Collected Poems and Plays 1909–1950*

The Cocktail Party, Act Two (p. 359)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Helmuth, William Tod** 1833–1902

American physician

She sent for me in haste to come and see,  
What her condition for a cure might be.  
Dear me! a patient — what a happy tone,  
To have a patient and one all my own —  
To have a patient and myself be feed,  
Raised expectations very high indeed —  
I saw a practice growing from the seed.

*Scratches of a Surgeon*

My First Patient (p. 61)

W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Heschel, Abraham J.** 1907–72

Jewish theologian

The patient must not be defined as a client who contracts a physician for service; he is a human being entrusted to the cure of a physician.

*The Insecurity of Freedom*

The Patient as a Person (p. 31)

Farrar, Straus & Giroux. New York, New York, USA. 1966

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

What I call a good patient is one who, having found a good physician, sticks to him till he dies.

*Medical Essays*

The Young Practitioner (p. 390)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Once in a while you will have a patient of sense, born with the gift of observation, from whom you may learn something.

*Medical Essays*

The Young Practitioner (pp. 382–383)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

If you are making choice of a physician, be sure to get one, if possible, with a cheerful and serene countenance.

*The Professor at the Breakfast Table*

Chapter VI (p. 180)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

**Hubbard, Kin** 1868–1930

American Democratic newspaper editor

Be kind t' th' henn egg. When sickness enters th' home an' th' patient comes thru th' crisis twenty pounds lighter than a straw hat, an' is propped up with pillows in th' bay window t' watch th' speedin', an' loved ones try t' tempt him with round steak, an' pickles an' near beer, he wearily waves 'em away. But with his first returnin' strength he squirms an' turns his listerless eyes toward th' kitchen an' says, in a voice weak an' scarcely audible, "Maw, I believe I could worry down an egg..."

*Abe Martin: Hoss Sense and Nonsense* (p. 53)

The Bobbs-Merrill Company, Indianapolis, Indiana, USA. 1926

**Mayo, William J.** 1861–1939

American physician

...the highly scientific development of this mechanistic age had led perhaps to some loss in appreciation of the individuality of the patient and to trusting largely to the laboratories and outside agencies which tended to make the patient not the hub of the wheel, but a spoke.

Edward Martin, M.D., 1859–1938

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 30, 1938

**Morris, Robert Tuttle** 1857–1945

Abdominal surgeon

It is the patient rather than the case which requires treatment.

*Doctors Versus Folks*

Chapter 2

Doubleday, Page & Company, Inc. Garden City, New York, USA. 1915

**Newman, Sir George** 1870–1948

English public health physician

There are four questions which in some form or other every patient asks his doctor: (a) What is the matter with me? This is diagnosis. (b) Can you put me right? This is treatment and prognosis. (c) How did I get it? This is causation. (d) How can I avoid it in future? This is prevention.

Preventive Medicine for the Medical Student

*The Lancet*, Volume 221, November 21, 1931 (p. 113)

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

To study the phenomena of disease without books is to sail an uncharted sea, while to study books without patients is not to go to sea at all.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter IV (p. 67)

Clarendon Press. Oxford, England. 1925

**Parrot, Max**

No biographical data available

It is often been said that the technical aspects of medicine are easy. The difficult part is dealing with the personality of the patient, the so-called psychological or human factor. This takes up a great deal of the time of the practicing physician. It is harder on the doctor's constitution than all of the technical aspects of medicine. It may even cause his or her demise, in the case of a physician with an autonomic nervous system that can't take the heat.

In Irving Oyle

*The New American Medical Show: Discovering the Healing Connection* (p. 25)

Unity Press. Santa Cruz, California, USA. 1979

**Potter, Stephen** 1900–69

No biographical data available

If Patient turns out to be really ill, it is always possible to look grave at the same time and say "You realize, I suppose, that 25 years ago you'd have been dead?"

*One-Upmanship*

Chapter II (p. 28)

Henry Holt & Company. New York, New York, USA. 1952

**Rhazes** 865–925

Persian physician

The patient who consults a great many physicians is likely to have a very confused state of mind.

In Samuel Evans Massengill

*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 45)

The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

**Sacks, Oliver W.** 1933–

American neurologist and author

There is only one cardinal rule: one must always listen to the patient.

Listening to the Lost

*Newsweek*, August 20, 1984 (p. 70)

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

"How does your patient," doctor?

"Not so sick, my lord,

As she is troubled with thick-coming fancies."

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Macbeth

Act V, Scene iii, l. 37–39

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**PATTERN****Burns, Marilyn**

No biographical data available

Searching for patterns is a way of thinking that is essential for making generalizations, seeing relationships, and understanding the logic and order of mathematics.



Functions evolve from the investigation of patterns and unify the various aspects of mathematics.

*About Teaching Mathematics: A K–8 Resource*

Patterns and Functions (p. 112)

Math Solutions Publications, USA. 1992

**Derry, Gregory N.** 1952–

American professor of physics

In trying to understand nature, we rarely attempt to grasp completely every possible detail. If we did, we'd be overwhelmed by the mass of inconsequential information. As a result, we would miss the truly interesting patterns and relationships that give us scientific insight.

*What Science Is and How It Works*

Chapter 6 (p. 69)

Princeton University Press. Princeton, New Jersey, USA. 1999

**Gardner, Martin** 1914–

American writer and mathematics games editor

If the cosmos were suddenly frozen, and all movement ceased, a survey of its structure would not reveal a random distribution of parts. Simple geometrical patterns, for example, would be found in profusion — from the spirals of galaxies to the hexagonal shapes of snow crystals. Set the clockwork going, and its parts move rhythmically to laws that often can be expressed by equations of surprising simplicity. And there is no logical or a priori reason why these things should be so.

*Order and Surprise*

Chapter 4 (p. 57)

Prometheus Books. Buffalo, New York, USA. 1983

**Hofstadter, Douglas** 1945–

American cognitive scientist and author

Yes, I am a relentless quester after the chief patterns of the universe — central organizing principles, clean and powerful ways to categorize what is “out there.”

*Metamagical Themas: Questing for the Essence of Mind and Pattern*

Introduction (p. xxv)

Basic Books, Inc. New York, New York, USA. 1985

**Huxley, Aldous** 1894–1963

English writer and critic

The difference between a piece of stone and an atom is that an atom is highly organised, whereas the stone is not. The atom is a pattern, and the molecule is a pattern, and the crystal is a pattern; but the stone, although it is made up of these patterns, is just a mere confusion. It's only when life appears that you begin to get organisation on a larger scale. Life takes the atoms and molecules and crystals; but, instead of making a mess of them like the stone, it combines them into new and more elaborate patterns of its own.

*Time Must Have a Stop*

Chapter XIV (p. 145)

The Sun Dial Press. Garden City, New York, USA. 1944

**MacArthur, Robert H.** 1930–72

American ecologist

To do science is to search for repeated patterns, not simply to accumulate facts, and to do the science of geographical ecology is to search for patterns of plants and animal life that can be put on a map.

*Geographical Ecology*

Introduction (p. 1)

Harper & Row, Publishers, New York, New York, USA. 1972

**Peterson, Ivars**

Mathematics writer

In their search for patterns and logical connections, mathematicians face a vast, mysterious ocean of possibilities. Over the centuries, they have discovered an extensive archipelago of truth and beauty. Much of that accumulated knowledge is passed on to succeeding generations. Even more wonders await future explorers of deep, mathematical waters.

*Islands of Truth: A Mathematical Mystery Cruise*

Chapter 8 (p. 292)

W.H. Freeman & Company. New York, New York, USA. 1990

**Stevens, Peter S.**

No biographical data available

It turns out that those patterns and forms are peculiarly restricted, that the immense variety that nature creates emerges from the working and reworking of only a few formal themes. These limitations on nature bring harmony and beauty to the natural world.

*Patterns in Nature*

Chapter 1 (p. 3)

Little, Brown & Company. Boston, Massachusetts, USA. 1974

## PAULI PRINCIPLE

**Gamow, George** 1904–68

Russian-born American physicist

We do not know why they have the masses they do; we do not know why they transform into another the way they do; we do not know anything! The one concept that stands like the Rock of Gibraltar in our sea of confusion is the Pauli principle.

The Exclusion Principle

*Scientific American*, Volume 201, Number 1, July 1959 (p. 86)

## PENDULUM

**Eco, Umberto** 1932–

Italian novelist, essayist, and scholar

That was when I saw the Pendulum.

The sphere, hanging from a long wire set into the ceiling of the choir, swayed back and forth with isochronal majesty.

I knew — but anyone could have sensed it in the magic of that serene breathing — that the period was governed by the square root of the length of the wire and by pi, that number which, however irrational to sublunar minds, though a higher rationality binds the circumference and diameter of all possible circles. The time it took the sphere to swing from end to end was determined by an arcane conspiracy between the most timeless of measures: the singularity of the point of suspension, the duality of the plane's dimensions, the triadic beginning of  $\pi$ , the secret quadratic nature of the root, and the unnumbered perfection of the circle itself.

Translated by William Weaver

*Foucault's Pendulum*

Chapter 1 (p. 3)

Harcourt Brace Jovanovich, Publishers. San Diego, California, USA. 1988

### Graham, L. A.

No biographical data available

Rock-a-bye baby in the tree top,  
As a compound pendulum, you are a flop.  
Your center of percussion is safe and low,  
As one may see when the wind doth blow.  
Your frequency of vibration is pretty small,  
Frankly, I don't think you'll fall at all.

*Ingenious Mathematical Problems and Methods*

Mathematical Nursery Rhyme Number 2

Dover Publications, Inc. New York, New York, USA. 1959

## PENICILLIN

### Fleming, Sir Alexander 1881–1955

Scottish bacteriologist

I have been frequently asked why I invented the name "Penicillin." I simply followed perfectly orthodox lines and coined a word which explained that the substance penicillin was derived from a plant of the genus *Penicillium* just as many years ago the word "Digitalin" was invented for a substance derived from the plant *Digitalis*.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1945

Penicillin (p. 83)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## PERCENTAGE

### Barnes, Michael R.

No biographical data available

There's a 50 percent chance of anything — either it happens or it doesn't.

In Paul Dickson

*The Official Explanations* (p. B–9)

Delacorte Press. New York, New York, USA. 1980

### Bloch, Arthur 1948–

American humorist

90% of everything is crap.

*Murphy's Law*

Sturgeon's Law (p. 21)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

### Crichton, Michael 1942–

American novelist

John. Trust us on this, we have the figures. We are telling you with ninety-five percent confidence intervals how the people feel.

*Rising Sun*

Second Day (p. 255)

Ballantine Books. New York, New York, USA. 1993

"I did," Gerhard said. "But I don't know any more. We've passed the confidence limits already. They were about plus or minus two minutes for ninety-nine percent."

*The Terminal Man*

Chapter 6 (p. 157)

Alfred A. Knopf. New York, New York, USA. 1972

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

When half a million babies are born in England in a year, we may say that 20 percent of them are born in London, 2 percent in Manchester, 1 percent in Bristol, and so on. But when we think of one baby born in a single minute of time, we cannot say that 20 percent of it was born in London, 2 percent in Manchester, and so on. We can only say that there is a 20 percent probability of its being born in London, a 2 percent probability of its being born in Manchester, and so on.

*Physics and Philosophy*

Chapter V (p. 136)

Dover Publications, Inc. New York, New York, USA. 1981

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

...I do not remember just when, for I was not born then and cared nothing for such things. It was a long journey in those days and must have been a rough and tiresome one. The village contained a hundred people and I increased the population by 1 percent. It was more than many of the best men in history could have done for a town. It may not be modest in me to refer to this but it is true.

*Mark Twain's Autobiography* (Volume 1)

Chapter Begun in Vienna (pp. 94–95)

Harper & Brothers. New York, New York, USA. 1924

## PERCEPTION

### Adams, Douglas 1952–2001

English author, comic radio dramatist, and musician

Everything you see or hear or experience in any way at all is specific to you. You create a universe by perceiving it.

*The Ultimate Hitchhiker's Guide to The Galaxy*

Mostly Harmless

Chapter 9 (p. 703)

The Ballantine Book Company. New York, New York, USA. 2002

**Blake, William** 1757–1827

English poet, painter, and engraver

As to that false appearance which appears to the reasoner  
As of a Globe rolling thro' Voidness, it is a delusion of  
Ulro.

The Microscope knows not of this nor the Telescope:  
they alter

The ratio of the Spectator's Organs, but leave Objects  
untouch'd.

*The Complete Poetry and Prose of William Blake*

The Building of Time

University of California Press. Berkeley, California, USA. 1982

**Cousins, Norman** 1912–90

American editor and author

As we enlarge our sense of the cosmos, we are enlarging  
our consciousness. As we extend the reach of the mind,  
we are learning more about our potentialities. As we  
move beyond the human habitat, we are gaining perspective  
on ourselves as custodians of the planet.

Rendezvous with Infinity

*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979

(pp. 30–31)

**Murphy, Michael**

No biographical data available

To a frog with its simple eye, the world is a dim array of  
grays and blacks. Are we like frogs in our limited sensorium,  
apprehending just part of the universe we inhabit?  
Are we as a species now awakening to the reality of multidimensional  
worlds in which matter undergoes subtle reorganizations in some  
sort of hyperspace?

*The Future of the Body*

Part I, Chapter 8 (p. 216)

Penguin Putnam, Inc. New York, New York, USA. 1992

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Physics and perception are like two people on opposite  
sides of a brook which slowly widens as they walk; at  
first it is easy to jump across, but imperceptibly it grows  
more difficult, and at last a vast labor is required to get  
from one side to the other.

*Analysis of Matter*

Chapter XIV (p. 137)

Dover Publications, Inc., New York, New York, USA, 1954

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Our problem is, in fact, to fit the world to our perceptions,  
and not our perceptions to the world.

*The Organization of Thought*

Chapter VIII (p. 228)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

## PERCUSSION

**Auenbrugger, Leopold** 1722–1809

Viennese physician

I present the reader with a new sign, which I have  
discovered for detecting diseases of the chest, This consists  
in the percussion of the human thorax, whereby  
according to the character of the particular sounds  
thence elicited, an opinion is formed of the internal state  
of that cavity.

*New Invention by Means of Percussing the Human Thorax for Detecting  
Signs of Obscure Disease of the Interior of the Chest*

December 31, 1761

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Even perfection will not bear the tedium of indefinite  
repetition.

*Atlantic*, September 29, 1979 (p. 244)

## PERIODIC TABLE

**Atkins, Peter William** 1940–

English physical chemist and writer

The periodic table is arguably the most important concept  
in chemistry, both in principle and in practice. It is the  
everyday support for students, it suggests new avenues  
of research to professionals, and it provides a succinct  
organization of the whole of chemistry. It is a remarkable  
demonstration of the fact that the chemical elements  
are not a random clutter of entities but instead display  
trends and lie together in families. Anyone who seeks to  
be familiar with a scientist's-eye view of the world must  
be aware of the general form of the periodic table, for it  
is a part of scientific culture.

*The Periodic Kingdom: A Journey into the Land of the Chemical Elements*

Preface (pp. vii–viii)

Basic Books, Inc. New York, New York, USA. 1995

**Bolton, Henry Carrington** 1843–1903

American chemist, bibliographer, and historian

The periodic law has given to chemistry that prophetic  
power long regarded as the peculiar dignity of its sister  
science, astronomy.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 9 (p. 122)

Longmans. London, England. 1967

**Mendeleev, Dmitry** 1834–1907  
Russian chemist

I shall endeavor to show, as briefly as possible, ...how far the periodic law contributes to enlarge our range of vision. Before the promulgation of this law the chemical elements were mere fragmentary, incidental facts in Nature; there was no special reason to expect the discovery of new elements, and the new ones which were discovered from time to time appeared to be possessed of quite novel properties. The law of periodicity first enabled us to perceive undiscovered elements at a distance which formerly was inaccessible to chemical vision...

The Periodic Law of the Chemical Elements  
*Journal of the Chemical Society*, Volume 55, 1889 (p. 648)

There must be some bond of union between mass and the chemical elements; and as the mass of a substance is ultimately expressed...in the atom, a functional dependence should exist and be discoverable between the individual properties of the elements and their atomic weights. But nothing, from mushrooms to a scientific law, can be discovered without looking and trying. So I began to look about and write down the elements with their atomic weights and typical properties, analogous elements and like atomic weights on separate cards, and this soon convinced me that the properties of elements are in periodic dependence upon their atomic weights.

In Thomas H. Pope (ed.)  
Translated by George Kamensky  
*The Principles of Chemistry* (Volume 2)  
Longmans, Green & Company. London, England. 1905

By ordering the elements according to increasing atomic weight in vertical rows so that the horizontal rows contain analogous elements, still ordered by increasing atomic weight, one obtains the following arrangement, from which a few general conclusions may be derived.

David M. Knight (ed.)  
*Classical Scientific Papers — Chemistry, Second Series*  
On the Relationship of the Properties of the Elements to Their Atomic Weights (1869)  
American Elsevier Publishing Company. New York, New York, USA. 1968

An established system is limited by its order of known or discovered elements. With the periodic and atomic relations now shown to exist between all the atoms and the properties of their elements, we see the possibility not only of noting the absence of some of them but even of determining, and with great assurance and certainty, the properties of these as yet unknown elements; it is possible to predict their atomic weight, density in the free state or in the form of oxides, acidity or basicity, degree of oxidation, and ability to be reduced and to form double salts and to describe the properties of the metalloorganic compounds and chlorides of the given element; it is even possible...to describe the properties of some compounds of these unknown elements in still greater detail. ...[A]t

the present time it is not possible to say when one of these bodies...will be discovered, yet the opportunity exists for finally convincing myself and other chemists of the truth of those hypotheses which lie at the base of the system I have drawn up.

A Natural System of the Elements and Its Use in Predicting the Properties of Undiscovered Elements  
*Journal of the Russian Chemical Society*, Volume 3, 1871 (p. 25)

"I shall not form any hypothesis, either here nor further on to explain the nature of the periodic law. For first of all, the law itself is too simple; and secondly, this new subject has been too little studied yet, in its diverse parts for us to form any hypothesis."

In B. Bensaude-Vincent  
Mendeléeev's Periodic System (Part I)  
*British Journal for the History of Science*, Volume 19, Number 61, March 1986 (p. 7)

**Roscoe, Henry E.** 1833–1915  
English chemist

We must then find that these numbers regularly increase by a definite amount, *i.e.*, by the average age of a generation, which will be approximately the same in all the four families. Comparing the ages of the chemists themselves, we shall observe certain differences, but these are small in comparison with the period which has elapsed since the birth of their ancestors. Now each individual in this series of family trees represents a chemical element; and just as each family is distinguished by certain idiosyncrasies, so each group of the elementary bodies thus arranged shows distinct signs of consanguinity.

*Report of the British Association of the Advancement of Science*  
1887 (p. 10)  
Publisher undetermined

**Sanderson, R. T.**  
No biographical data available

Students may readily be bewildered by the apparently fundamental lack of agreement among various periodic tables, and some may even acquire reasonable doubt as to whether chemists actually know what they are doing.

One More Periodic Table  
*Journal of Chemical Education*, Volume 31, 1954 (p. 481)

## PERPETUAL MOTION

**Burroughs, John** 1837–1921  
American naturalist and writer

Physics proves to us the impossibility of perpetual motion among visible, tangible bodies, at the same time that it reveals to us a world where perpetual motion is the rule — the world of molecules and atoms.

*The Breath of Life*  
Chapter IX (p. 190)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Scientists have searched for a perpetuum mobile; they have found it: it is science itself.

In Rolf Huisgen

*The Adventure Playground of Mechanisms and Novel Reactions*

Has Chemistry Reached the Postmechanistic Era? (p. 244)

American Chemical Society. Washington, D.C. 1994

**PESSIMISM****Rashevsky, Nicolas** 1899–1972

Mathematical biophysicist

Pessimism is not a healthy thing in science, but neither is unrealistic optimism.

*Mathematical Biophysics: Physico-Mathematical Foundations of**Biology* (Volume 2)

Chapter XXVIII (p. 307)

Dover Publications, Inc. New York, New York, USA. 1960

**PEST CONTROL****Müller, Paul** 1899–1965

Swiss chemist

The field of pest control is immense, and many problems impatiently await a solution. A new territory has opened up for the synthetic chemist, a territory which is still unexplored and difficult, but which holds out the hope that in time further progress will be made.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1948

Dichloro-Diphenyl-Trichloroethane and Newer Insecticides (p. 236)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**PESTILENCE****Camus, Albert** 1913–1960

Algerian-French author and philosopher

A pestilence isn't a thing made to man's measure; therefore we tell ourselves that pestilence is a mere bogey of the mind, a bad dream that will pass away. But it doesn't pass away and, from one bad dream to another, it is men who pass away.

*The Plague*

Part I, Chapter 5 (p. 37)

Vintage Books. New York, New York, USA. 1991

**Hugo, Victor** 1802–85

French author, lyric poet and dramatist

...death has a way of its own of harassing victory, and it causes pestilence to follow glory. Typhus is an annex of triumph.

*Les Misérables*

Volume 2, Book I, Chapter 2 (p. 7)

The Heritage Press. New York, New York, USA. 1938

**PETRIFICATION****Leclerc, Georges-Louis, Comte de Buffon** 1707–

88

French naturalist

Petrification is the great means of nature to keep the transitory creatures of all epochs.

In Jochen Helms

*Fossils: The Oldest Treasures that Ever Lived*

The Berlin Specimen of the Primitive Bird Archaeopteryx (p. 94)

T.H.F. Publications, Inc. Neptune City, New Jersey, USA. 1985

**PETROLOGY****Wyllie, Peter J.**

Geologist

The results of experimental petrology...help to distinguish between possible and impossible processes.

In M.P. Atherton and C.D. Gribble (eds.)

*Migmatites, Melting and Metamorphism*

Experimental Studies on Biotite- and Muscovite-Granites and Some

Crustal Magmatic Sources (p. 13)

Shiva Geology Series. 1983

**PH.D.****Chargaff, Erwin** 1905–2002

Austrian biochemist

The Ph.D. is essentially a license to start unlearning.

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 1 (p. 2)

The Seabury Press. New York, New York, USA. 1977

**Dyson, Freeman J.** 1923–

American physicist and educator

The average student emerges at the end of the Ph.D. program, already middle-aged, overspecialized, poorly prepared for the world outside, and almost unemployable except in a narrow area of specialization. Large numbers of students for whom the program is inappropriate are trapped in it, because the Ph.D. has become a union card required for entry into the scientific job market.

*From Eros to Gaia*

Chapter 16 (p. 195)

Pantheon Books. New York, New York, USA. 1992

**PHARMACIST****Eisenschiml, Otto** 1880–1963

Austrian-American chemist and historian

The surgeon who has performed scores of brilliant operations is less talked about than the one who has inadvertently killed a patient; the pharmacist who has carefully

filled prescriptions for a lifetime remains obscure, but will gain publicity by a single oversight.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Seven (p. 87)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Flexner, Abraham** 1866–1959

American educator

The physician thinks, decides, and orders; the pharmacist obeys — obeys, of course, with discretion, intelligence, and skill — yet, in the end, obeys and does not originate. Pharmacy therefore is an arm added to the medical profession, a specially and distinctly higher form of handicraft, not a profession...

Is Social Work a Profession?

*School and Society*, Volume 1, 1915 (p. 905)

## PHARMACY

**Ghalioungui, Paul**

The word pharmakon, whence pharmacy is derived, meant in Greek not only medicament, poison, or magical procedure, but also that which is slain to expiate the crimes of a city, like the scapegoat of Biblical times.... In other words, it meant “what carries off disease.”

*Magic and Medical Science in Ancient Egypt*

Chapter II (p. 35)

Barnes and Nobles. New York, New York, USA. 1965

## PHENOMENA

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

When we speak of a phenomenon, we speak only of an event, or of a succession of events, arbitrarily isolated from the universe whose evolution they share. By isolating a fact in order to study it, we give it a beginning and an end, which are artificial and relative. In relation to the evolution of the universe, birth is not a beginning, and death is not an end. There are no more isolated phenomena in nature than there are isolated notes in a melody.

*The Road to Reason*

Chapter 2 (p. 53)

Longmans, Green & Company. London, England. 1949

**Griffin Jay**

Fictional character

There are some things in science which should be brought to light. There are others, doctor, which should be left alone.

*The Mummy*

Film (1940)

**Haas, W. H.**

American microbiologist

As most of us are aware, the world is now divided into two sets of phenomena, scientific and non-scientific.

The Teaching of Geography as a Science

*Journal of Geography*, Volume 30, 1931 (p. 323)

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Phenomena may well be suspected of anything, are capable of anything. Hypothesis proclaims the infinite; that is what gives hypothesis its greatness. Beneath the surface fact it seeks the real fact. It asks creation for her thoughts, and then for her second thoughts. The great scientific discoverers are those who hold nature suspect.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 415)

The Heritage Press. New York, New York, USA. 1961

**Jevons, William Stanley** 1835–82

English economist and logician

...every strange phenomenon may be a secret spring which, if rightly touched, will open the door to new chambers in the palace of nature.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book V, Chapter XXIX (p. 671)

Macmillan & Company Ltd. London, England. 1887

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The phenomena of nature are most often enveloped by so many strange circumstances, and so great a number of disturbing causes mix their influence, that it is very difficult to recognize them.

*A Philosophical Essay on Probabilities*

Chapter IX (p. 73)

Dover Publications, Inc. New York, New York, USA. 1951

**Lederer, Charles** 1906–76

American film writer and director

There are no enemies in science, professor. Only phenomena to study.

*The Thing From Another World*

Film (1951)

**Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

The intellect is presented with phenomena marching in review before the sensory organs. It can be truly useful and productive only when limiting itself to the modest tasks of observation, description, and comparison, and of classification that is based on analogies and differences.

*Advice for a Young Investigator*

Chapter 1 (p. 2)

The MIT Press. Cambridge, Massachusetts, USA. 1999

**Spencer, Herbert** 1820–1903  
English social philosopher

Sad, indeed, is it to see how men occupy themselves with trivialities, and are indifferent to the grandest phenomena...

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 73)

A.L. Fowle. New York, New York, USA. 1860

**Wilson, Edward O.** 1929–  
American biologist and author

...all tangible phenomena, from the birth of stars to the workings of social institutions, are based on material processes that are ultimately reducible, however long and tortuous the sequences, to the laws of physics.

*Consilience: The Unity of Knowledge*  
Chapter 12 (p. 266)

Alfred A. Knopf. New York, New York, USA. 1998

## PHILOSOPHER

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

Somehow or other no statement is too absurd for some philosophers to make.

Translated by William Armistead Falconer  
*Cicero: De Senectute, De Amicitia, De Divinatione*  
De Divinatione, II, LVIII (p. 505)

Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Darwin, Charles Robert** 1809–82  
English naturalist

Why should the souls [of philosophers] be deeply vexed? The majesty of Fact is on their side, and the elemental forces of Nature are working for them. Not a star comes to the meridian at its calculated time but testifies to the justice of their methods — their beliefs are “one with the falling rain and with the growing corn.” By doubt they are established, and open inquiry is their bosom friend.

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 53)

Macmillan & Company Ltd. London, England. 1904

**Faraday, Michael** 1791–1867  
English physicist and chemist

The philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances; have no favorite hypothesis; be of no school; and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities he added industry, he may indeed hope to walk within the veil of the temple of Nature.

*The Life and Letters of Faraday* (Volume 1) (p. 220)

Longmans, Green & Company. London, England. 1870

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

...to the natural philosopher there is no natural object unimportant or trifling.

*A Preliminary Discourse on The Study of Natural Philosophy*  
Part I, Chapter I, Section 10 (p. 14)

Printed for Longman, Rees, Orme, Brown, and Green. London, England. 1831

**Lindley, David** 1956–  
English astrophysicist and author

As philosophers have frequently found, the real world seems to messy, too stubbornly arbitrary, to be found out by the power of thought alone, no matter how fine the guiding sense of aesthetics.

*The End of Physics: The Myth of a Unified Theory*  
Part III, Chapter 8 (p. 231)

Basic Books, Inc. New York, New York, USA. 1993

## PHILOSOPHER'S STONE

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

The philosopher's stone is no more to be found in the organic than the inorganic world; and we shall seek as vainly to transform the lower animal types into the higher ones by any of our theories, as did the alchemists of old to change the baser metals into gold.

*Methods of Study in Natural History*

Chapter XVI (p. 319)

Ticknor & Fields. Boston, Massachusetts, USA. 1863

## PHILOSOPHY

**Astaire, Fred** 1899–1955  
American dancer, actor, and singer

I wish I had your confidence...without your viewpoint.

*Holiday Inn*

Film (1942)

**Barthelme, Donald** 1931–89  
American author

But I think everyone should have a little philosophy, Thomas said. It helps, a little. It helps. It is good. It is about half as good as music.

*The Dead Father* (p. 76)

Pocket Books. New York, New York, USA. 1975

**Bell, R. P.**  
English chemist

The exact verbal definition of qualitative concepts is more often the province of philosophy than of physical science.

*The Proton in Chemistry*

Chapter II (p. 7)

Cornell University Press. Ithaca, New York, USA. 1959

**Bernard, Claude** 1813–78  
French physiologist

I can no more accept a philosophy, then, which tries to assign boundaries to science, than a science which claims to suppress philosophic truths that are at present outside its own domain.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter III, Section iv (p. 223)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Born, Max** 1882–1970  
German-born English physicist

A philosophy in which the notions of chance and freedom are fundamental seems to me preferable to the almost inhuman determinism of the previous epoch — but that is no scientific argument.

*Les Prix Nobel. The Nobel Prizes in 1954*  
Nobel banquet speech for award received in 1954  
Nobel Foundation. Stockholm, Sweden. 1955

**Burnet, Thomas** 1635–1715  
English cleric and scientist

Orators and Philosophers treat Nature after a very different manner...with all her graces and ornaments, and if there be anything which is not capable of that, they dissemble it, or pass it over slightly. But Philosophers view Nature with a more impartial eye, and without favor or prejudice give a just and free account [of] how they find all the parts of the Universe, some more, some less perfect.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)  
Book I, Chapter IX (p. 90)  
Printed by R. Norton. London, England. 1691

**Clarke, Samuel** 1675–1729  
English philosopher

‘Tis of singular use, rightly to understand, and carefully to distinguish from hypotheses or mere suppositions, the true and certain consequences of experimental and mathematical philosophy; which do, with wonderful strength and advantage, to all such as are capable of apprehending them, confirm, establish, and vindicate against all objections, those great and fundamental truths of natural religion, which the wisdom of providence has at the same time universally implanted, in some degree, in the minds of persons even of the meanest capacities, not qualified to examine demonstrative proofs.

In H.G. Alexander  
*The Leibniz–Clarke Correspondence*  
Dedication (p. 6)  
Philosophical Library Inc. New York, New York, USA. 1956

**Dawson, Sir John William** 1820–99  
Canadian geologist and educator

It is a wise and thoughtful philosophy which can distinguish what is fixed and unchangeable from that which is fluctuating and capable of development.

*Some Salient Points in the Science of the Earth*  
Chapter XII (p. 342)  
Hodder & Stoughton. London, England. 1893

**de Botton, Alain** 1969–  
Swiss-born English writer and television producer

Seneca believed...arguments are like eels: however logical, they may slip from the mind’s weak grasp unless fixed there by imagery and style.

*The Consolations of Philosophy* (p. 92)  
Vintage Books. New York, New York, USA. 2000

**Dewey, John** 1859–1952  
American philosopher and educator

What would happen to philosophy...if it ceased to deal with the problem of reality and knowledge at large?... From this point of view, the problem of philosophy concerns the *interaction* of our judgments about ends to be sought with the knowledge of the means for achieving them.

*Quest for Certainty: A Study of the Relation of Knowledge and Action*  
Chapter II (pp. 36–37)  
Minton, Balch & Company. New York, New York, USA. 1929

[Philosophy] has tried to combine acceptance of the conclusions of scientific inquiry as to the natural world with the acceptance of doctrines about the nature of mind and knowledge which originated before there was such a thing as systematic experimental inquiry. Between the two there is an inherent incompatibility.

*Quest for Certainty: A Study of the Relation of Knowledge and Action*  
Chapter III (p. 49)  
Minton, Balch & Company. New York, New York, USA. 1929

**Disraeli, Benjamin, 1<sup>st</sup> Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

Philosophy becomes poetry, and science imagination, in the enthusiasm of genius.

*Miscellanies of Literature, by the Author of ‘Curiosities of Literature’*  
(p. 426)  
G. Routledge. London, England. 1886

**Donne, John** 1572–1631  
English poet and divine

And new Philosophy calls all in doubt,  
The Element of fire is quite put out;  
The sun is lost, and th’ earth, and no man’s wit  
Can well direct him where to look for it.  
And freely men confess that this world’s spent,  
When in the Planets and the Firmament  
They seek so many new, they see that this  
Is crumbled out again to his Atomies.

*An Anatomy of the World*



The First Anniversary, II, 205–212

Presented for presentation to members of the Roxburge Club. Cambridge, England. 1951

**Durant, William James** 1885–1981

American historian and essayist

Science gives us knowledge, but only philosophy can give us wisdom.

*The Story of Philosophy*

Introduction (p. 3)

Simon & Schuster. New York, New York, USA. 1953

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The recent tendencies of science do...take us to an eminence from which we can look down into the deep waters of philosophy; and if I rashly plunge into them, it is not because I have confidence in my powers of swimming, but to try to show that the water is really deep.

*The Nature of the Physical World*

Chapter XIII (p. 276)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

The Heisenberg–Bohr tranquilizing philosophy — or religion? — is so delicately contrived that, for the time being, it provides a gentle pillow for the true believer from which he cannot very easily be aroused. So let him lie there.

*Letters on Wave Mechanics*

Letter to Schrödinger, 31 May, 1928 (p. 31)

I have never belonged wholeheartedly to a country, a state, nor to a circle of friends, nor even to my own family. When I was still a rather precocious young man, I already realized most vividly the futility of the hopes and aspirations that most men pursue throughout their lives. Well-being and happiness never appeared to me as an absolute aim. I am even inclined to compare such moral aims to the ambitions of a pig.

In C.P. Snow

*Variety of Men* (p. 77)

Penguin Books, Harmondsworth, U.K. 1969

**Foster, Hannah W.** 1758–1840

English writer

You ask me, my friend, whether I am in pursuit of truth, or [of] a lady? I answer, both. I hope and trust they are united; and really expect to find truth and the virtues and graces besides in a fair form.

*The Coquette: The History of Eliza Norton (A Novel)* (p. 10)

Oxford University Press. 1986

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

I realized that only in music could I find the answer I was seeking to the questions of the previous evening. Argument I could follow, it weighed with me, yet I could decide nothing from it.

*October the First Is Too Late*

Chapter Fourteen (p. 187)

Harper & Row, Publishers. New York, New York, USA. 1966

**Inge, William Ralph** 1860–1954

English religious leader and author

...science and philosophy can not be kept in water-tight compartments.

*God and the Astronomers*

Preface (p. vii)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Lewis, Gilbert Newton** 1875–1946

American chemist

The average scientist, unequipped with the powerful lenses of philosophy, is a nearsighted creature, and cheerfully attacks each difficulty in the hope that it may prove to be the last.

*The Anatomy of Science*

Chapter I (p. 1)

Yale University Press. New Haven, Connecticut, USA. 1926

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

...every philosopher has his own private view of science, and every scientist his private philosophy.

*Knowledge and Error: Sketches on the Psychology of Enquiry*

Chapter I (p. 3)

D. Reidel Publishing Company. Dordrecht, Germany. 1976

**Maclaurin, Colin** 1698–1746

Scottish mathematician and natural philosopher

Is it not therefore the business of philosophy, in our present situation in the universe, to attempt to take in at once, in one view, the whole scheme of nature; but to extend, with great care and circumspection, our knowledge, by just steps, from sensible things as far as our observations or reasonings from them will carry us in our enquiries concerning either the greater motions and operations of nature, or her more subtle and hidden works.

*An Account of Sir Isaac Newton's Philosophical Discoveries*

Book I, Chapter I (p. 19)

Printed for the Author's Children. London, England. 1748

**Nielsen, Kai**

American-born Canadian philosopher

We must be on guard against the irrational heart of rationalism and not set out on the quest for certainty.

*Ethics Without God* (Revised edition) (p. 47)

Prometheus Books. Amherst, New York, USA. 1990

**Paine, Thomas** 1737–1809  
Anglo-American political theorist and writer

Natural philosophy, mathematics and astronomy, carry the mind from the country to the creation, and give it a fitness suited to the extent.  
Address to the People of England  
Philadelphia, March, 1780

**Raether, H.**  
No biographical data available

There are more things between cathode and anode than are dreamt of in your philosophy.  
*Electron Avalanches and Breakdown in Gases*  
Introduction (p. 1)  
Butterworths. London, England. 1964

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Philosophy, from the earliest times, has made greater claims, and achieved fewer results, than any other branch of learning.  
*Our Knowledge of the External World*  
Lecture I (p. 3)  
The Open Court Publishing Company. Chicago, Illinois. 1914

...science is what you more or less know and philosophy is what you do not know.  
*Logic and Knowledge*  
The Philosophy of Logical Atomism (p. 281)  
George Allen & Unwin Ltd. London, England. 1926

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Hamlet, Prince of Denmark  
Act I, Scene v, l. 167–168  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Updike, John** 1932–  
American novelist, short story writer, and poet

The mad things dreamt up in the sky  
Discomfort our philosophy.  
*Collected Poems 1953–1993*  
Skyey Developments (p. 334)  
Alfred A. Knopf. New York, New York, USA. 1993

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Philosophy begins in wonder. And, at the end, when philosophical thought has done its best, the wonder remains. There have been added, however, some grasp of the immensity of things, some purification of emotion by understanding.  
*Modes of Thought*

Chapter III, Lecture VIII (p. 232)  
The Macmillan Company. New York, New York, USA. 1938

Philosophy asks the simple question, What is it all about?  
Whitehead's Philosophy  
*Philosophical Review*, Volume 46, Number 2, March 1937 (p. 178)

## PHILOSOPHY OF SCIENCE

### American Institute of Biological Science 1963

What is science? Is it a body of factual information? Is it a set of theories? Is it an activity or set of procedures for finding facts and developing theories? Science is really a combination of all three of these.  
*Biological Science: Molecules to Man* (p. 3)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1963

**Asimov, Isaac** 1920–92  
American author and biochemist

Science is a process. It is a way of thinking, a manner of approaching and of possibly resolving problems, a route by which one can produce order and sense out of disorganized and chaotic observations. Through it we achieve useful conclusions and results that are compelling and upon which there is a tendency to agree.  
"X" *Stands for Unknown*  
Introduction (p. 10)  
Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Ayala, Francisco J.** 1934–  
Spanish-born American biologist

Science is systematic organisation of knowledge about the universe on the basis of explanatory hypotheses which are genuinely testable. Science advances by developing gradually more comprehensive theories; that is, by formulating theories of greater generality which can account for observational statements and hypotheses which appear as *prima facie* unrelated.  
*Studies in the Philosophy of Biology: Reduction and Related Problems*  
Introduction (p. ix)  
Macmillan & Company Ltd. London, England. 1974

**Barrow, John D.** 1952–  
English theoretical physicist

The goal of science is to make sense of the diversity of Nature.  
*Theories of Everything: The Quest for Ultimate Explanation*  
Chapter One (p. 10)  
The Clarendon Press. Oxford, England. 1991

**Bauer, Henry H.** 1931–  
American chemist

Science is uniquely distinguished from other human practices: it is the only activity in which the constraints

of reality have brought to the quest for deep answers an effective consensus across all the variations that in other respects divide the human species.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 7 (p. 143)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Bernard, Claude** 1813–78

French physiologist

True science suppresses nothing, but goes on searching and is undisturbed in looking straight at things that it does not yet understand.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter III, Section iv (p. 223)

Henry Schuman, Inc. New York, New York, USA. 1927

True science teaches us to doubt and, in ignorance, to refrain.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter II, Section VIII (p. 55)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bohm, David** 1917–92

American physicist

**Peat, D.**

No biographical data available

The essential activity of science consists of thought, which arises in creative perception and is expressed through play. This gives rise to a process in which thought unfolds into provisional knowledge which then moves outward into action and returns as fresh perception and knowledge. This process leads to a continuous adoption of knowledge which undergoes constant growth, transformation, and extension. Knowledge is therefore not something rigid and fixed that accumulates indefinitely in a steady way but is a continual process of change. Its growth is closer to that of an organism than a data bank. When serious contradictions in knowledge [are] encountered, it is necessary to return to creative perception and free play, which act to transform existing knowledge. Knowledge apart from this cycle of activity, has no meaning.

*Science, Order, and Creativity*  
Chapter One (p. 56)

Bantam Books. New York, New York, USA. 1987

**Bondi, Sir Hermann** 1919–2005

English mathematician and cosmologist

Science is driven forward by unexpected and surprising results emerging from new experiments or by the appearance of contradictions between theories previously thought compatible. Solving such problems as they arise is of the essence of our work. Thus science is not something strange and odd but the most human of pursuits.

The Philosopher of Science

*Nature*, Volume 358, Number 6385, 30 July, 1992 (p. 363)

**Boulding, Kenneth E.** 1910–93

English economist and social scientist

Science might also be defined as the process of substituting unimportant questions which can be answered for important questions which cannot.

*Image: Knowledge in Life and Society*  
Chapter XI (p. 154)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1956

**Bushnell, Horace** 1802–76

American Congregational minister

What is science, anyhow, but the knowledge of species? And if species do not keep their places, but go a masking or really becoming one another, in strange transmutations, what is there to know, and where is the possibility of science? If there is no stability or fixity in species, then, for aught that appears, even science itself may be transmuted into successions of music, and moonshine, and auroral fires. If a single kind is all kinds, then all are one, and since that is the same as none, there is knowledge no longer. The theory may be true, but it never can be proved, for that reason if no other. And when it is proved, if that must be the fact, we may well enough agree to live without religion.

*Science and Religion*

*Putnam's Magazine*, Volume 1, 1868 (p. 271)

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

Science is the creation of concepts and their exploration in the facts. It has no other test of the concept than its empirical truth to fact.

*Science and Human Values*

*The Sense of Human Dignity* (p. 60)

Harper & Row, Publishers. New York, New York, USA. 1965

Science is not a mechanism but a human progress, and not a set of findings but the search for them.

*Science and Human Values*

*The Sense of Human Dignity* (p. 63)

Harper & Row, Publishers. New York, New York, USA. 1965

Science is a great many things...but in the end they all return to this: science is the acceptance of what works and the rejection of what does not. That needs more courage than we might think. It need more courage than we have ever found when we have faced our worldly problems.

*The Common Sense of Science*

Chapter IX, Section 6 (p. 148)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Carnap, Rudolf** 1891–1970

American philosopher

Science is a system of statements based on direct experience, and controlled by experimental verification. Verification in science is not, however, of single statements but of the entire system or a sub-system of such statements.

*The Unity of Science*

Physics as a Universal Science, Section 3 (p. 42)

Thommes Press. Bristol, England. 1995

### **Burhoe, R. W.**

Founding editor of *Zygon*

...in the usual sense a science is a discipline possessed of an empirically validated theoretical structure, which can indeed explain or account for and not simply describe, categorize, and correlate, patterns of human experience/behavior.

The Source of Civilization in the Natural Selection of Coadapted Information in Genes and Culture

*Zygon*, Volume 11, Number 3, September 1976 (p. 264)

### **Campbell, Norman R.** 1880–1949

English physicist and philosopher

There are two aspects of science. First, science is a body of useful and practical knowledge and a method of obtaining it. It is science of this form which played so large a part in the destruction of war, and, it is claimed, should play an equally large part in the beneficent restoration of peace. ... In its second form or aspect, science has nothing to do with practical life, and cannot affect it, except in the most indirect manner, for good or for ill. Science of this form is a pure intellectual study. ... [I]ts aim is to satisfy the needs of the mind and not those of the body; it appeals to nothing but the disinterested curiosity of mankind.

*What Is Science?*

Chapter I (p. 1)

Dover Publications. New York, New York, USA. 1952

### **Cassirer, Ernst** 1874–1945

German philosopher

Are we to be disgusted with science because it has not fulfilled our hopes or redeemed its promises? And are we, for this reason, to announce the “bankruptcy” of science, as is so often and so flippantly done? But this is rash and foolish: for we can hardly blame science just because we have not asked the right questions.

In David Hackett Fischer

*Historian's Fallacies: Toward a Logic of Historical Thought*

Chapter I (p. 3)

Harper & Row, Publishers. New York, New York, USA. 1970

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

The sciences have started to swell. Their philosophical basis has never been very strong. Starting as modest probing operations to unravel the works of God in the world, to follow its traces in nature, they were driven gradually to ever more gigantic generalizations. Since the pieces

of the giant puzzle never seemed to fit together perfectly, subsets of smaller, more homogeneous puzzles had to be constructed, in each of which the fit was better.

Voices in the Labyrinth

*Perspectives in Biology and Medicine*, VII, Volume 18, Spring 1975

(p. 323)

In science, there is always one more Gordian knot than there are Alexanders. One could almost say that science, as it is practiced today, is an arrangement through which each Gordian knot, once cut, gives rise to two new knots, and so on. Out of one problem considered as solved, a hundred new ones arise; and this has created the myth of the limitlessness of the natural sciences. Actually, many sciences now look as feeble and emaciated as do mothers who have undergone too many deliveries.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part II

More Foolish and More Wise (p. 116)

Rockefeller University Press. New York, New York, USA. 1978

### **Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Science finds facts in Nature, but Science is not Nature; because Science has co-ordinated ideas, interpretations and analyses; and can say of Nature what Nature cannot say for itself.

*The Resurrection of Rome*

Chapter IV (p. 126)

Dodd, Mead & Company. New York, New York, USA. 1930

### **Clark, Gordon H.** 1902–85

American philosopher

The theologians who reply to...attacks [on religious faith] are under a disadvantage. When a scientist or a philosopher argues against religion, he does not need to know much about religion; but when a theologian discusses science, he must know quite a lot. The scientist can get by if he understands no more than that Christians believe God to be an incorporeal spirit; but the theologian is called upon to discuss space, time, motion, energy, electrodynamics, the solar system, quantum theory, relativity, and other assorted items. There is something else the theologian must know, and something more important. In addition to a selection of particular pieces of information, such as the details just mentioned, the theologian must have an overall view of science as a whole. He must have a philosophy of science; that is, he must know what science is. Obviously he cannot compare, contrast, or relate religion and science unless he knows them both.... The scientific method is said to be the best, indeed, the only method for solving any problem, so that in every debate it is science, not theology, that has the last word. Since every curious and intelligent person naturally wishes to understand his own times, he must be prepared to give science sustained attention.

*The Philosophy of Science* (pp. 8–9)  
Craig Press. Nutley, New Jersey, USA. 1964

**Cohen, Morris Raphael** 1880–1947  
American philosopher

The certainty which science aims to bring about is not a psychologic feeling about a given proposition but a logical ground on which its claim to truth can be founded.

*Reason and Nature*  
Chapter Three, Section II (A) (p. 84)  
The Free Press, Publishers. Glencoe, Illinois, USA. 1931

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

The aim of science is to apprehend this purely intelligible world as a thing in itself, an object which is what it is independently of all thinking, and thus antithetical to the sensible world.... The world of thought is the universal, the timeless and spaceless, the absolutely necessary, whereas the world of sense is the contingent, the changing and moving appearance which somehow indicates or symbolizes it.

*Essays in the Philosophy of Art*  
Outlines of a Philosophy of Art  
Chapter 6, Section 27 (p. 142)  
Indiana University Press. Bloomington, Indiana, USA. 1964

Science in general...does not consist in collecting what we already know and arranging it in this or that kind of pattern. It consists in fastening upon something we do not know, and trying to discover it.

*The Idea of History*  
Introduction, Section 2 (p. 9)  
At The Clarendon Press. Oxford, England. 1967

**Courant, Richard** 1888–1972  
German-born American mathematician

**Robbins, Herbert** 1915–2001  
American mathematician

A serious threat to the very life of science is implied in the assertion that mathematics is nothing but a system of conclusions drawn from definitions and postulates that must be consistent but otherwise may be created by the free will of the mathematician. If this description were accurate, mathematics could not attract any intelligent person. It would be a game with definitions, rules and syllogisms, without motivation or goal.

*What Is Mathematics?* (p. xvii)  
Oxford University Press, Inc. London, England. 1941

The notion that the intellect can create meaningful postulational systems at its whim is a deceptive half-truth. Only under the discipline of responsibility to the organic whole, only guided by intrinsic necessity, can the free mind achieve results of scientific value.

*What Is Mathematics?* (p. xvii)  
Oxford University Press, Inc. London, England. 1941

**Davy, Sir Humphry** 1778–1829  
English chemist

Natural science is founded on minute critical views of the general order of events taking place upon our globe, corrected, enlarged, or exalted by experiments, in which the agents concerned are placed under new circumstances, and their diversified properties separately examined. The body of natural science, then, consists of facts; is analogy, — the relation of resemblance of facts by which its different parts are connected, arranged, and employed, either for popular use, or for new speculative improvements.

In John Davy (ed.)  
*The Collected Works of Sir Humphry Davy* (Volume 8)  
Introductory Lecture to the Chemistry of Nature (pp. 167–168)  
Smith, Elder & Company. London, England. 1839–1840

**Dawson, Sir John William** 1820–99  
Canadian geologist and educator

It is of the nature of true science to take nothing on trust or on authority. Every fact must be established by accurate observation, experiment, or calculation. Every law and principle must rest on inductive argument. The apostolic motto, “Prove all things, hold fast that which is good,” is thoroughly scientific. It is true that the mere reader of popular science must often be content to take that on testimony which he cannot personally verify; but it is desirable that even the most cursory reader should fully comprehend the modes in which facts are ascertained and the reasons on which the conclusions are based.

*The Chain of Life in Geological Time*  
Chapter I (p. 1)  
Religious Tract Society. London, England. 1888

**de Unamuno, Miguel** 1864–1936  
Spanish philosopher and writer

Wisdom is to science what death is to life, or, if you prefer it, wisdom is to death what science is to life.

*Essays and Soliloquies*  
Some Arbitrary Reflections Upon Europeanization (p. 55)  
Alfred A. Knopf. New York, New York, USA. 1925

**Dennett, Daniel Clement** 1942–  
American philosopher

Science does not answer all good questions. Neither does philosophy. But for that very reason the phenomena of consciousness...do not need to be protected from science — or from the sort of demystifying philosophical investigation we are embarking on.... Looking on the bright side, let us remind ourselves of what has happened in the wake of earlier demystifications. We find no diminution of wonder; on the contrary, we find deeper beauties and more dazzling visions of the complexity of the universe than the protectors of mystery ever conceived. The “magic” of earlier visions was, for the most part, a

cover-up for frank failures of imagination, a boring dodge enshrined in the concept of a *deus ex machina*.

*Consciousness Explained* (pp. 22, 25)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

...there is no such thing as philosophy-free science; there is only science whose philosophical baggage is taken on board without examination.

*Darwin's Dangerous Idea*

Chapter One, Section 1 (p. 21)

Simon & Schuster. New York, New York, USA. 1995

### **Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Science in its entirety is true and evident cognition. He is no more learned who has doubts on many matters than the man who has never thought of them; nay he appears to be less learned if he has formed wrong opinions on any particulars. Hence it were better not to study at all than to occupy one's self with objects of such difficulty, that, owing to our inability to distinguish true from false, we are forced to regard the doubtful as certain; for in those matters any hope of augmenting our knowledge is exceeded by the risk of diminishing it. Thus in accordance with the above maxim we reject all such merely probable knowledge and make it a rule to trust only what is completely known and incapable of being doubted.

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule II (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Einstein, Albert** 1879–1955

German-born physicist

The aim of science is...a comprehension, as complete as possible, of the connection between the sense experience in [its] totality, and...the accomplishment of this aim by the use of a minimum of primary concepts and relations.

*Out of My Later Years*

Physics and Reality, I (p. 63)

Thames & Hudson. London, England. 1950

Science is the attempt to make the chaotic diversity of our sense experience correspond to a logically uniform system of thought.

Considerations Concerning the Fundamentals of Theoretical Physics

*Science*, Volume 91, Number 2369, May 24, 1940 (p. 487)

Although it is true that it is the goal of science to discover rules which permit the association and foretelling of facts, this is not its only aim. It also seeks to reduce the connections discovered to the smallest possible number of mutually independent conceptual elements. It is in this striving after the rational unification of the manifold that it encounters its greatest successes, even though it is precisely this attempt which causes it to run the greatest risk of falling a prey to illusion. But whoever has undergone

the intense experience of successful advances made in this domain, is moved by profound reverence for the rationality made manifest in existence.

*Ideas and Opinions*

Science and Religion (p. 49)

Crown Publishers, Inc. New York, New York, USA. 1954

The belief in the external world independent of the perceiving subject is the basis of all natural science.

Translated by Alan Harris

*Essays in Science*

Clerk Maxwell's Influence on the Evolution of the Idea of Physical Reality (p. 40)

Philosophical Library. New York, New York, USA. 1934

The grand aim of all science...is to cover the greatest number of empirical facts by logical deductions from the smallest number of hypotheses or axioms.

In Lincoln Barnett

The Meaning of Einstein's New Theory

*Life*, January 9, 1950 (p. 22)

### **Feynman, Richard P.** 1918–88

American theoretical physicist

What is the fundamental hypothesis of science, the fundamental philosophy? ...[It is that] the sole test of the validity of any idea is experiment... We will invent some way to summarize the results of the experiment, and we do not have to be told ahead of time what this way will look like. If we are told that the same experiment will always produce the same result, that is all very well, but if when we try it, it does not, then it does not. We just have to take what we see, and then formulate all the rest of our ideas in terms of our actual experience.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Basic Physics (p. 32)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Science came to recognize that its only proper objects of study were the sensations that the objects of the external universe produced on our senses. The dictum *esse est percipi* was adopted whole-heartedly from philosophy — not because scientists had any predilection for an idealist philosophy, but because the assumption that things existed which could not be perceived had led them into a whole morass of inconsistencies and impossibilities. Those who did not adopt it were simply left behind, and the torch of those who did.

The Mathematical Aspect of the Universe

*Philosophy*, Volume VII, Number 25, January 1932 (p. 11)

### **Joad, Cyril Edwin Mitchinson** 1891–1953

English philosopher and broadcasting personality

...the philosophising of the physicists is noticeably inferior to their physics, and eminent men are at the moment engaged in making all the mistakes which the philosophers made for themselves some three hundred years ago and have been engaged in detecting and correcting ever since. In particular it is thought that modern physics lends support to Idealism, and suggests, if it does not actually require, a religious interpretation of the universe.

*Guide to Modern Thought*

Chapter I (pp. 15–16)

Faber & Faber Ltd. London, England. 1936

### **Meredith, Patrick**

No biographical data available

Hence a true philosophy of science must be a philosophy of scientists and laboratories as well as one of waves, particles and symbols.

*Instruments of Communication*

Chapter 2, Section 5 (p. 40)

Pergamon Press. Oxford, England. 1966

### **Moreland, J. P.** 1936–

American philosopher

For the question What is the proper definition of science? is itself a philosophical question about science that assumes a vantage point above science; it is not a question of science. One may need to reflect on specific episodes in the history of science to answer the question. But the question and the reflection required to answer it are philosophical in nature, a point not diminished merely because a scientist may try to define science. When she does so, she is doing philosophy.

*Christianity and the Nature of Science: A Philosophical Investigation*  
(pp. 20–21)

Baker Book House. Grand Rapids, Michigan, USA. 1989

### **Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...I shall certainly admit a system as empirical or scientific only if it is capable of being tested by experience. These considerations suggest that not the verifiability but the falsifiability of a system is to be taken as a criterion of demarcation. In other words: I shall not require of a scientific system that it shall be capable of being singled out, once and for all, in a positive sense: but I shall require that its logical form shall be such that it can be singled out, by means of empirical tests, in a negative sense: it must be possible for an empirical scientific system to be refuted by experience.

*The Logic of Scientific Discovery*

Part I, Chapter I, Section 6 (p. 40)

Basic Books, Inc. New York, New York, USA. 1959

We do not know: we can only guess.

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (p. 278)

Basic Books, Inc. New York, New York, USA. 1959

### **Shapere, Dudley**

No biographical data available

...philosophy of science is immune to the vicissitudes of science — the coming and going of particular theories; for those changes have to do with content of science, whereas the philosopher is concerned with its structure — not with specific theories, but with the meaning of “theory” itself.

*Philosophical Problems of Natural Science*

Introduction, Section IV (p. 9)

The Macmillan Company. New York, New York, USA. 1965

### **Simpson, George Gaylord** 1902–84

American paleontologist

It is inherent in any acceptable definition of science that statements that cannot be checked by observation are not really about anything...or at the very least, they are not science.

The Nonprevalence of Humanoids

*Science*, Volume 143, Number 3608, February 21, 1964 (p. 770)

### **Spencer, Herbert** 1820–1903

English social philosopher

Every science begins by accumulating observations, and presently generalizes these empirically; but only when it reaches the stage at which its empirical generalizations are included in a rational generalization does it become developed science.

*The Data of Ethics*

Chapter IV, Section 22a (p. 51)

William & Norgate. London, England. 1907

### **Torrance, Thomas F.**

No biographical data available

In natural science we are concerned ultimately, not with convenient arrangements of observational data which can be generalized into universal explanatory form, but with movements of thought, at once theoretical and empirical, which penetrate into the intrinsic structure of the universe in such a way that there becomes disclosed to us its basic design and we find ourselves at grips with reality.... We cannot pursue natural science scientifically without engaging at the same time in meta-scientific operations.

*Divine and Contingent Order* (p. 3)

Oxford University Press, Inc. Oxford. 1981

### **Toulmin, Stephen** 1922–

Anglo-American philosopher

Certainly, every statement in a science should conceivably be capable of being called in question, and of being shown empirically to be unjustified; for only so can the science be saved from dogmatism.

*The Philosophy of Science*

Harper & Row, Publishers. New York, New York, USA. 1960

**Toynbee, Arnold J.** 1852–83  
English historian

[T]here will be differences in the degree of approximation to scientific study, ...determined by the nature of the part or aspect of the Universe under consideration. Study will be most scientific when its object is the physical structure of the Universe. ... The object of study that will be the least amenable to scientific treatment is the non-physical facet of human nature. Students in this field had better avoid letting themselves be tempted by the present-day prestige of the word "science" into applying that label to their own work.

*Occasional Paper, The Institute for the Study of Science in Human Affairs*

Science in Human Affairs: An Historian's View

**van Fraassen, Bas C.** 1941–  
Dutch-born philosopher

To develop an empiricist account of science is to depict it as involving a search for truth only about the empirical world, about what is actual and observable. ... It must involve throughout a resolute rejection of the demand for an explanation of the regularities in the observable course of nature, by means of truths concerning a reality beyond what is actual and observable, as a demand which plays no role in the scientific enterprise.

*The Scientific Image*

Chapter 6 (p. 203)

Clarendon Press. Oxford, England. 1990

...certain issues in philosophy of science (having to do with observation and the definition of a theory's empirical import) had been misconstrued as issues in philosophy of logic and of language. With respect to modality, I hold the exact opposite: important philosophical problems concerning language have been misconstrued as relating to the content of science and the nature of the world. This is not at all new, but is the traditional nominalist line.

*The Scientific Image*

Chapter 6 (p. 196)

Clarendon Press. Oxford, England. 1980

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science developed only when men refrained from asking general questions such as: What is matter made of? How was the universe created? What is the essence of life? Instead they asked limited questions such as: How does an object fall? How does water flow in a tube? Thus, in place of asking general questions and receiving limited answers, they asked limited questions and found general answers. It remains a great miracle, that this process succeeded, and that the answerable questions became gradually more and more universal.

The Significance of Science

*Science*, Volume 176, Number 4031, April 14, 1972 (p. 143)

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

The aim of science is to seek the simplest explanation of complex facts.... Seek simplicity and distrust it.

*The Concept of Nature*

Chapter VII (p. 163)

At The University Press. Cambridge, England. 1920

Science is simply setting out on a fishing expedition to see whether it cannot find some procedure which it can call measurement of space and some procedure which it can call the measurement of time, and something which it can call a system of forces, and something which it can call masses....

*The Concept of Nature*

Chapter VI (p. 139)

At The University Press. Cambridge, England. 1920

**Wright, Chauncey** 1830–75  
American philosopher of science

Science asks no questions about the ontological pedigree or a priori character of a theory, but is content to judge it by its performance; and it is thus that a knowledge of nature, having all the certainty which the senses are competent to inspire, has been attained — a knowledge which maintains a strict neutrality toward all philosophical systems and concerns itself not with the genesis or a priori grounds of ideas.

*The Philosophical Writings of Chauncey Wright*

The Philosophy of Herbert Spencer (p. 8)

The Liberal Arts Press. New York, New York, USA. 1958

## PHOSPHORUS

### Author undetermined

Red phosphorus is used for matches so that people who are in the habit of chewing matches will not suffer.

Class-Room Chemical Emanations

*Journal of Chemical Education*, Volume 3, Number 1, 1926

## PHOTOELECTRIC

**Glashow, Sheldon L.** 1932–  
American physicist

Einstein examined the photoelectric effect, which is now so well understood that it is used to open the doors of supermarkets and elevators when you step through a beam of light. In 1905 it was still a mystery.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 3 (p. 52)

Warner Books. New York, New York, USA. 1988



**PHOTOGRAPHY**

**Adams, Robert** 1937–  
American photographer

No place is boring, if you've had a good night's sleep and have a pocket full of unexposed film.

*Darkroom and Creative Camera Techniques*, May 1995

**PHOTON**

**Einstein, Albert** 1879–1955  
German-born physicist

Every physicist thinks that he knows what a photon is....  
I spent my life to find out what a photon is and I still don't know it.

In Eugene Hecht

*Optics*

Chapter 1 (p. 9)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Jespersen, James**

No biographical data available

**Fitz-Randolph, Jane**

No biographical data available

We can think of the photons as being like a shower of snowballs flying back and forth between the two electrons. And like the opponents in a snowball fight, the electrons retreat from each other under the assault of the photons.

*From Quarks to Quasars: A Tour of the Universe*

Chapter 11 (p. 125)

Athenaeum. New York, New York, USA. 1987

**Roberts, Michael**

No biographical data available

While I, maybe, precisely seize

The elusive photon's properties

In a's and b's, set in bronze-

bright vectors, grim quaternions.

Notes on q, f, and y

*The New Statesman*, March 23, 1935

**Rucker, Rudy** 1946–

Science and science fiction author

A photon is a wavy yet solid little package that can zip through empty space without the benefit of any invisible jelly vibrating underfoot.

*The Fourth Dimension: Toward a Geometry of Higher Reality*

Chapter 6 (p. 73)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1984

**PHOTOSYNTHESIS**

**Baum, Harold**

No biographical data available

When sunlight bathes the chloroplast, and photons are absorbed

The energy's transduced so fast that food is quickly stored,

Photosynthetic greenery traps light the spectrum through

Then dark pathway machinery fixes the CO<sub>2</sub>.

*The Biochemists' Handbook*

Photosynthesis (Tune: Auld Lang Syne)

Van Nostrand. Princeton, New Jersey, USA. 1961

**Pallister, William Hales** 1877–1946

Canadian physician

The sunlight gives the stimulus

Which makes a plant of you;

Your chemic process puzzles us,

We look and see you do

Your photo-synthesis, and thus

Grow and divide in two.

*Poems of Science*

The Nature of Things, *Euglena viridis* (p. 5)

Playford Press. New York, New York, USA. 1931

**Rabinowitch, Eugene** 1901–73

Russian-born American biophysicist

In photosynthesis we are like travelers in an unknown country around whom the early morning fog slowly begins to rise, vaguely revealing the outlines of the landscape. It will be thrilling to see it in bright daylight!

In A Scientific American Book

*The Physics and Chemistry of Life*

Photosynthesis (p. 47)

Simon & Schuster. New York, New York, USA. 1955

**PHYLOGENESIS**

**Haeckel, Ernst** 1834–1919

German biologist and philosopher

Phylogenesis is the mechanical cause of ontogenesis.

The connection between them is not of an external or superficial, but of a profound, intrinsic, and causal nature.

*Anthropogenie, oder; Entwicklungsgeschichte des Menschen gemeinverstandliche wissenschaftliche Vortrage uber die Grundzuge der mensch*

W. Engelman, Leipzig, Germany. 1874

**PHYLOGENY**

**Abbott, Donald Putnam** 1920–86

American marine biologist and professor

Cultivate a suspicious attitude toward people who do phylogeny.

In Galen Howard Hilgard (ed.)

*Observing Marine Invertebrates: Drawings from the Laboratory*

Author's Preface (p. xvi)

Stanford University Press. Stanford, California, USA. 1987

**PHYSIC**

**Boorde, Andrew** 1490–1549  
English traveler, physician, and writer

A good cook is half a physician. For the chief physic (the counsel of a physician excepted) doth come from the kitchen; wherefore the physician and the cook for sick men must consult together for the preparation of meat for sick men. For if the physician, without the cook, prepared any meat, except he be very expert, he will make a wearish dish of meat, the which the sick cannot take.

*The Wisdom of Andrew Boorde* (p. 49)  
Edgar Backus. Leicester, England. 1936

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

No men despise physic so much as physicians, because no men so thoroughly understand how little it can perform.

*Lacon; or Many Things in a Few Words*  
1:179  
William Gowans. New York, New York, USA. 1849

**Heurnius**  
No biographical data available

Many of them to get a fee, will give physic to every one that comes, when there is no cause.

In William Tod Helmoth  
*Scratches of a Surgeon*  
Medical Pomposity (p. 9)  
W.A. Chatterton & Company, Chicago, Illinois, USA. 1879

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

Not to take authority when I can have facts; not to guess when I can know; not to think a man must take physic because he is sick.

In Robert Coope  
*The Quiet Art* (p. 101)  
E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Lettsom, J. C.**  
No biographical data available

When people is ill, they comes to I,  
I physics, bleed, and sweats ‘em;  
Sometimes they live, sometimes they die.  
What’s that to I? I lets ‘em.

In William Davenport Adams  
*English Epigrams*  
On Dr. Lettsom, by Himself (cclxxii)  
G. Routledge. London, England. 1878

**Milton, John** 1608–74  
English poet

...in Physic, things of melancholic hue and quality are us’d against melancholy, sour against sour, salt to remove salt humours.

*Samson Agonistes*  
On that Sort of Dramatic Poem Which Is Call’d Tragedy (p. 79)  
The Doves Press. London, England. 1905

**Pope, Alexander** 1688–1744  
English poet

Learn from the beasts the physic of the field.  
*The Complete Poetical Works* (Volume 3)  
Essay on Man, Epis. Iii, l. 174  
Houghton Mifflin Company. New York, New York, USA. 1903

**Proverb**

Warre and Physicke are governed by the eye.  
In George Herbert  
*Outlandish Proverbs*  
#906  
Printed by T. Maxey for T. Garthwait. London, England. 1651

**Ray, John** 1627–1705  
English naturalist

If physic do not work, prepare for the kirk.  
*A Complete Collection of English Proverbs* (p. 149)  
Printed for G. Cowie. London, England. 1813

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Throw physic to the dogs; I’ll none of it.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Macbeth  
Act V, Scene iii, l. 47  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

‘Tis time to give ‘em physic, their diseases  
Are grown so catching.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
The Famous History of the Life of King Henry the Eighth  
Act I, Scene iii, l. 36–37  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Take physic, pomp;  
Expose thyself to feel what wretches feel.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
King Lear  
Act III, Scene ii, l. 33–34  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In this point  
All his tricks founder, and he brings his physic  
After his patient’s death.  
In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
The Famous History of the Life of King Henry the Eighth  
Act III, Scene ii, l. 39–41  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**PHYSICAL LAW**

**Feynman, Richard P.** 1918–88  
American theoretical physicist

...there is...a rhythm and pattern between the phenomena of nature which is not apparent to the eye, but only to the eye of analysis; and it is these rhythms and patterns which we call Physical Laws.

*The Character of Physical Law*

Chapter 1 (p. 13)

BBC. London, England. 1965

## PHYSICAL SCIENCE

**Huxley, Thomas Henry** 1825–95

English biologist

When simple curiosity passes into the love of knowledge as such, and the gratification of the aesthetic sense of the beauty of completeness and accuracy seems more desirable than the easy indolence of ignorance; when the finding out of the causes of things becomes a source of joy, and he is counted happy who is successful in the search, common knowledge of Nature passes into what our forefathers called Natural History, from whence there is but a step to that which used to be termed Natural Philosophy, and now passes by the name of Physical Science.

*The Crayfish*

Chapter 1 (p. 3)

D. Appleton & Company. New York, New York, USA. 1880

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Physical science began in the witch's kitchen. It now embraces the organic and inorganic worlds, and with the physiology of articulation and the theory of the senses, has even pushed its researches, at times impertinently, into the province of mental phenomena.

*Popular Scientific Lectures*

Why Has Man Two Eyes? (p. 87)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

**Thompson, Sir D'Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

How far...then mathematics will suffice to describe, and physics to explain, the fabric of the body, no man can foresee. It may be that all the laws of energy, and all the properties of matter, and all the chemistry of all the colloids are as powerless to explain the body as they are impotent to comprehend the soul. For my part, I think it is not so. Of how it is that the soul informs the body, physical science teaches me nothing; and that living matter influences and is influenced by mind is a mystery without a clue. Consciousness is not explained to my comprehension by all the nerve-paths and neurons of the physiologist; nor do I [explain by] physics how goodness shines in one man's face, and evil betrays itself in another. But of the construction and growth and workings of the body, as of all else that is of the earth earthy, physical science is, is, in my opinion, our only teacher and guide.

*On Growth and Form* (Volume 1)

Chapter I (p. 13)

At The University Press. Cambridge, England. 1951

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

There can be no true physical science which looks first to mathematics for the provision of a conceptual model. Such a procedure is to repeat the errors of the logicians of the middle ages.

*Principles of Relativity* (p. 39)

Cambridge University Press. Cambridge, England. 1922

## PHYSICIAN

**Alexander the Great** 356 BCE–323 BCE

Macedonian emperor

I am dying with the help of too many physicians.

Attributed

**Allman, David**

American physician

The dedicated physician is constantly striving for a balance between personal, human values, scientific realities and the inevitabilities of God's will.

Address to National Conference of Christian and Jews

The Brotherhood of Healing, 1 February 1958

**Arnaldus de Villa Nova** 1235–1313

Alchemist, astrologer and physician

...the physician must be learned in diagnosing, careful and accurate in prescribing, circumspect and cautious in answering questions, ambiguous in making prognosis, just in making promises; and he should not promise health because in doing so he would assume a divine function and insult God.

In Henry E. Sigerist (trans.)

Bedside Manners in the Middle Ages: The Treatise De Cautelis Medicorum Attributed to Arnald de Villanova

*Quarterly Bulletin of Northwestern University Medical School*, Volume 20, 1946

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Think continually how many physicians are dead after often contracting their eyebrows over the sick...

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, # 48 (p. 267)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## Author undetermined

...a new physician must have a new church-yard...

In Robert Burton

*The Anatomy of Melancholy* (Volume 2)

Part 2, Sect. IV, Memb. I, subsect. 1 (p. 230)  
AMS Press, Inc. New York, New York, USA. 1973

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Physicians are some of them so pleasing and conformable to the humor of the patient, as they press not the true cure of the disease; and some other are so regular in proceeding according to art for the disease, as they respect not sufficiently the condition of the patient. Take one of a middle temper; or if it may not be found in one man, combine two of either sort; and forget not to call as well the best acquainted with your body, as the best reputed of for his faculty.

*Essays, Advancement of Learning, New Atlantis, and Other Pieces*  
The Essays or Counsels, Civil and Moral: I. Of Regiment of Health (p. 94)  
Odyssey Press. New York, New York, USA. 1937

The weakness of patients, and sweetness of life, and nature of hope, maketh men depend upon physicians with all their defects.

In *Great Books of the Western World* (Volume 30)  
*Advancement of Learning*  
Second Book, Chapter X, Section 2 (p. 51)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...it is the office of a physician not only to restore health, but to mitigate pain and dolors; and not only when such mitigation may conduce to recovery, but when it may serve to make a fair and easy passage.

In *Great Books of the Western World* (Volume 30)  
*Advancement of Learning*  
Second Book, Chapter X, Section 7 (p. 52)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bailey, Percival**

No biographical data available

The function of the physician is to cure a few, help many, and comfort all.

*Perspectives in Biology and Medicine*, Volume 4, Number 254, 1961

**Baldwin, Joseph G.** 1815–64

American writer

Nobody knew who or what they were, except as they claimed, or as a surface view of their characters indicated. Instead of taking to the highway and magnanimously calling upon the wayfarer to stand and deliver, or to the fashionable larceny of credit without prospect or design of paying, some unscrupulous horse doctor would set up his sign as “Physician and Surgeon” and draw his lancet on you, or fire at random a box of pills into your bowels, with a vague chance of hitting some disease unknown to him, but with a better prospect of killing the patient, whom or whose administrator he charged some ten dollars a trial for his marksmanship.

*The Flush Times of Alabama and Mississippi: A Series of Sketches*

How the Times Served the Virginians (p. 89)  
Louisiana State University Press. Baton Rouge, Louisiana, USA. 1987

**Bass, Murray H.**

No biographical data available

The ideal physician should be a combination of three persons — a clergyman, a fireman and a scientist. He must know how to handle and console the patient and his family...he must be ready to answer an “alarm” day and night; he must know the science of medicine...using its present potentialities to the utmost of his ability.

*Clinical Pediatrics*, Volume 3, Number 50, 1964

**Bernard, Claude** 1813–78

French physiologist

Medical personality is placed above science by physicians themselves; they seek their authority in tradition, in doctrines or in medical tact. This state of affairs is the clearest of proofs that the experimental method has by no means come into its own in medicine.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter Two, Section IV (p. 43)  
Henry Schuman, Inc. New York, New York, USA. 1927

...physicians, in their treatment, often have to take account of the so-called influence of the moral over the physical, and also of any number of family and social considerations which have nothing to do with science. Therefore, an accomplished practising physician should be not only learned in his science, but also upright and endowed with keenness, tact and good sense.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter IC, Section III (p. 206)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Blackwell, Elizabeth** 1821–1910

First woman to practice medicine in the United States

The true physician must possess the essential qualities of maternity. The sick are as helpless in his hands as the infant. They depend absolutely upon the insight and judgment, the honesty and hopefulness, of the doctor.

*The Influence of Women in the Profession of Medicine* (p. 11)  
G. Bell. Baltimore, Maryland, USA. 1890

**Bonaparte, Napoleon** 1769–1821

French soldier and emperor of France

You are a physician, doctor. You would promise life to a corpse if he could swallow pills...

In J. Christopher Herold (ed.)  
*The Mind of Napoleon*  
Science and the Arts (pp. 137–138)  
Columbia University Press. New York, New York, USA. 1955

In my opinion physicians kill as many people as we generals.

In J. Christopher Herold (ed.)  
*The Mind of Napoleon*  
 Science and the Arts (p. 137)  
 Columbia University Press. New York, New York, USA. 1955

**Brackenridge, Hugh Henry** 1748–1816  
 American author and jurist

Gravity is the most practical qualification of the physician.

*Modern Chivalry*  
 Part II, Volume I, Chapter X (p. 378)  
 American Book Company. New York, New York, USA. 1937

**Brown, Michael S.** 1941–  
 American physician

To apply tools of science, physicians must learn to think like scientists. They must acquire technical ability, taste in evaluating experiments, and a sense of creative adventure.

*Les Prix Nobel. The Nobel Prizes in 1985*  
 Nobel banquet speech for award received in 1985  
 Nobel Foundation. Stockholm, Sweden. 1986

**Buchan, William** 1729–1805  
 Physician

Physicians, like other people, must live by their employment.

*Domestic Medicine*  
 Introduction (p. xviii)  
 Publisher undetermined. New York, New York, USA. 1816

No two characters can be more different than that of the honest physician and the quack; yet they have generally been much confounded.

*Domestic Medicine*  
 Introduction (p. xvi)  
 Publisher undetermined. New York, New York, USA. 1816

**Burgess, Anthony** 1917–93  
 English novelist

Keep away from physicians. It is all probing and guessing and pretending with them. They leave it to Nature to cure in her own time, but they take the credit. As well as very fat fees.

*Nothing Like the Sun: A Story of Shakespeare's Love-Life*  
 Chapter VIII (p. 180)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1964

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
 English Romantic poet and satirist

This is the way physicians mend or end us,  
*Secundum aartem*: but although we sneer  
 In health — when ill, we call them to attend us,  
 Without the least propensity to jeer.

*The Complete Poetical Works of Byron*  
 Don Juan  
 Canto X, Stanza 42  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Camden, William** 1551–1623  
 English historian

Few physicians live well.  
*Remains Concerning Britain*  
 Proverbs (p. 322)  
 J.R. Smith. London, England. 1870

**Carlyle, Thomas** 1795–1881  
 English historian and essayist

The healthy know not of their health, but only the sick: this is the physician's aphorism.

*Characteristics, by Thomas Carlyle; Favorite Poems, by Percy Bysshe Shelley; The Eve of St. Agnes; and Other Poems, by John Keats*  
 Paragraph 1 (p. 3)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1882

**Clowes, William** 1540–1604  
 English physician

When a physician or a surgeon comes to a man that lies sick and is in danger of death, yet by his judgment and skill, promises with God's help to cure him of his griefs and maladies, then the sick patient greatly rejoices and presently compares him to a god. But afterwards, being somewhat recovered, and perceiving good amendment, he says he is but an angel and not a god. Again, after he begins to walk abroad and to fall to his meat, truly he is then accounted no better than a man. In the end, when he happily comes for his money for the curing of his grievous sickness, he now reports him to be a devil and shuts the door.

*Selected Writings*  
 A Tragical History (p. 63)  
 Harvey & Blythe. London, England. 1948

**Collins, Joseph**  
 No biographical data available

The longer I practice medicine, the more I am convinced every physician should cultivate lying as a fine art. There are lies which contribute enormously to the success of the physician's mission of mercy and salvation.  
*Reader's Digest*, May 1933 (p. 16)

**Colton, Charles Caleb** 1780–1832  
 English sportsman and writer

Physicians must discover the weaknesses of the human mind, and even condescend to humor them, or they will never be called in to cure the infirmities of the body.

*Lacon; or Many Things in a Few Words*  
 1.482  
 William Gowans. New York, New York, USA. 1849

**Croll, Oswald** 1560–1609  
 German chemist and physician

...a Physitian therefore should have both the Theory and Practice, he must both know and prepare his medicines...

*Philosophy Reformed and Improved in Four Profound Tractates* (p. 152)  
Printed by M.S. for Lodowick Lloyd. London, England. 1657

A Physition should be born out of the Light or Grace and Nature of the inward and invisible Man...

*Philosophy Reformed and Improved in Four Profound Tractates* (p. 22)  
Printed by M.S. for Lodowick Lloyd. London, England. 1657

**Cushing, Harvey** 1869–1939

American neurosurgeon

A physician is obligated to consider more than a diseased organ, more even than the whole man — he must view the man in his world.

In René J. Dubos

*Man Adapting*

Chapter XII (p. 342)

Yale University Press. New Haven, Connecticut, USA. 1965

**Davies, Robertson** 1913–95

Canadian novelist

I delivered my body into the hands of Learned Physicians this morning confiding that they may discover why I have hay fever. As soon as they got me out of my clothes I ceased to be a man to them, and they began to talk about me as though I did not understand English.

*The Table Talk of Samuel Marchbanks* (p. 194)

Clarke, Irwin. Toronto, Ontario, Canada. 1949

**Belleville, Nicholas** 1753–1831

French-born American physician

If you get one good doctor, you get one good thing, but if you get one bad doctor, you get one bad thing. If you have a lawsuit, you get a bad lawyer, you lose your suit — you can appeal; but if you have one bad doctor, and he kills you, then there can be no appeal.

In Stephen Wickes

*History of Medicine in New Jersey*

Part 2 (p. 143)

Martin R. Dennis & Company. Newark, New Jersey, USA. 1879

**de Montaigne, Michel Eyquem** 1533–92

French Renaissance writer

If your physician does not think it good for you to sleep, to drink wine, or to eat such and such meats, never trouble yourself; I will find you another that shall not be of that opinion...

In *Great Books of the Western World* (Volume 25)

*The Essays*

Book III, 13 (p. 528)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Dekker, Thomas** 1570–1632

English dramatist

A good physician comes to thee in the shape of an angel, and therefore let him boldly take thee by the hand, for he has been in God's garden, gathering herbs and sovereign

roots to cure thee. The good physician deals in simples and will be simply honest with thee in they preservation.

In Robert Coope

*The Quiet Art* (p. 192)

E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

**Donne, John** 1572–1631

English poet and divine

Whilst my Physitians by their love are growne  
Cosmographers, and I their Mapp, who lie  
Flat on this bed, that by them may be showne  
That this is my South-west discoverie  
per-fretum febris, by these streights to die.

In A.J. Smith (ed.)

*The Complete English Poems*

Hymne to God My God, in *My Sicknesse*, l. 6–10

St. Martin's Press. New York, New York, USA. 1971

I observe the Physician with the same diligence as hee the disease.

*Devotions Upon Emergent Occasions*

Meditation, VI (p. 29)

McGill-Queen's University Press. Montreal, Canada. 1975

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

...if a gentleman walks into my room smelling of iodoform, with a black mark of nitrate of silver upon his right forefinger, and a bulge on the right side of his top-hat to show where he has secreted his stethoscope, I must be dull, indeed, if I do not pronounce him to be an active member of the medical profession.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Scandal in Bohemia (p. 349)

Wings Books. New York, New York, USA. 1967

**Drake, Daniel** 1785–1852

American physician

The young physician is not aware how soon his elementary knowledge — much of which is historical and descriptive, rather than philosophical — will fade from his mind, when he ceases to study. That which he possesses can only be retained by new additions.

*Practical Essays on Medical Education, and the Medical Profession*

Essay IV (p. 61)

Roff & Young. Cincinnati, Ohio. 1832

Professional fame, is the capital of a physician, and he must not suffer it to be purloined, even should its defence involve him in quarrels.

*Practical Essays on Medical Education, and the Medical Profession*

Essay VII (p. 99)

Roff & Young. Cincinnati, Ohio. 1832

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

The first Physicians by Debauch were made:

Excess began, and Sloth sustains the Trade.

*The Poems of John Dryden* (Volume 4)

To John Dryden, of Chesterton, l. 73 (p. 1530)

Longman. London, England. 1995

**Duffy, John C.**

No biographical data available

**Litin, Edward M.**

No biographical data available

These are the duties of a physician: First...to heal his mind and to give help to himself before giving it to anyone else.

Psychiatric Morbidity of Physicians

*Journal of the American Medical Association*, Volume 189, 1964

(p. 989)

**Dumas, Alexandre** 1824–95

French dramatist and novelist

The physician has a sacred mission on earth; and to fulfill it he begins at the source of life, and goes down to the mysterious darkness of the tomb.

*The Count of Monte Cristo*

Chapter 80 (p. 1000)

Grosset & Dunlap Publishers. New York, New York, USA. 1946

**Eisenschiml, Otto** 1880–1963

Austrian-American chemist and historian

The wise physician...knows when not to prescribe...

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Six (p. 71)

Duell, Sloan & Pearce. New York, New York, USA. 1947

The wise physician avoids the knife; if he prescribes a bitter draft, he prescribes it in small doses or sweetens it to disguise its taste.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part Seven (p. 87)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The physician prescribes hesitatingly out of his few resources.... If the patient mends, he is glad and surprised.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Considerations by the Way (p. 1079)

The Library of America. New York, New York, USA. 1983

**Field, Eugene** 1850–95

American poet and journalist

When one's all right, he's prone to spite

The doctor's peaceful mission;

But when he's sick, it's loud and quick

He bawls for a physician.

*The Poems of Eugene Field*

Doctors

Charles Scribner's Sons. New York, New York, USA. 1910

No matter what conditions

Dyspeptic come to feaze,

The best of all physicians

Is apple pie and cheese!

*The Poems of Eugene Field*

Apple-Pie and Cheese, Stanza 5

Charles Scribner's Sons. New York, New York, USA. 1910

**Fielding, Henry** 1707–54

English novelist, playwright, and barrister

...as a wise general never despises his enemy, however inferior that enemy's force may be, so neither doth a wise physician ever despise a distemper, however inconsiderable.

*The History of Tom Jones: A Foundling* (Volume 1)

Book V, Chapter VIII (p. 229)

P.F. Collier & Son. New York, New York, USA. 1917

...every physician almost hath his favorite disease...

*The History of Tom Jones: A Foundling* (Volume 1)

Book II, Chapter 9 (p. 85)

P.F. Collier & Son. New York, New York, USA. 1917

...the gentleman of the Aesculapin art are in the right in advising, that the moment the disease has entered at one door, the physician should be introduced at the other.

*The History of Tom Jones: A Foundling* (Volume 1)

Book V, Chapter VII (p. 219)

P.F. Collier & Son. New York, New York, USA. 1917

**Florio, John** 1553?–1625

English teacher, writer, and translator

Unto a deadly disease, neyther

Phisition nor phisick wil serve.

*Firste Fruites*

Proverbs, Chapter 19

Da Capo Press. New York, New York, USA. 1969

From the phisito & Attorney,

keepe not the truth hidden.

*Firste Fruites*

Proverbs, Chapter 19

Da Capo Press. New York, New York, USA. 1969

**Ford, John** 1586–?1640

English dramatist

Physicians are the bodies' cobblers, rather than the Botchers, of men's bodies; as the one patches our tattered clothes, so the other solders our diseased flesh.

*The Lovers Melancholy*

Act I, Scene I (p. 13)

Da Capo Press. New York, New York, USA. 1970

**Freeman, R. Austin** 1862–1943

British physician and mystery novelist

Take the case of an aurist. You think that he lives by dealing with obscure and difficult middle and internal ear cases. Nothing of the kind. He lives on wax. Wax is the foundation of his practice. Patient comes to him deaf as a post. He does all the proper jugglery — tuning fork, otoscope, speculum, and so on, for the moral effect. Then he hikes out a good old plug of cerumen, and the patient hears perfectly. Of course he is delighted. Thinks a miracle has been performed.

*The D'Arblay Mystery* (p. 61)

Dodd, Mead & Company New York, New York, USA. 1926

### Fox, Sir Theodore

No biographical data available

The patient may well be safer with a physician who is naturally wise than with one who is artificially learned.

Purposes of Medicine

*The Lancet*, Volume 2, October 23, 1965 (p. 801)

### Fuller, Thomas 1608–61

English clergyman and author

Every man is a fool or a physician at forty.

*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings.*

*Ancient and Modern, Foreign and British*

No. 1428

Printed for Thomas and Joseph Allman. London, England. 1816

Commonly Physicians like beer are best when they are old; & Lawyers like bread when they are young and new.

*The Holy and Profane State*

Book II, Chapter I, Maxim VI (p. 50)

Printed for Thomas Tegg. London, England. 1841

### Gisbourne, Thomas 1758–1846

English Anglican priest

It is frequently of much importance, not to the comfort only, but to the recovery of the patient, that he should be enabled to look upon his Physician as his friend.

*An Enquiry into the Duties of Men*

The Duties of Physicians (p. 398)

Printed by J. Davis. London, England. 1794

### Gracian, Baltasar 1601–58

Spanish philosopher

The wise physician, if he has failed to cure, looks out for someone who, under the name of consultation, may help him carry out the corpse.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#4587 (p. 257)

Harper & Row, Publishers. New York, New York, USA. 1969

### Gregg, Alan 1890–1957

American medical educator and philosopher

The true physician cannot remain outside the manifold of the events he observes.

Humanism and Science

*Bulletin of the New York Academy of Sciences*, Volume 17, 1941

### Gregory, John 1724–73

Scottish physician and philosopher

I come now to mention the moral qualities peculiarly required in the character of a physician. The chief of these is humanity; that sensibility of heart which makes us feel for the distresses of our fellow creatures, and which of consequence incites in us the most powerful manner to help them.

*Lectures on the Duties and Qualifications of a Physician* (p. 19)

W. Strahan. London, England. 1772

### Gull, Sir William Withey 1816–90

English physician

There are many good general practitioners, there is only one good universal practitioner — “a warm bed.”

*A Collection of The Published Writings* (Volume 2) (p. viii)

New Sydenham Society. London, England. 1894

### Harrison, Tinsley R. 1900–78

American physician

No greater opportunity, responsibility, or obligation can fall to the lot of a human being than to become a physician. In the care of the suffering he needs technical skill, scientific knowledge, and human understanding. He who uses these with courage, with humility, and with wisdom will provide a unique service for his fellow man and will build an enduring edifice of character within himself. The physician should ask of his destiny no more than this; he should be content with no less.

*Principles of Internal Medicine* (p. 1)

Blakiston. Philadelphia, Pennsylvania, USA. 1950

The true physician has a Shakespearean breadth of interest in the wise and the foolish, the proud and the humble, the stoic hero and the whining rouse. He cares for people.

*Principles of Internal Medicine* (4<sup>th</sup> ed.) (p. 7)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1962

### Hazlitt, William Carew 1834–1913

English bibliographer

One said Physicians had the best of it; for, if they did well, the world did proclaime it; if ill, the earth did cover it.

*Shakespeare Jest Books* (Volume 3)

Conceit, Cliches, Flashes and Whimzies, Number 127

Willis & Sotheran. London, England. 1864

One said a Physitian was naturall brother to the wormes, because he was ingendered out of man's corruption.

*Shakespeare Jest Books* (Volume 3)

Conceit, Clichés, Flashes and Whimzies, Number 42

Willis & Sotheran. London, England. 1864



**Heberden, William** 1710–1801  
Physician

Plutarch says that the life of a Vestal virgin was divided into three portions; in the first of which she learned the duties of her profession, in the second she practiced them, and in the third she taught them to others. This is no bad model for the life of a physician.

*Commentaries on the History and Cure of Diseases*  
Preface (p. vii)  
T. Payne, Mews-Gate. London, England. 1802

**Herophilus** 325 BCE–255 BCE  
Greek physician

He is the best physician who knows how to distinguish the possible from the impossible.

In Samuel Evans Massengill  
*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 28)  
The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

**Heschel, Abraham J.** 1907–72  
Jewish theologian

What manner of man is the doctor? Life abounds in works of achievement, in areas of excellence and beauty, but the physician is a person who has chosen to go to the areas of distress, to pay attention to sickness and affliction, to injury and anguish.

*The Insecurity of Freedom*  
The Patient as a Person (p. 28)  
Farrar, Straus & Giroux. New York, New York, USA. 1966

**Hippocrates** 460 BCE–377 BCE  
Greek physician

...physicians are many in title but very few in reality.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
The Law, 1 (p. 144)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It appears to me a most excellent thing for the physician to cultivate Prognosis; for by foreseeing and foretelling, in the presence of the sick, the present, the past, and the future, and explaining the omissions which patients have been guilty of, he will be the more readily believed to be acquainted with the circumstances of the sick; so that men will have confidence to entrust themselves to such a physician.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
The Book of Prognostics, 1 (p. 19)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hoffmann, Friedrich** 1660–1742  
German physician

The perfect physician must have not only the knowledge of medical art but also prudence and wisdom.

*Fundamenta Medicinæ*

Physiology, Chapter I, 10 (p. 6)  
American Elsevier. New York, New York, USA. 1971

The physician is the servant of nature, not her master; the principles of nature and of art are the same and hence the physician must work and act with nature.

*Fundamenta Medicinæ*  
Physiology, (p. 5)  
American Elsevier. New York, New York, USA. 1971

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

The life of a physician becomes ignoble when he suffers himself to feed on petty jealousies and sours his temper in perpetual quarrels.

*Medical Essays*  
The Young Practitioner (p. 392)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The face of a physician, like that of a diplomat, should be impenetrable.

*Medical Essays*  
The Young Practitioner (p. 388)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The old age of a physician is one of the happiest periods of his life. He is loved and cherished for what he has been, and even in the decline of his faculties there are occasions when his experience is still appealed to, and his trembling hands are looked to with renewing hope and trust...The young man feels uneasy if he is not continually doing something to stir up his patient's internal arrangements. The old man takes things more quietly, and is much more willing to let well enough alone.

*Medical Essays by Oliver Wendell Holmes*  
Address  
Graduating Class of the Bellevue Hospital College, March 2, 1871 (pp. 377, 395)  
Classics of Medicine Library. Birmingham, Alabama, USA. 1987

But the practising physician's office is to draw the healing waters, and while he gives his time to this labor he can hardly be expected to explore all the sources that spread themselves over the wide domain of science. The traveler who would not drink of the Nile until he had tracked it to its parent lakes would be like to die of thirst; and the medical practitioner who would not use the results of many laborers in other departments without sharing their special toils, would find life far too short and art immeasurably too long.

*Medical Essays*  
Scholastic and Bedside Teaching (p. 274)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

...a physician's business is to avert disease, to heal the sick, to prolong life, and to diminish suffering...

*Medical Essays*  
Scholastic and Bedside Teaching (p. 274)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The specialist is much like other people engaged in lucrative business. He is apt to magnify his calling, to make much of any symptom which will bring a patient within range of his battery of remedies.

*Over the Teacups*

Chapter VI (p. 129)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1892

A physician who talks about ceremony and gratitude, and services rendered, and the treatment he got, surely forgets himself...

*Medical Essays*

The Contagious of Puerperal Fever (p. 115)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

A man of very moderate ability may be a good physician if he devotes himself faithfully to the work.

*Medical Essays*

Scholastic and Bedside Teaching (p. 300)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### **Howells, William Dean** 1837–1920

American realist novelist

I do not know how it is that clergymen and physicians keep from telling their wives the secrets confided to them; perhaps they can trust their wives to find them out for themselves whenever they wish.

*The Rise of Silas Lapham*

Chapter XXVII (p. 511)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

### **Hufeland, Christoph Wilhelm** 1762–1836

German physician

The physician must generalize the disease, and individualize the patient.

In Oliver Wendell Holmes

*Medical Essays*

Scholastic and Bedside Teaching (p. 275)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

### **Hutchison, Sir Robert Grieve** 1871–1960

English radiologist

From inability to let well alone; from too much zeal for the new and contempt for what is old; from putting knowledge before wisdom, science before art, and cleverness before common sense, from treating patients as cases, and from making the cure of the disease more grievous than the endurance of the same, Good Lord, deliver us.

*British Medical Journal*, Volume 1, 1953 (p. 671)

### **Jackson, James**

No biographical data available

I have often remarked that, though a physician is sometimes blamed very unjustly, it is quite as common for him to get more credit than he is fairly entitled to; so that he has not, on the whole, any right to complain.

*Letters to a Young Physician Just Entering Upon Practice*

Letter II (p. 41)

Phillips, Sampson & Company. Boston, Massachusetts, USA. 1855

### **Jekyll, Joseph**

No biographical data available

See, one physician, like a sculler, plies,  
The patient lingers and by inches dies.  
But two physicians, like a pair of oars,  
Waft him more swiftly to the Stygian shores.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.

*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*

#1661 (p. 94)

Harper & Row, Publishers. New York, New York, USA. 1969

### **Jesus Christ**

It is not the healthy who need a doctor, but the sick.

*The Revised English Bible*

Matthew 9:12

Oxford University Press, Inc. Oxford, England. 1989

Physician, heal yourself.

*The Revised English Bible*

Luke 4:23

Oxford University Press, Inc. Oxford, England. 1989

### **John of Salisbury** ca. 1115–80

English author and diplomatist

The common people say, that physicians are the class of people who kill other men in the most polite and courteous manner.

*Policraticus*

Book II, Chapter 29

Cambridge University Press. Cambridge, England. 1990

### **Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

A physician in a great city seems to be the mere plaything of fortune; his degree of reputation is for the most part totally casual; they that employ him know not his excellence; they that reject him know not his deficiency.

In William Osler

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Preceding Chapter VIII (p. 132)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

### **Jonsen, Albert**

No biographical data available

...the absolute asceticism of the residency recreates, for the young physician, the sacrificial ethic of monastic medicine. That ethic is service: immediate response to the emergency room, to the demands of reports, unmitigated responsibility for correct decisions made promptly and communicated clearly; flagellating denial of sleep, self-indulgence, and frivolity, even to the point of depression and deterioration of personal life, of friendship and love.

Watching the Doctor

*New England Journal of Medicine*, Volume 308, Number 25, June 23, 1983 (p. 1534)

### King, William H.

No biographical data available

The first requisite for a physician is spiritual character and the next requisites are sympathy and a sense of humor.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter V (p. 52)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

### La Bruyère, Jean 1645–96

French satiric moralist

As long as men are liable to die and desirous to live, a physician will be made fun of, but he will be well paid.

*The Characters of Jean La Bruyère*

Characters 14.65

George Routledge & Sons, Ltd. London, England. 1929

### Lamb, William 1779–1848

British prime minister

English physicians kill you, the French let you die.

In Elizabeth Longford

*Queen Victoria: Born to Succeed*

Chapter 5 (p. 69)

Harper & Row, Publishers. New York, New York, USA. 1964

### Latham, Peter Mere 1789–1875

English physician

There are always two parties of the management of the disease — the physician and the patient.

In William B. Bean

*Aphorisms from Latham* (p. 21)

Prairie Press. Iowa City, Iowa, USA. 1962

We physicians had need be a self-confronting and a self-reproving race; for we must be ready, without fear or favor, to call in question our own Experience and to judge it justly; to confirm it, to repeal it, to reverse it, to set up the new against the old, and again to reinstate the old and give it preponderance over the new.

In William B. Bean

*Aphorisms from Latham* (pp. 93–94)

Prairie Press. Iowa City, Iowa, USA. 1962

The end of all the thought and labour of physicians is to make experiments with men's lives.

In William B. Bean

*Aphorisms from Latham* (p. 91)

Prairie Press. Iowa City, Iowa, USA. 1962

The best physicians have begun by being the physician of the poor.

In William B. Bean

*Aphorisms from Latham* (p. 25)

Prairie Press. Iowa City, Iowa, USA. 1962

Physicians are in a manner often called upon to be wiser than they possibly can be. Disease or imperfection of a vital organ is a fearfully interesting thing to him who suffers it, and he presses to learn all that is known, and often much more than is known about it.

In William B. Bean

*Aphorisms from Latham* (p. 26)

Prairie Press. Iowa City, Iowa, USA. 1962

Physicians, who have worthily achieved great reputation, become the refuge of the hopeless, and earn for themselves the misfortune of being expected to cure incurable diseases.

In William B. Bean

*Aphorisms from Latham* (p. 25)

Prairie Press. Iowa City, Iowa, USA. 1962

But Nature, in all her powers and operations, allows herself to be led, directed, and controlled. And to lead, direct, or control for purposes of good, this is the business of the physician.

In William B. Bean

*Aphorisms from Latham* (p. 24)

Prairie Press. Iowa City, Iowa, USA. 1962

I am persuaded that when the physician is called upon to perform great things, even to arrest destructive disease, and to save life, his skill in wielding the implements of his art rests mainly upon the right understanding of simple and single indications, and of the remedies which have power to fulfill them.

In William B. Bean

*Aphorisms from Latham* (p. 19)

Prairie Press. Iowa City, Iowa, USA. 1962

### Longfellow, Henry Wadsworth 1807–82

American poet

You behold in me

Only a traveling Physician;

One of the few who have a mission

To cure incurable diseases,

Or those that are called so.

*The Works of Henry Wadsworth Longfellow* (Volume 5)

Christus, The Golden Legend, Part I (p. 144)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

### Ludmerer, Kenneth M.

Physician

The thinking physician...is the one who in the practice of medicine asks not "What is there to do?" but "should it be done?"

*Learning to Heal: The Development of American Medical Education*

(p. 280)

Basic Books, Inc., Publishers. New York, New York, USA. 1985

### Luther, Martin 1483–1546

Leader of the Protestant Reformation

Able, cautious, and experienced physicians, are gifts of God. They are the ministers of nature, to whom human

life is confided; but a moment's negligence may ruin everything. No physician should take a single step, but in humility and the fear of God; they who are without the fear of God are mere homicides.

Translated by W. Hazlitt

*The Table-Talk of Martin Luther* (p. 383)

The Lutheran Publication Society. Philadelphia, Pennsylvania, USA. 1868

**MacPhail, Sir Andrew** 1864–1938

Canadian physician

I am well aware that in these days, when a student must be converted into a physiologist, a physicist, a chemist, a biologist, a pharmacologist, and an electrician, there is no time to make a physician of him.

*British Medical Journal*, Volume 1, 1933

**Massinger, Philip** 1583–1640

English dramatic poet

1 October What art can do, we promise; physic's hand  
As apt is to destroy as to preserve,  
If Heaven make not the med'cine: all this while,  
Our skill hath combat hell with his disease;  
But 'tis so arm'd, and a deep melancholy,  
To be such in part with death, we are in fear  
The grave must mock our labours.

*The Plays of Philip Massinger* (Volume 1)

The Virgin-Martyr, Act IV, Scene I (p. 76)

G. & W. Nicol. London, England. 1805

**Mather, Cotton** 1663–1728

American minister and religious writer

Of a Distemper we commonly say, To know the Cause,  
is Half the Cure. But, alas, how little Progress is there  
yett made in that Knowledge! Physicians talk about the  
Causes of Diseases. But their Talk is very Conjectural,  
very Uncertain, very Ambiguous; and often times a meer  
Jargon; and in it, they are full of Contradiction to One  
another.

*The Angel of Bethesda*

Capsula VII (p. 43)

American Antiquarian Society and Barre Publishers. Barre, Massachusetts, USA. 1972

**Mayo, Charles Horace** 1865–1939

American physician

The definition of a specialist as one who “knows more and more about less and less” is good and true. Its truth makes essential that the specialist, to do efficient work, must have some association with others who, taken altogether, represent the whole of which the specialty is only a part.

*Surgery's Problems as They Affect the Hospital*

Modern Hospital, Volume 51, September 1938

The true physician will never be satisfied just to pass his therapeutic wares over a counter.

Problems in Medical Education

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 18, 1926

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

The true physician does not preach repentance; he offers absolution.

*Prejudices: Third Series*

Chapter XIV, Section 5 (p. 269)

Alfred A. Knopf. New York, New York, USA. 1922

**Meyer, Adolf** 1866–1950

American neurologist and psychiatrist

I wonder how soon we shall be far enough along to have the physician ask: How much and what, if anything, is structural? how much Functional, somatic or metabolic? How much constitutional, psychogenic and social?

The “Complaint” as the Center of Genetic-Dynamic and Nosological

Teaching in Psychiatry

*New England Journal of Medicine*, August 23, 1928

**Miller H.**

No biographical data available

The worst mistakes...must be laid at the door of the specialist rather than the general practitioner, who, from his intimate contact with sick people in their natural surroundings, often has a lively understanding of the nervous patient, and is able to see him and his problems as a whole.

The Recognition of Neurotic Illness

*Practitioner*, Volume 159, 1947

**Molière (Jean-Baptiste Poquelin)** 1622–1673

French playwright and actor

What will you do, sir, with four physicians? Is not one enough to kill any one body?

In Logan Clendening

*Sourcebook of Medical History*

Love's the Best Doctor

Act II, Scene I (p. 222)

General Publishing Company Ltd. Toronto, Ontario, Canada. 1942

**Moore, Merrill**

No biographical data available

If the average man is a harp on whom Nature occasionally plays, the physician is an instrument on whom the emotions are played continuously during his waking hours and that is not too good for any man.

In Mary Lou McDonough

*Poet Physician: An Anthology of Medical Poetry Written by Physicians*

Afterthought (p. 198)

C.C. Thomas. Springfield, Illinois, USA. 1945

**More, Hannah** 1745–1833

English religious writer

I used to wonder why people should be so fond of the company of their physician, till I recollected that he is the only person with whom one dares to talk continually of oneself, without interruption, contradiction or censure; I suppose that delightful immunity doubles their fees.

In William Roberts

*Memoirs of the Life and Correspondence of Mrs. Hannah Moore* (Volume 1)

Letter to Horace Walpole, 27 July 1789 (p. 317)

Harper & Brothers. New York, New York, USA. 1837

### **Nuland, Sherwin B.** 1930–

American surgeon and teacher of bioethics and medicine

The very success of his esoteric therapeutics too often leads the physician to believe he can do what is beyond his doing and save those who, left to their own unhindered judgment, would choose not to be subjected to his saving.

*How We Die: Reflections on Life's Final Chapter* (p. 221)

Alfred A. Knopf. New York, New York, USA. 1994

Just as physicians must constantly admonish one another to seek the most subtle beginnings of disease, they must also forgive themselves when timing or circumstances frustrate their best intentions.

The Uncertain Art: The Whole Law of Medicine

*The American Scholar*, Summer, Volume 67, Number 3, 1998

### **Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

‘Tis no idle challenge which we physicians throw out to the world when we claim that our mission is of the highest and of the noblest kind, not alone in curing disease but in educating the people in the laws of health, and in preventing the spread of plagues and pestilences...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XVI (p. 408)

Clarendon Press. Oxford, England. 1925

To wrest from nature the secrets which have perplexed philosophers of all ages, to track to their sources the causes of disease, to correlate the vast stores of knowledge, that they may be quickly available for the prevention and cure of disease — these are our ambitions.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 267)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

To investigate the causes of death, to examine carefully the condition of organs, after such changes have gone on in them as to render existence impossible and to apply such Knowledge to the prevention and treatment of disease, is one of the highest objects of the Physician...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter IV (p. 85)

Clarendon Press. Oxford, England. 1925

To prevent disease, to relieve suffering and to heal the sick — this is our work.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

Chauvinism in Medicine (p. 267)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

Permanence of residence, good undoubtedly for the pocket, is not always best for wide mental vision in the physician.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Army Surgeon (p. 101)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

No class of men needs friction so much as physicians; no class gets less. The daily round of busy practitioners tends to develop an egoism of a most intense kind, to which there is no antidote. The few setbacks are forgotten, the mistakes are often buried, and ten years of successful work tend to make a man touchy, dogmatic, intolerant of correction, and abominably self-centered. To this mental attitude the medical society is the best corrective, and a man misses a good part of his education who does not get knocked about a bit by his colleagues in discussions and criticisms...

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter VXII (p. 447)

Clarendon Press. Oxford, England. 1925

Few men live lives of more devoted self-sacrifice than the family physician but he may become so completely absorbed in work that leisure is unknown... There is danger in this treadmill life lest he lose more than health and time and rest — his intellectual independence. More than most men he feels the tragedy of isolation — that inner isolation so well expressed in Matthew Arnold's line — "We mortal millions live alone." Even in populous districts the practice of medicine is a lonely road which winds up-hill all the way and a man may easily go astray and never reach the Delectable Mountains unless he early finds those shepherd guides of which Bunyan tells, Knowledge, Experience, Watchful and Sincere. The circumstances of life mould him into a masterful, self-confident, self-centered man, whose worst faults often partake of his best qualities.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 1)

Chapter XXI (p. 588)

Clarendon Press. Oxford, England. 1925

The physician who shows in his face the slightest alteration, expressive of anxiety or fear, has not his medullary centres under the highest control, and is liable to disaster at any moment. I have spoken this to you on many occasions, and have urged you to educate your nerve centres so that not the slightest dilator or contractor influence shall pass to the vessels of your face under any professional trial.

In Christopher Lawrence and Steven Shapin  
*Science Incarnate: Historical Embodiments on Natural Knowledge*  
 (p. 171)  
 The University of Chicago Press. Chicago, Illinois, USA. 1998

It may be well for a physician to have pursuits outside his profession, but it is dangerous to let them become too absorbing.

In Harvey Cushing  
*The Life of Sir William Osler* (Volume 1)  
 Chapter III (p. 67)  
 Clarendon Press. Oxford, England. 1925

A physician who does not use books and journals, who does not need a library, who does not read one or two of the best weeklies and monthlies, soon sinks to the level of the cross-counter prescriber, and not alone in practice, but in those mercenary feelings and habits which characterize a trade...

In Harvey Cushing  
*The Life of Sir William Osler* (Volume 1)  
 Chapter XVII (p. 448)  
 Clarendon Press. Oxford, England. 1925

**Ovid** 43 BCE–17 AD  
 Roman poet

‘Tis not always in a physician’s power to cure the sick...

In Arthur Leslie Wheeler  
*Ovid with an English Translation*  
 Ex Ponto, Book I, iii (p. 281)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1924

**Owen, John** 1616–83  
 English Puritan divine and theologian

Physicians take Gold, but seldom give:  
 They Physick give, take none; yet healthy live.  
 A Diet They prescribe; the Sick must for’t  
 Give Gold; Each other Thus supply-support.

*Latine Epigrams*  
 Book I, Number 53  
 Louisiana State University Press. Baton Rouge, Louisiana, USA. 1997

**Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim)** 1493–1541  
 Alchemist and mystic

The book of Nature is that which the physician must read; and to do so he must walk over the leaves.  
*Encyclopædia Britannica* (9<sup>th</sup> edition), Volume 18 (p. 234)

**Parkinson, John**  
 No biographical data available

The common duty required of a physician lies in the recognition and treatment of disease. If he enlarges his study to cover life as affected by disease, and masters the psychology of the individual sick in body, he will widen his usefulness and reach a fuller life himself as a physician.  
*Annals of Internal Medicine*

The Patient and the Physician  
 Address  
 32<sup>nd</sup> Annual Session of the American College of Physicians, St Louis, Missouri, April 11, 1951

**Percival, Thomas** 1740–1804  
 English physician, philosopher, and writer

The relations in which a physician stands to his patients, to his brethren, and to the public, are complicated, and multifarious; involving much knowledge of human nature, and extensive moral duties.

*Medical Ethics*  
 To E.C. Percival (p. viii)  
 Printed by S. Russell. Manchester, England. 1803

Hospital physicians and surgeons should minister to the sick, with due impressions of the importance of their office; reflecting that the ease, the health, and the lives of those committed to their charge depend on their skill, attention, and fidelity.

*Medical Ethics*  
 Chapter I (p. 9)  
 Printed by S. Russell. Manchester, England. 1803

**Piozzi, Hester Lynch** 1741–1821  
 English writer

A physician can sometimes parry the scythe of death, but has no power over the sand in the hourglass.  
 Letter to Fanny Burney, 12 November 1781

**Plato** 428 BCE–347 BCE  
 Greek philosopher

...no physician, in so far as he is a physician, considers his own good in what he prescribes, but the good of his patient; for the true physician is also a ruler having the human body as a subject, and is not a mere money-maker.

In *Great Books of the Western World* (Volume 7)  
*The Republic*  
 Book I, Section 342 (p. 303)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...so to in the body the good and healthy elements are to be indulged and the elements of disease are not to be indulged, but discouraged. And this is what the physician has to do, and in this the art of medicine consists: for medicine may be regarded generally as the knowledge of the loves and desires of the body, and how to satisfy them or not; and the best physician is he who is able to separate fair love from foul, or to convert one into the other; and he who knows how to eradicate and how to implant love, whichever is required, and can reconcile the most hostile elements in the constitution and make them loving friends, is a skillful practitioner.

In *Great Books of the Western World* (Volume 7)  
*Symposium*  
 Section 186 (p. 156)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the most skillful physicians are those who, from their youth upwards, have combined with the knowledge of their art the greatest experience of disease; they had better not be robust in health, and should have had all manner of diseases in their own persons.

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book 3, Section 408 (p. 337)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Plutarch 46–119

Greek biographer and author

...a skillful physician, who, in a complicated and chronic disease, as he sees occasion, at one while allows his patient the moderate use of such things as please him, at another while gives him keen pains and drugs to work the cure.

In *Great Books of the Western World* (Volume 7)

*Pericles* (p. 129)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Poe, Edgar Allan 1809–49

American short story writer

Is there — is there balm in Gilead? — tell me — tell me, I implore!

*The Raven and Other Poems*

The Raven, Stanza 15

Columbia University Press. New York, New York, USA. 1942

### Prior, Matthew 1664–1721

English poet and diplomat

I sent for Ratcliffe; was so ill  
That other doctors gave me over:  
He felt my pulse — prescrib'd his pill,  
And I was likely to recover.  
But when the wit began to wheeze,  
And wine had warm'd the politician  
Cur'd yesterday of my disease,  
I died last night of my physician.

In Helen & Lewis Melville

*An Anthology of Humorous Verse*

The Remedy Worse than the Disease

Dodd, Mead & Company. New York, New York, USA. 1924

### Proverb

Where there are three physicians, there are two atheists.

In Oliver Wendell Holmes

*Medical Essays*

The Medical Profession in Massachusetts (p. 364)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Go not for every grief to the Physitian, nor for every quarrel to the Lawyer, nor for every thirst to the pot.

In George Herbert

*Outlandish Proverbs*

#290

Printed by T. Maxey for T. Garthwait. London, England. 1651

Deceive not thy Physitian, Confessor, nor Lawyer.

In George Herbert

*Outlandish Proverbs*

#105

Printed by T. Maxey for T. Garthwait. London, England. 1651

There are more Physitians in health than drunkards.

In George Herbert

*Outlandish Proverbs*

#903

Printed by T. Maxey for T. Garthwait. London, England. 1651

The Physitian owes all to the patient, but the patient owes nothing to him but a little money.

In George Herbert

*Outlandish Proverbs*

#921

Printed by T. Maxey for T. Garthwait. London, England. 1651

God heales, and the Physitian hath the thankses.

In George Herbert

*Outlandish Proverbs*

#169

Printed by T. Maxey for T. Garthwait. London, England. 1651

A disobedient patient makes an unfeeling physician.

In Robert Christy

*Proverbs, Maxims and Phrases of All Ages* (p. 255)

G.P. Putnam's Sons. New York, New York, USA. 1888

### Proverb, Chinese

The physician can cure the sick, but he cannot cure the dead.

In Robert Christy

*Proverbs, Maxims and Phrases of All Ages* (p. 259)

G.P. Putnam's Sons. New York, New York, USA. 1888

### Proverb, German

When you call a physician call the judge to make your will.

In Robert Christy

*Proverbs, Maxims and Phrases of All Ages* (p. 259)

G.P. Putnam's Sons. New York, New York, USA. 1888

### Proverb, Italian

From your confessor, lawyer and physician,

Hide not your case on no condition.

In Sir John Harrington

*Metamorphosis of Ajax*

The Second Section (p. 154)

Columbia University Press. New York, New York, USA. 1962

### Proverb, Italian

*Dove non va il sole, va il medico*: Where the sunlight enters not, there goes the physician.

In Robert Means Lawrence

*Primitive Psycho-Therapy and Quackery*

The Blue-Glass Mania (p. 95)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1910

**Quarles, Francis** 1592–1644  
English poet

Physicians of all men are most happy; what good success  
soever they have, the world proclaimeth, and what faults  
they commit, the earth coverth.

*Hieroglyphikes of the Life of Man*

Part iv, Nicocles (p. 17)

Printed for M. Fleshor. London, England. 1638

**Rabelais, François** ca. 1490–1553  
French writer and physician

Happy is the physician, whose coming is desired at the  
declension of a disease.

In *Great Books of the Western World* (Volume 24)

*Gargantua and Pantagruel*

*Pantagruel*

Book 3, Chapter 41 (p. 209)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ray, John** 1627–1705  
English naturalist

The best physicians are Dr. Diet, Dr. Quiet, and  
Dr. Merryman.

*A Complete Collection of English Proverbs* (p. 34)

Printed for G. Cowie. London, England. 1813

Piss clear, and defy the physician.

*A Complete Collection of English Proverbs* (p. 35)

Printed for G. Cowie. London, England. 1813

**Saint Augustine of Hippo** 354–430  
Theologian and doctor of the Church

...as it happens usually to him that having had experience  
of a bad physician, is fearful afterwards to trust himself  
with a good [physician]...

*St. Augustine's Confessions* (Volume 1)

Book VI, IV (p. 281)

William Heinemann. London, England. 1912

**Scott, Sir Walter** 1771–1832  
Scottish novelist and poet

The praise of the physician...is the recovery of the  
patient.

*The Talisman*

Chapter VIII (p. 112)

Grosset & Dunlap. New York, New York, USA. 1929

...the sick chamber of the patient is the kingdom of the  
physician.

*The Talisman*

Chapter VII (p. 99)

Grosset & Dunlap. New York, New York, USA. 1929

...a slight touch of the cynic in manner and habits, gives  
the physician, to the common eye, an air of authority  
which greatly tends to enlarge his reputation.

*The Complete Works of Sir Walter Scott* (Volume 5)

*The Surgeon's Daughter*

Chapter I (p. 23)

Conner & Cooke. New York, New York, USA. 1833

**Seegal, David**

No biographical data available

The young physician today is so generously provided  
with a kit of diagnostic and therapeutic tools, his atten-  
tion might be wisely directed to the question of “what not  
to do” as well as “what to do.”

*Journal of Chronic Diseases*, Volume 17, 299, 1964

**Selden, John** 1584–1654  
English jurist

Preachers say, do as I say, not as I do. But if the physician  
had the same disease upon him that I have, and he should  
bid me to do one thing, and he do quite another, could I  
believe him?

*Table Talk of John Selden*

Preaching #13 (p. 145)

J.M. Dent. London, England. 1899

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

The physician cannot prescribe by letter...he must feel  
the pulse.

Translated by Richard M. Gummere

*Ad Lucilium Epistulae Morales* (Volume 1)

Epistle xxii, Section 1 (p. 149)

Harvard University Press. Cambridge, Massachusetts, USA. 1925

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Trust not the physician;

His antidotes are poison, and he slays

More than you rob.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Timon of Athens

Act IV, Scene iii, l. 434–436

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Kill thy physician, and the fee bestow

Upon thy foul disease.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

King Lear

Act I, Scene i, l. 164–165

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sheridan, Richard Brinsley** 1751–1816  
English dramatist and politician

The art of the physician consists, in a great measure, in  
exciting hope, and other friendly passions and feelings.

*Laconic Manual and Brief Remarker Containing Over a Thousand*

*Subjects Alphabetically and Systematically Arranged* (p. 330)

Robert Dick. Toronto, Ontario, Canada. 1853

...I had rather follow you to your grave, than see you  
owe your life to any but a regular bred physician.



*St. Patrick's Day*

Act II, Scene Justice Hoofe (p. 24)  
Publisher undetermined

**Sissman, Louis Edward** 1928–76  
Poet

The doctors — eleven of them, all told — marshaled their forces for a truly impressive attack on the disease. Everything, I felt was meticulously planned in some War Room in the depths of the hospital: the battery of tests in just such a sequence; the alternative battle plans contingent on the outcome of the tests; the choice of weapons — radiation or chemotherapy — for the mopping-up afterward.

*The Atlantic*

A Little Night Music: A Tangential Line  
February 1972

**Smollett, Tobias George** 1721–71  
Scottish novelist

The character of a physician, therefore, not only presupposes natural sagacity, and acquired erudition, but it also implies every delicacy of sentiment, every tenderness of nature, and every virtue of humanity.

*The Life and Adventures of Sir Launcelot Greaves*  
Chapter XXIV (p. 192)

Oxford University Press, Inc. London, England. 1973

**Stanton, Elizabeth Cady** 1815–1902  
American reformer

Besides the obstinacy of the nurse, I had the ignorance of the physicians to contend with.

*Eighty Years and More (1815–1897) Reminiscences of Elizabeth Cady Stanton*

Motherhood (pp. 118–119)

T. Fisher Unwin. London, England. 1898

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

There are men and classes of men that stand above the common herd; the soldier, the sailor, and the shepherd not unfrequently; the artist rarely; rarer still, the clergyman; the physician almost as a rule. He is the flower (such as it is) of our civilization; and when that stage of man is done with, and only remembered to be marveled at in history, he will be thought to have shared as little as any in the defects of the period, and most notably exhibited the virtue of the race. Generosity he has, such as is possible to those who practice an art, never to those who drive a trade; discretion, tested by a hundred secrets; tact, tried in a thousand embarrassments; and, what are more important, Herculean cheerfulness and courage. So it is that he brings air and cheer into the sick-room, and often enough, though not so often as he wishes, brings healing.

*Underwoods*

Preface

Charles Scribner's Sons. New York, New York, USA. 1887

**Swift, Jonathan** 1667–1745  
Irish-born English writer

Physicians ought not to give their Judgment of Religion, for the same Reason that Butchers are not admitted to be Jurors upon Life and Death.

*Satires and Personal Writings*

Thoughts on Various Subjects (p. 410)

Oxford University Press, Inc. New York, New York, USA. 1965

**Taylor, Jeremy** 1613–67  
English clergyman

...to preserve a man alive in the midst of so many chances, and hostilities, is as great a miracle as to create him...

*Holy Living and Holy Dying* (Volume 2)

Chapter I, Section 1, I. 7–9

At The Clarendon Press. Oxford, England. 1989

## The Bible

Is there no balm in Gilead, no physician there?

*The Revised English Bible*

Jeremiah 8:22

Oxford University Press, Inc. Oxford, England. 1989

...Asa became gravely affected with disease in his feet; he did not seek guidance of the Lord but resorted to physicians.

*The Revised English Bible*

II Chronicles 16:12–13

Oxford University Press, Inc. Oxford, England. 1989

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Priests and physicians should never look one another in the face. They have no common ground, nor is there any to mediate between them. When the one comes, the other goes. They could not come together without laughter, or a significant silence, for the one's profession is a satire on the other's, and either's success would be the other's failure.

*The Writings of Henry David Thoreau* (Volume 1)

A Week on the Concord and Merrimac Rivers

Wednesday (p. 339)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

It is wonderful that the physician should ever die, and that the priest should ever live. Why is it that the priest is never called to consult with the Physician? It is because men believe practically that matter is independent of spirit. But what quackery? It is commonly an attempt to cure the disease of a man by addressing his body alone. There is a need of a physician who shall minister to both soul and body at once, that is to man. Now he falls between two stools.

*The Writings of Henry David Thoreau* (Volume 1)

A Week on the Concord and Merrimac Rivers

Wednesday (p. 339)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Tupper, Kerr Boyce**

No biographical data available

Let a physician believe with all his heart that God meant him to be a physician, only a physician, wholly a physician, always a physician, then will he be a physician indeed, uncorrupted by the love of money, untainted by infection for fame, untimidated by danger.... Have appetite for your life calling, and you will have aptitude for all its duties.

*The Ideal Physician* (p. 37)

Lea Brothers/Philadelphia, Pennsylvania, USA. 1899

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

Only those who regard healing as the ultimate goal of their efforts can, therefore, be designated as physicians.

Translated by Leland J. Rather

*Disease, Life, and Man, Selected Essays*

Standpoints in Scientific Medicine (1847) (p. 26)

Stanford University Press. Stanford, California, USA. 1958

...there are circumstances in which the split between scientific and practical medicine is so great that the learned physician can do nothing, while the practical physician knows nothing. Lord Bacon has said, *scientia est potentia*. Knowledge which is unable to support action is not genuine, and how unsure is activity without understanding! This split between science and practice is rather new; our century and our country have brought it into being.

Translated by Leland J. Rather

*Disease, Life, and Man*

Standpoints in Scientific Medicine (p. 27)

Stanford University Press. Stanford, California, USA. 1958

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

The Devil should not try his tricks on a clever physician. Those familiar with nature are dangerous for the wonderworkers. I advise the Devil always to apply to the faculty of theology — not to the medical faculty.

In Pearch Bailey

Voltaire's Relation to Medicine

*Annals of Medical History*, Volume 1, 1917 (p. 58)

Let nature be your first physician. It is she who made all.

*The Works of Voltaire* (Volume 11)

*Philosophical Dictionary* (Volume 7)

Medicine (p. 169)

The St. Hubert Guild. Akron, Ohio, USA. 1901

But nothing is more estimable than a physician who, having studied nature from his youth, knows the properties of the human body, the diseases which assail it, the remedies which will benefit it, exercises his art with caution, and pays equal attention to the rich and the poor.

*The Works of Voltaire* (Volume 12)

*Philosophical Dictionary* (Volume 8)

Physicians (pp. 199–200)

The St. Hubert Guild. Akron, Ohio, USA. 1901

**von Ebner-Eschenbach, Marie** 1830–1916

Austrian writer

Physicians are hated either on principle or for financial reasons.

Translated by David Scrase and Wolfgang Mieder

*Aphorisms* (p. 50)

Aridne Press. Riverside, California, USA. 1994

**Webster, John** 1580?–1625?

English playwright

Physicians are like kings — they brook no contradiction.

*The Duchess of Malfi*

Act V, Scene II, l. 69–70

Chatto & Windus. London, England. 1958

**Wordsworth, William** 1770–1850

English poet

Physician art thou? one, all eyes,  
Philosopher! a fingering slave,  
One that would peep and botanize  
Upon his mother's grave.

*The Complete Poetical Works of William Wordsworth*

A Poet's Epitaph

Crowell. New York, New York, USA. 1888

**Young, Arthur** 1741–1820

English traveler

...there is a great difference between a good physician and a bad one; yet very little between a good one and [no physician] at all.

*Travels in France*

9 September 1787 (p. 66)

G. Bell. London, England. 19112

**PHYSICIST**

Up to the time of the foundation of the Institute of Physics, the physicists had hardly been recognized as a member of one of the professions.

*The Institute of Physics: Objects of the Institute* (p. 5)

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Very strange people, physicists...in my experience the ones who aren't actually dead are in some way very ill.

*The Long Dark Tea-Time of the Soul*

Chapter II (p. 140)

Simon & Schuster. New York, New York, USA. 1990

It startled him even more when just after he was awarded the Galactic Institute's Prize for Extreme Cleverness he got lynched by a rampaging mob of respectable physicists

who had finally realized that the one thing they really couldn't stand was a smart-ass.

*The Ultimate Hitchhiker's Guide to the Galaxy*

The Hitchhiker's Guide to the Galaxy

Chapter 10 (p. 60)

The Ballantine Book Company. New York, New York, USA. 2002

**Adams, Henry Brooks** 1838–1918

American man of letters

...the future of Thought and therefore of History lies in the hands of physicists, and therefore the future historian must seek his education in the world of mathematical physics.

*The Degradation of the Democratic Dogma*

The Rule of Phase Applied to History (p. 283)

Peter Smith. New York, New York, USA. 1949

### Author undetermined

We seek, we study, and we stare

At particles that weren't quite there.

In H. Arthur Klein

*The World of Measurements*

Song for A High-Energy Physicist (p. 180)

Simon & Schuster. New York, New York, USA. 1974

### Baker, Adolph

No biographical data available

Physics is engaged neither in the development of time machines nor in the fabrication of bombs. But it is the business of physicists to take flights of fancy which carry them far beyond the boundaries imposed by current technology.

*Modern Physics and Antiphysics*

Chapter 3 (p. 27)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1970

**Barnett, Lincoln** 1909–79

Science writer

The young physicists are beyond all doubt the noisiest, rowdiest, most active and most intellectually alert group we have here. For them the world changes every week and they are simply delighted by it. A few days ago I asked one of them as they came bursting out of a seminar, "How did it go?" "Wonderful" he said. "Everything we knew about physics last week isn't true!"

*Writing on Life: Sixteen Close-Ups*

Physicist Oppenheimer (p. 378)

William Sloane Associates, Publishers. New York, New York, USA. 1951

### Bergmann, P.

No biographical data available

In many aspects, the theoretical physicist is merely a philosopher in a working suit.

In Jean-Pierre Luminet

*Black Holes* (p. 51)

Cambridge University Press. New York, New York, USA. 1992

**Birkhoff, George David** 1884–1944

American mathematician

It is to be hoped that in the future more and more theoretical physicists will command a deep knowledge of mathematical principles; and also that mathematicians will no longer limit themselves so exclusively to the aesthetic development of mathematical abstractions.

Mathematical Nature of Physical Theories

*American Scientist*, Volume 31, Number 4, October 1943 (p. 286)

**Boltzmann, Ludwig Edward** 1844–1906

Austrian Physicist

$S = k \log w$

Carved on Boltzmann's gravestone

**Brecht, Bertolt** 1898–1956

German writer

VIRGINIA: Father says theologians have their bells to ring: physicists have their laughter.

Translated by John Willett

*Life of Galileo*

Scene 9 (p. 74)

Arcade Publishing. New York, New York, USA. 1994

**Brillouin, Léon** 1889–1969

French physicist

It is impossible to study the properties of a single mathematical trajectory. The physicist knows only bundles of trajectories, corresponding to slightly different initial conditions.

In John D. Barrow

*The World Within the World* (p. 277)

Clarendon Press. Oxford, England. 1988

**Burroughs, William S.** 1914–97

American writer

No atomic physicist has to worry, people will always want to kill other people on a mass scale.

*The Adding Machine: Selected Essays*

A Word to the Wise Guy (p. 29)

Seaver Books. New York, New York, USA. 1986

**Crick, Francis Harry Compton** 1916–2004

English biochemist

Physicists are all too apt to look for the wrong sorts of generalizations, to concoct theoretical models that are too neat, too powerful, and too clean. Not surprisingly, these seldom fit well with data. To produce a really good biological theory, one must try to see through the clutter produced by evolution to the basic mechanisms. What seems to physicists to be a hopelessly complicated process may have been what nature found simplest, because nature could build on what was already there.

*What Mad Pursuit?: A Personal View of Scientific Discovery* (p. 139)

Basic Books, Inc. New York, New York, USA. 1988

**Cvitanovic, Predrag**

Physicist

Indicative of the depth of mathematics lurking behind physicists' conjectures is that fact that the properties that one would like to establish about the renormalization theory of critical circle maps might turn out to be related to number-theoretic abysses such as the Riemann conjecture....

In C. Itzykson, et al. (eds.)

*From Number Theory and Physics*

Circle Maps: Irrationally Winding

Springer-Verlag New York, Inc. New York, New York, USA. 1992

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

**Brown, Julian R.**

No biographical data available

Physicists, like theologians, are wont to deny that any system is in principle beyond the scope of their subject.

*Superstrings: A Theory of Everything*

Introduction (p. 1)

Cambridge University Press. Cambridge, England. 1988

**Dicke, R. H.**

No biographical data available

It is well known that carbon is required to make physicists.

Dirac's Cosmology and Mach's Principle

*Nature*, Volume 192, Number 4801, November 4, 1961 (p. 440)**Dirac, Paul Adrian Maurice** 1902–84

English theoretical physicist

Some physicists may be happy to have a set of working rules leading to results in agreement with observation. They may think that this is the goal of physics. But it is not enough. One wants to understand how Nature works.

*Proceedings of the Conference Perturbative Quantum Chromodynamics*

Volume 74, 1981 (pp. 129–130)

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

The watchmaker to whom one gives a watch that does not run will take it all apart and will examine each of the pieces until he finds out which one is damaged. The physician to whom one presents a patient cannot dissect him to establish the diagnosis. He has to guess the seat of the illness by examining the effect on the whole body. The physicist resembles a doctor, not a watchmaker.

Quelques reflexions au sujet de la physique experimentale

*Revue des questions scientifiques.*, Volume 36, 1897 (p. 55)

...if the aim of physical theories is to explain experimental laws, theoretical physics is not an autonomous science; it is subordinate to metaphysics.

*The Aim and Structure of Physical Theory*

Part I, Chapter I (p. 10)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Dürrenmatt, Friedrich** 1921–90

Swiss playwright and novelist

Dear Mobius. You have visitors. Now leave your physicist's lair for a moment and come in here.

Translated by James Kirkup

*The Physicists*

Act One (p. 37)

Grove Press, Inc. New York, New York, USA. 1964

It's ludicrous. Here we have hordes of highly paid physicists in gigantic state-supported laboratories working for years and years and years vainly trying to make some progress in the realm of physics, while you do it quite casually at your desk in this madhouse.

Translated by James Kirkup

*The Physicists*

Act Two (p. 75)

Grove Press, Inc. New York, New York, USA. 1964

**Dyson, Freeman J.** 1923–

American physicist and educator

Theoretical physicists are accustomed to living in a world which is removed from tangible objects by two levels of abstraction. From tangible atoms we move by one level of abstraction to invisible fields and particles. A second level of abstraction takes us from fields and particles to the symmetry-groups by which fields and particles are related. The superstring theory takes us beyond symmetry-groups to two further levels of abstraction. The third level of abstraction is the interpretation of symmetry-groups in terms of states in ten-dimensional space-time. The fourth level is the world of the superstrings by whose dynamical behavior the states are defined.

*Infinite in All Directions*

Part One, Chapter Two (p. 18)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

To the pure geometer the radius of curvature is an incidental characteristic — like the grin of the Cheshire cat. To the physicist it is an indispensable characteristic. It would be going too far to say that to the physicist the cat is merely incidental to the grin. Physics is concerned with interrelatedness such as the interrelatedness of cats and grins. In this case the “cat without a grin” and the “grin without a cat” are equally set aside as purely mathematical phantasies.

*The Expanding Universe*

Chapter IV, Section III (pp. 103–104)

The University Press. Cambridge. 1933

Wheresoever the carcass is, there will the eagles be gathered together, and where the symbols of the mathematical physicists flock, there presumably is some prey for them to settle on, which the plain man at least will prefer to call by a name suggestive of something more than passive emptiness.

*New Pathways in Science*

Chapter II, Section IV (p. 39)

The Macmillan Company. New York, New York, USA. 1935

Life would be stunted and narrow if we could feel no significance in the world around us beyond that which can be weighed and measured with the tools of the physicist or described by the metrical symbols of the mathematician.

In Arthur Beiser

*The World of Physics*

Introduction

Simon & Schuster. New York, New York, USA. 1987

### **Einstein, Albert** 1879–1955

German-born physicist

The supreme task of the physicist is to arrive at those universal elementary laws from which the cosmos can be built up by pure deduction.

*The World As I See It* (p. 22)

Philosophical Library. New York, New York, USA. 1949

Dear Schrödinger: You are the only contemporary physicist, besides Laue, who sees that one cannot get around the assumption of reality — if only one is honest. Most of them simply do not see what sort of risky game they are playing with reality — reality as something independent of what is experimentally established.

In A.P. French & P.J. Kennedy (eds.)

*Niels Bohr: A Centenary Volume*

Letter, Albert Einstein to Erwin Schrödinger, December 22, 1950

(p. 143)

Harvard University Press. Cambridge, Massachusetts, USA. 1985

How wretchedly inadequate is the theoretical physicist as he stands before Nature — and before his students!

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 15 March 1922 (p. 24)

Princeton University Press. Princeton, New Jersey, USA. 1979

If you want to find out anything from the theoretical physicists about the methods they use, I advise you to stick closely to one principle: Don't listen to their words, fix your attention on their deeds.

*Ideas and Opinions*

On the Method of Theoretical Physics (p. 270)

Crown Publishers, Inc. New York, New York, USA. 1954

...the supreme task of the physicist is the discovery of the most general elementary laws from which the world-picture can be deduced logically.

In Max Planck

*Where Is Science Going?*

Prologue (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

### **Feynman, Richard P.** 1918–88

American theoretical physicist

A professor of theoretical physics always has to be told what to look for. He just uses his knowledge to explain the observations of the experimenters!"

*What Do You Care What Other People Think?*

The Cold Facts (p. 140)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

The limited imagination of physicists: When we see a new phenomenon we try to fit it into the framework we already have.... It's not because Nature is really similar; it's because the physicists have only been able to think of the same damn thing, over and over again.

*QED: The Strange Theory of Light and Matter*

Chapter 4 (p. 149)

Princeton University Press. Princeton, New Jersey, USA. 1985

Physicists sometimes feel so superior and smart that other people would like to catch them out once on something. I will give you something to get them on. They should be utterly ashamed of the way they take energy and measure it in a host of different ways, with different names. It is absurd that energy can be measured in calories, in ergs, in electron volts, in foot pound, in B.T.U.s, in horsepower hours, in kilowatt hours — all measuring exactly the same thing.... For those who want some proof that physicists are human, the proof is in the idiocy of all the different units which they use for measuring energy.

*The Character of Physical Law*

Chapter 3 (p. 74)

BBC. London, England. 1965

### **Foster, G. C.**

No biographical data available

...from the very outset of his investigations the physicist has to rely constantly on the aid of the mathematician, for even in the simplest cases, the direct result of his measuring operations are entirely without meaning until they have been submitted to more or less [a] mathematical discussion.

Mathematical and Physical Opening Address,

*Nature*, Section A, Volume 16, Number 407, August 16, 1887 (p. 312)

### **Gamow, George** 1904–68

Russian-born American physicist

Now, Physicists, take warning,  
Observe this sober test...

When new fleas are a-borning  
Make sure they're fully dressed!

*Thirty Years That Shook Physics*

First Part (p. 193)

Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Gibbs, J. Willard** 1839–1903  
American mathematician

A mathematician may say anything he pleases, but a physicist must be at least partially sane.

In R.B. Lindsay  
On the Relation of Mathematics and Physics  
*The Scientific Monthly*, December 1944 (p. 456)

**Green, Celia** 1935–  
English philosopher and psychologist

If you say to a theoretical physicist that something is inconceivable, he will reply: “It only appears inconceivable because you are naively trying to conceive it. Stop thinking and all will be well.”

*The Decline and Fall of Science*  
Aphorisms (pp. 2–3)  
Hamilton. London, England. 1976

**Greene, Brian** 1963–  
American physicist

Physicists are more like avant-garde composers, willing to bend traditional rules.... Mathematicians are more like classical composers....”

*The Elegant Universe*  
Chapter 11 (p. 271)  
W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Gribbin, John**  
English science writer and astronomer

**Rees, Martin John** 1942–  
15<sup>th</sup> Astronomer Royal of England

...the fate of the Universe, like its present appearance, was imprinted right at the beginning, in the hot, dense fireball era. And to understand that era, and the nature of the relics it could have left behind, we enter the realm of the particle physicist.

*Cosmic Coincidences: Dark Matter, Mankind, and Anthropic Cosmology*  
Part One, Chapter Three (p. 99)  
Bantam Books. New York, New York, USA. 1989

**Hanson, Norwood Russell** 1924–67  
American philosopher of science

Physicists do not start from hypotheses; they start from data. By the time a law has been fixed into an H-D [hypothetico-deductive] system, really original physical thinking is over.

*Patterns of Discovery*  
Chapter IV (p. 70)  
At The University Press. Cambridge, England. 1958

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Some physicists would prefer to come back to the idea of an objective real world whose smallest parts exist objectively in the same sense as stones or trees exist

independently of whether we observe them. That, however, is impossible.

*Physics and Philosophy: The Revolution in Modern Science*  
July, 1992  
Harper & Row, Publishers. New York, New York, USA. 1958

The physicist may be satisfied when he has the mathematical scheme and knows how to use it for the interpretation of the experiments. But he has to speak about his results also to non-physicists who will not be satisfied unless some explanation is given in plain language. Even for the physicist the description in plain language will be the criterion of the degree of understanding that has been reached.

*Physics and Philosophy: The Revolution in Modern Science*  
Chapter X (p. 168)  
Harper & Row, Publishers. New York, New York, USA. 1958

**Hoffmann, Banesh** 1906–86  
Mathematician and educator

They could but make the best of it, and went around with woebegone faces sadly complaining that on Mondays, Wednesdays and Fridays they must look on light as a wave; on Tuesdays, Thursdays and Saturdays, as a particle. On Sundays they simply prayed.

*The Strange Story of the Quantum*  
Chapter IV (p. 42)  
Dover Publications, Inc. New York, New York, USA. 1959

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

The physicist is mainly interested in the detailed structure of the threads in our tapestry. He is less interested in the broad pattern on the tapestry itself. The broadest pattern of all, on the scale of stars and galaxies, is the business of the astronomer.

*Ten Faces of the Universe*  
The Astrophysicist’s Universe (p. 55)  
W.H. Freeman & Company. San Francisco, California, USA. 1977

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The physicist who can discard his human spectacles, and can see clearly in the strange new light which then assails his eyes, finds himself living in an unfamiliar world, which even his immediate predecessors would probably fail to recognize.

*The New Background of Science*  
Chapter I (pp. 5–6)  
The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

**Johnson, George** 1952–  
American science writer

Trying to capture the physicists’ precise mathematical description of the quantum world with our crude words

and mental images is like playing Chopin with a boxing glove on one hand and a catcher's mitt on the other.

On Skinning Schrödinger's Cat  
*The New York Times*, Section 4, Sunday, 2 June 1996 (p. 16)

**Joyce, James** 1882–1941

Irish-born author

As a physicist he had learned that of the 70 years of complete human life at least 2/7, viz. 20 years are passed in sleep.

*Ulysses* (p. 704)  
Random House, Inc. New York, New York, USA. 1946

**Krauss, Lawrence M.** 1954–

American theoretical physicist

For the most part, physicists follow the same guidelines that have helped keep Hollywood movie producers rich: If it works, exploit it. If it still works, copy it.

*Fear of Physics: A Guide for the Perplexed*  
Chapter 1 (p. 4)  
Basic Books, Inc. New York, New York, USA. 1993

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

Electronic calculators can solve problems which the man who made them cannot solve; but no government-subsidized commission of engineers and physicists could create a worm...

*The Twelve Seasons*  
March (p. 184)  
W. Sloane Associates. New York, New York, USA. 1949

**Kuhn, Thomas S.** 1922–96

American historian of science

Looking at a contour map, the student sees lines on paper, the cartographer a picture of a terrain. Looking at a bubble-chamber photograph, the student sees confused and broken lines, the physicist a record of familiar sub-nuclear events. Only after a number of such transformations of vision does the student become an inhabitant of the scientist's world.

*The Structure of Scientific Revolutions*  
Chapter X (p. 111)  
The University of Chicago Press. Chicago, Illinois, USA. 1970

**Kusch, Polykarp** 1911–93

German-American physicist

Our early predecessors observed Nature as she displayed herself to them. As knowledge of the world increased, however, it was not sufficient to observe only the most apparent aspects of Nature to discover her more subtle properties; rather, it was necessary to interrogate Nature and often to compel Nature, by various devices, to yield an answer as to her functioning. It is precisely the role of the experimental physicist to arrange devices and

procedures that will compel Nature to make a quantitative statement of her properties and behavior.

*Nobel Lectures, Physics 1942–1962*  
Nobel lecture for award received in 1955  
The Magnetic Moment of the Electron (p. 298)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Ladenburg, Rudolf** 1882–1952

German physicist

There are two kinds of physicists in Berlin: on the one hand was Einstein, and on the other all the rest.

In A.P. French  
*Einstein: A Centenary Volume*  
Chapter 4 (p. 125)  
Harvard University Press. Cambridge, Massachusetts, USA. 1979

**Lederman, Leon** 1922–

American high-energy physicist

Today we have two groups of physicists both with the common aim of understanding the universe but with a large difference in cultural outlook, skills, and work habits. Theorists tend to come in late to work, attend grueling symposiums on Greek islands or Swiss mountaintops, take real vacations, and are at home to take out the garbage much more frequently. They tend to worry about insomnia.... Experimenters don't come in late — they never went home. During an intense period of lab work, the outside world vanishes and the obsession is total. Sleep is when you can curl up on the accelerator floor for an hour.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 1 (p. 14)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Lichtenberg, Georg Christoph** 1742–99

German physicist and satirical writer

The myths of the physicists.

*Lichtenberg: Aphorisms & Letters*  
Aphorisms (p. 57)  
Jonathan Cape. London, England. 1969

**Lindley, David** 1956–

English astrophysicist and author

But by tradition the physicist, having found one level of order in nature, invariably wants to know, like the archaeologist digging down into the remains of Troy, whether there is another, more primitive layer underneath.

*The End of Physics: The Myth of a Unified Theory*  
Part I, Chapter 3 (p. 98)  
Basic Books, Inc. New York, New York, USA. 1993

**Lodge, Sir Oliver** 1851–1940

English physicist

But, notwithstanding any temptation to idolatry, a physicist is bound in the long run to return to his right mind; he must cease to be influenced unduly by superficial

appearances, impracticable measurements, geometrical devices, and weirdly ingenious modes of expression; and remember that his real aim and object is absolute truth, however difficult of attainment that may be, that his function is to discover rather than to create, and that beneath and above and around all Appearances there exists a universe of full-bodied, concrete, absolute, reality.

Geometrisation of Physics, and Its Supposed Bias on the Michelson–Morley Experiment

*Nature*, Volume 106, Number 2677, February 17, 1921 (p. 800)

### Marcus, Adrianne

No biographical data available

Let others lie about the universe,  
make visible worlds. I am the keeper  
of particles, custodian of stray  
atoms.

In Steve Rasic Tem (ed.)

*The Umbral Anthology of Science Fiction Poetry*

The Physicist's Purpose, 1978

Umbral Press. Denver, Colorado, USA. 1982

### Mermin, Norman David

1935–

Mathematician

...contemporary physicists come in two varieties. Type 1 physicists are bothered by EPR [electronparamagnetic resonance] and Bell's theorem. Type 2 (the majority) are not, but one has to distinguish two subvarieties. Type 2a physicists explain why they are not bothered. Their explanations tend either to miss the point entirely (like Born's to Einstein) or to contain physical assertions that can be shown to be false. Type 2b are not bothered and refuse to explain why.

Is the Moon There When Nobody Looks? Reality and the Quantum Theory *Physics Today*, Volume 38, Number 4, April 1985 (p. 41)

### Michelson, Albert Abraham

1852–1931

German-American physicist

If a poet could at the same time be a physicist, he might convey to others the pleasure, the satisfaction, almost the reverence, which the subject inspires. The aesthetic side of the subject is, I confess, by no means the least attractive to me. Especially is its fascination felt in the branch which deals with light...

*Light Waves and Their Uses*

Lecture I (p. 1)

The University of Chicago Press. Chicago, Illinois, USA. 1903

### Nietzsche, Friedrich

1844–1900

German philosopher

We must be physicists in order...to be creative since so far codes of values and ideals have been constructed in ignorance of physics or even in contradiction to physics.

*The Gay Science*

Aphorism 335

Cambridge University Press. Cambridge, England. 2001

### Oppenheimer, J. Robert

1904–67

American theoretical physicist

In some sort of crude sense which no vulgarity, no humor, no overstatement can quite extinguish, the physicists have known sin, and this is a knowledge which they cannot lose.

Expiation

*Time*, Volume 51, Number 8, 23 February 1948 (p. 94)

### Pagels, Heinz R.

1939–88

American physicist and science writer

I once heard a story that physicists when they die go to a heavenly academy where their purpose is to lay down the laws of nature. But there is a rule they must obey: Any new law they make cannot contradict ones already discovered and verified by their colleagues back on earth. The legend says that Pauli, one of the sharpest critics of physics, is there now setting intellectual traps and doing physics tricks to foul our best efforts.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part III, Chapter 1 (p. 339)

Simon & Schuster. New York, New York, USA. 1982

### Petroski, Henry

1942–

Civil engineer

Embedded in a matrix of mistakes  
And slips of sighs, his next equation lies  
About its symmetry. Among the lines  
Of exercise and bold heuristic thrusts  
Of algebra and calculus, it takes  
His magic mirror mind to recognize  
A juxtaposition that unifies  
His theory of another universe.  
Extracting the law from the accidents,  
He calls it Theorem and proceeds to prove  
It logically follows from stronger laws.  
He makes some definitions and extends  
The theorem more and more and marvels at the rules  
His universe follows, effect from cause.

The Mathematical Physicist

*Southern Humanities Review*, Volume 8, Number 2, 1972 (p. 184)

### Poincaré, Henri

1854–1912

French mathematician and theoretical astronomer

Nothing but facts are of importance. John Lackland passed by here. Here is something that is admirable. Here is a reality for which I would give all the theories in the world." That is the language of the historian. The physicist would say rather: "John Lackland passed by here; that makes no difference to me, for he never will pass this way again."

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 128)

The Science Press. New York, New York, USA. 1913



**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

I think physicists are the Peter Pans of the human race. They never grow up, and they keep their curiosity.

In Jeremy Bernstein  
*Experiencing Science*

Part 1. Two Faces of Physics. Chapter 2. Rabi: The Modern Age (p. 102)  
Basic Books, Inc. New York, New York, USA. 1978

**Rees, Martin John** 1942–  
15<sup>th</sup> Astronomer Royal of England

The physicist is like someone who's watching people playing chess and, after watching a few games, he may have worked out what the moves in the game are. But understanding the rules is just a trivial preliminary on the long route from being a novice to being a grand master. So even if we understand all the laws of physics, then exploring their consequences in the everyday world where complex structures can exist is a far more daunting task, and that's an inexhaustible one I'm sure.

In Lewis Wolpert and Alison Richards

*A Passion for Science*

Chapter 3 (p. 37)

Oxford University Press, Inc. Oxford, England. 1988

**Robinson, Howard A.**

No biographical data available

Because physicists are a small group, they often suffer in many ways from psychoses similar to those found in political minorities. In an effort to keep their own individuality they feel it necessary to resist pressure from the outside and the result is...that a group of physicists tend to behave like an amoebae.

The Challenge of Industrial Physics

*Physics Today*, June 1948 (p. 7)

**Rogers, Eric**

No biographical data available

The physicist who does not enjoy watching a dime and a quarter drop together has no heart.

*Astronomy for the Inquiring Mind*

Preliminary Introduction (p. 4)

Princeton University Press. Princeton, New Jersey, USA. 1982

**Rorty, Richard** 1931–  
American philosopher

Here is one way to look at physics: the physicists are men looking for new interpretations of the Book of Nature. After each pedestrian period of normal science, they dream up a new model, a new picture, a new vocabulary, and then they announce that the true meaning of the Book has been discovered. But, of course, it never is, any more than the true meaning of Coriolanus or the Dunciad or the Phenomenology of the Spirit or the Philosophical Investigations. What makes them physicists is that

their writings are commentaries on the writings of earlier interpreters of Nature, not that they all are somehow "talking about the same thing"...

Philosophy as a Kind of Writing

*New Literary History*, Volume 10, Number 1, Autumn 1978 (p. 141)

**Ruelle, David** 1935–  
Belgian-French mathematical physicist

What is the origin of the urge, the fascination that drives physicists, mathematicians, and presumably other scientists as well? Psychoanalysis suggests that it is sexual curiosity. You start by asking where little babies come from, one thing leads to another, and you find yourself preparing nitroglycerine or solving differential equations. This explanation is somewhat irritating, and therefore probably basically correct.

*Chance and Chaos*

Chapter 26 (p. 164)

Princeton University Press. Princeton, New Jersey, USA. 1991

**Russell, Henry Norris** 1877–1957  
American astronomer

If a first-rate physicist, well versed in all the knowledge acquired in the laboratory during the last quarter century on the structure and properties of the atom, should have lived his life on a planet so enshrouded by clouds that neither he nor others had ever glimpsed the starry heavens, yet if he had the imagination to conceive that immense quantities of matter might lie beyond the clouds, he would be able to picture the heavens much as they are, tell the probable maximum masses of the stars, their minimum distances, the range of their diameters and temperatures, the differences of their spectra, and in short to duplicate by prediction, not only in general features but in many of the finest details the actual appearance of the universe forever hidden from him.

Quoted in C.G. Abbot

*Annual Report of the Board of Regents of the Smithsonian Institution, 1922*

The Architecture of Atoms and a Universe Built of Atoms (p. 157)

Government Printing Office. Washington, D.C. 1924

**Sagan, Carl** 1934–96  
American astronomer and author

Physicists had to invent words and phrases for concepts far removed from everyday experience. It was their fashion to avoid pure neologisms and instead to evoke, even if feebly, some analogous commonplace. The alternative was to name discoveries and equations after one another. This they did also. But if you didn't know it was physics they were talking, you might very well worry about them.

*Contact: A Novel*

Chapter 19 (p. 331)

Simon & Schuster. New York, New York, USA. 1985

**Singer, Kurt** 1886–1962  
German philosopher

...the true mathematician and physicist know very well that the realms of the small and the great often obey quite different rules.

*Mirror, Sword and Jewel: A Study of Japanese Characteristics*  
Chapter 5 (p. 75)  
Croom Helm. London, England. 1973

**Standen, Anthony**  
Anglo-American science writer

Physicists, being in no way different from the rest of the population, have short memories for what is inconvenient.

*Science Is a Sacred Cow*  
Chapter III (p. 68)  
Dutton. New York, New York, USA. 1950

**Strutt, John William (Lord Rayleigh)** 1842–1919  
English physicist

The different habits of mind of the two schools of physicists sometimes lead them to the adoption of antagonistic views on doubtful and difficult questions. The tendency of the purely experimental school is to rely almost exclusively upon direct evidence, even when it is obviously imperfect, and to disregard arguments which they stigmatize as theoretical. The tendency of the mathematician is to over-rate the solidity of his theoretical structures, and to forget the narrowness of the experimental foundation upon which many of them rest.

*Life of John William Strutt: Third Baron Rayleigh* (p. 132)  
University of Wisconsin Press. Madison, Wisconsin, USA. 1968

**Thomson, Sir Joseph John** 1856–1940  
English physicist

There is a school of mathematical physicists which objects to the introduction of ideas which do not relate to things which can actually be observed and measured.... I hold that if the introduction of a quantity promotes clearness of thought, then even if at the moment we have no means of determining it with precision, its introduction is not only legitimate but desirable. The immeasurable of today may be the measurable of tomorrow.

In John D. Barrow  
*The World Within the World* (p. 97)  
Clarendon Press. Oxford, England. 1988

**Toulmin, Stephen** 1922–  
Anglo-American philosopher

Natural historians...look for regularities of given forms, but physicists seek the form of given regularities.

*The Philosophy of Science: An Introduction*  
Chapter II, Section 2.8 (p. 53)  
Harper & Row, Publishers. New York, New York, USA. 1960

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

...cement, patch-up, and glue together, as witchdoctors do, the Newtonian doctrine, so that it could, as an embalmed corpse, preside in the style of ancient Egyptians, at the drinking bouts of physicists.

In S.L. Jaki  
*Goethe and the Physicists*  
American Journal of Physics, Volume 37 (p. 198)

**Wald, George** 1906–97  
American biologist and biochemist

It would be a poor thing to be an atom in a universe without physicists, and physicists are made of atoms. A physicist is an atom's way of knowing about atoms.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*  
Foreword  
Beacon Press. Boston, Massachusetts, USA. 1958

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

There are three kinds of physicists, as we know, namely the machine builders, the experimental physicists, and the theoretical physicists. If we compare those three classes, we find that the machine builders are the most important ones, because if they were not there, we could not get to this small-scale region. If we compare this with the discovery of America, then, I would say, the machine builders correspond to the captains and ship builders who really developed the techniques at that time. The experimentalists were those fellows on the ships that sailed to the other side of the world and then jumped upon the new islands and just wrote down what they saw. The theoretical physicists are those fellows who stayed back in Madrid and told Columbus that he was going to land in India.

In Heinz R. Pagels  
*The Cosmic Code: Quantum Physics as the Language of Nature*  
Part II, Chapter 1 (p. 198)  
Simon & Schuster. New York, New York, USA. 1982

Self-confidence is an important ingredient that makes for a successful physicist.

In L.M. Brown and L. Hoddeson  
*The Birth of Particle Physics*  
Growing Up with Field Theory: The Development of Quantum Electrodynamics (p. 75)  
Cambridge University Press. Cambridge, England. 1983

**Wheeler, John Archibald** 1911–  
American physicist and educator

The physicist does not have the habit of giving up something unless he gets something better in return.

In Cecil M. DeWitt and John A. Wheeler  
*Battelle Recontres: 1967 Lectures in Mathematics and Physics* (p. 261)  
W.A. Benjamin, Inc. New York, New York, USA. 1968

**White, Stephen**

No biographical data available

[Physicists] are, as a general rule, highbrows. They think and talk in long, Latin words, and when they write anything down they usually include at least one partial differential and three Greek letters.

A Newsmen Looks at Physicists

*Physics Today*, Volume 1, Number 1, May 1948 (p. 15)

**Wiener, Norbert** 1894–1964

American mathematician

Experience has pretty well convinced the working physicist that any idea of nature which is not only difficult to interpret but which actively resists interpretation has not been justified as far as his past work is concerned, and therefore, to be an effective scientist, he must be naive, and even deliberately naive, in making the assumption that he is dealing with an honest God, and must ask his questions of the world as an honest man.

*The Human Use of Human Beings*

Chapter XI (p. 189)

Da Capo Press. New York, New York, USA. 1988

**Zolynas, Al** 1945–

American poet

And so, the closer he looks at things, the farther away they seem. At dinner, after a hard day at the universe, he finds himself slipping through his food. His own hands wave at him from beyond a mountain of peas. Stars and planets dance with molecules on his fingertips. After a hard day with the universe, he tumbles through himself, flies through the dream galaxies of his own heart. In the very presence of his family he feels he is descending through an infinite series of Chinese boxes.

*The New Physics: Poems*

The New Physics (p. 55)

Wesleyan University Press. Middletown, Connecticut, USA. 1979

**PHYSICS****Achard, Franz Karl** 1753–1821

German chemist and experimental physicist

Everyone now agrees that a physics lacking all connection with mathematics...would only be an historical amusement, fitter for entertaining the idle than for occupying the mind of a philosopher.

In J.L. Heilbron

*Electricity in the 17<sup>th</sup> and 18<sup>th</sup> Centuries: A Study of Early Modern Physics* (p. 74)

University of California Press. Berkeley, California, USA. 1979

**Alvarez, Luis Walter** 1911–88

American experimental physicist

There is no democracy in physics. We can't say that some second rate guy has as much right to opinion as Fermi.

In Daniel S. Greenberg

*The Politics of Pure Science*

Book One, Chapter II (p. 42)

New American Library. New York, New York, USA. 1967

**Author undetermined**

The Euclidean foundation of geometry is to the Gaussian foundation of geometry as the Newton particle concept of physics is to the Faraday–Maxwell concept of physics.

In Howard W. Eves

*Mathematical Circles* (Volume 2)

Mathematical Circles Squared

73 (p. 56)

The Mathematical Association of America, Inc. 2003

If you think, you experience time.

If you feel, you experience energy.

If you intuit, you experience wavelength

If you sense, you experience space.

In Fred Alan Wolf

*Star Wave: Mind Consciousness of Quantum Physics* (p. 16)

Macmillan Publishing Company. New York, New York, USA. 1984

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

We have no sound notions either in logic or physics; substance, quality, action, passion, and existence are not clear notions; much less weight, levity, density, tenuity, moisture, dryness, generation, corruption, attraction, repulsion, element, matter, form, and the like. They are all fantastical and ill-defined.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 15 (p. 108)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Physic...is situate in a middle term or distance between natural history and metaphysic. For natural history describeth the variety of things; physic the causes, but variable or respective causes; and metaphysic the fixed and constant causes.

In *Great Books of the Western World* (Volume 30)

*Advancement of Learning*

Second Book, Chapter VII, Section 4 (p. 43)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ball, Walter William Rouse** 1850–1925

English mathematician

The advance in our knowledge of physics is largely due to the application to it of mathematics, and every year it becomes more difficult for an experimenter to make any mark in the subject unless he is also a mathematician.

*A Short Account of the History of Mathematics* (p. 503)

Macmillan & Company Ltd. London, England. 1908

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Daniel Bernoulli has been called the father of mathematical physics.

In James R. Newman (ed.)  
*The World of Mathematics* (Volume 2)  
Kinetic Theory of Gases (p. 774)  
Simon & Schuster. New York, New York, USA. 1956

**Bergson, Henri** 1859–1941  
French philosopher

...physics is but logic spoiled.

Translated by Arthur Mitchell  
*Creative Evolution*  
Chapter IV (p. 320)  
The Modern Library. New York, New York, USA. 1944

**Berry, M. V.**  
No biographical data available

...in one of those unexpected connections that make theoretical physics so delightful, the quantum chorology of spectra turns out to be deeply connected to the arithmetic of prime numbers, through the celebrated zeros of the Riemann zeta function: the zeros mimic quantum energy levels of a classically chaotic system. The connection is not only deep but also tantalizing, since its basis is still obscure — though it has been fruitful for both mathematics and physics.

In R.J. Russell, P. Clayton, K. Wegter-McNelly and J. Polkinghorne (eds.)  
*Quantum Mechanics: Scientific Perspectives on Divine Action*  
Chaos and the Semiclassical Limit of Quantum Mechanics (Is the Moon There When Somebody Looks?)  
University of Notre Dame Press. Notre Dame, Indiana, USA. 2002

**Birkhoff, George David** 1884–1944  
American mathematician

It will probably be the new mathematical discoveries suggested through physics that will always be the most important, for from the beginning Nature has led the way and established the pattern which mathematics, the language of Nature, must follow.

The Mathematical Nature of Physical Theories  
*American Scientist*, Volume 31, Number 4, October 1943 (p. 310)

**Blackett, Lord Patrick Maynard Stuart** 1897–1974  
English physicist

Thus was born the vast modern subject of nuclear physics, which now gives such fertile research problems to so many of the world's physicists and, incidentally, such headaches to so many of the world's statesmen.

In J.B. Birks  
*Rutherford at Manchester*  
Memories of Rutherford (p. 104)  
W.A. Benjamin. New York, New York, USA. 1962

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

My starting point was rather the stability of matter, a pure miracle when considered from the standpoint of classical physics. By “stability” I mean that the same substances always have the same properties...

In Werner Heisenberg  
*Physics and Beyond: Encounters and Conversations*  
Chapter 3 (p. 39)  
Harper & Row, Publishers. New York, New York, USA. 1971

It is wrong to think that the task of physics is to find out how nature is. Physics concerns what we can say about nature.

In N. Herbert  
*Quantum Reality: Beyond the New Physics*  
Chapter 3 (p. 45)  
Anchor Press/Doubleday. Garden City, New York, USA. 1985

In physics...our problem consists in the co-ordination of our experience of the external world...

*Atomic Theory and the Description of Nature*  
Introductory Survey (p. 1)  
Cambridge University Press. Cambridge, England. 1934

...the new situation in physics is that we are both onlookers and actors in the great drama of existence.

*Atomic Theory and the Description of Nature*  
Chapter IV (p. 119)  
Cambridge University Press. Cambridge, England. 1934

**Born, Max** 1882–1970  
German-born English physicist

The problem of physics is how the actual phenomena, as observed with the help of our sense organs aided by instruments, can be reduced to simple notions which are suited for precise measurement and used of the formulation of quantitative laws.

*Experiment and Theory in Physics* (pp. 8–9)  
Cambridge University Press. Cambridge, England. 1944

Hope is a word one is unlikely to find in the literature of physics.

*My Life and My Views*  
Chapter Six (p. 190)  
Charles Scribner's Sons. New York, New York, USA. 1968

It is natural that a man should consider the work of his hands or his brain to be useful and important. Therefore nobody will object to an ardent experimentalist boasting of his measurements and rather looking down on the “paper and ink” physics of his theoretical friend, who on his part is proud of his lofty ideas and despises the dirty fingers of the other.

*Experiment and Theory in Physics* (p. 1)  
Cambridge University Press. Cambridge, England. 1944

**Boyle, Robert** 1627–91  
English natural philosopher and theological writer

I confess, that after I began...to discern how useful mathematicks may be made to physicks, I have often wished that I had employed the speculative part of geometry, and the cultivation of the specious Algebra I had been taught very young, a good part of that time and industry, that I had spent about surveying and fortification (of which I remember I once wrote an entire treatise) and other parts of practick mathematicks.

*The Work of the Honourable Robert Boyles* (Volume 4)

The Usefulness of Mathematicks to Natural Philosophy, Volume 3 (p. 426)  
Printed for A. Millar. Ondon, England. 1744

**Bragg, Sir William Henry** 1862–1942  
English physicist

On Mondays, Wednesdays, and Fridays we teach the wave theory and on Tuesdays, Thursdays, and Saturdays the corpuscular theory.

Electrons and Ether Waves, 23<sup>rd</sup> Robert Boyle Lecture  
*Scientific Monthly*, Volume 4, Issue 2, 1922 (p. 11)

**Brennan, Richard P.**  
Science writer

Physics can be expected to continue because it is, by its nature, open-ended and exploratory and because, at its heart, science is simply people asking questions.

*Heisenberg Probably Slept Here*

Epilogue (p. 249)

John Wiley & Sons, Inc. New York, New York, USA. 1997

**Bronowski, Jacob** 1908–74  
Polish-born English mathematician and polymath

Physics becomes in those years the greatest collective work of art of the twentieth century.

*The Ascent of Man*

Chapter 10 (p. 328)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

One aim of the physical sciences has been to give an exact picture of the material world. One achievement of physics in the twentieth century has been to prove that that aim is unattainable.

*The Ascent of Man*

Chapter 11 (p. 353)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Burbridge, Geoffrey**  
American astronomer

We live in an era when it seems legitimate to try everything conceivable within the known laws of physics, particularly in the absence of data.

Focal Point

*Sky and Telescope*, Volume 78, Number 6, June 1990 (p. 580)

**Carnap, Rudolf** 1891–1970  
American philosopher

Physics originally began as a descriptive macrophysics, containing an enormous number of empirical laws with

no apparent connections. In the beginning of a science, scientists may be very proud to have discovered hundreds of laws. But, as the laws proliferate, they become unhappy with this state of affairs; they begin to search for underlying principles.

*An Introduction to the Philosophy of Science*. (p. 244)

Clarendon Press. Oxford, England. 1988

...the facts and objects of the various branches of Science are fundamentally the same kind. For all branches are part of the unified Science, of Physics.

*The Unity of Science*

Unified Science in Physical Language, Section 7 (p. 101)

Thommes Press. Bristol, England. 1995

**Cartwright, Nancy** 1943–  
Philosopher of physics

...the fundamental laws of physics do not describe true facts about reality. Rendered as descriptions of facts, they are false; amended to be true, they lose their explanatory force.

*How the Laws of Physics Lie*

Essay 3 (p. 54)

Clarendon Press. Oxford, England. 1983

Although philosophers generally believe in laws and deny causes, explanatory practice in physics is just the reverse.

*How the Laws of Physics Lie*

Essay 4 (p. 86)

Clarendon Press. Oxford, England. 1983

## CERN Courier

The main goal of physics is to describe a maximum of phenomena with a minimum of variables.

In John N Shive and Robert L. Weber

In *Similarities in Physics*

Chapter 16 (p. 213)

John Wiley & Sons, Inc. New York, New York, USA. 1982

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

In the last fifty years physics has exerted a more powerful beneficial influence on the intellectual, economic and social life of the world than has been exerted in a comparable time by any other agency in history. Its influence has far exceeded that of wars, political alignment or social theories.

*Science (supplement)*, Volume 84, Number 10, 1936

**Comte, Auguste** 1798–1857  
French philosopher

The domain of physics is no proper field for mathematical pastimes. The best security would be in giving a geometrical training to physicists, who need not then

have recourse to mathematicians, whose tendency is to despise experimental science.

*The Positive Philosophy of Auguste Comte*  
Book III, Chapter I (p. 220)  
John Chapman. London, England. 1853

...the education of physicists must be more complicated than that of astronomers.

*The Positive Philosophy of Auguste Comte*  
Book III, Chapter I (p. 222)  
John Chapman. London, England. 1853

**Condon, Edward Uhler** 1902–74

American physicist

I take it to be the object of physics so to organize past experience and so to direct the acquisition of new experience that ultimately it will be possible to predict the outcome of any proposed experiment which is capable of being carried out — and to make the prediction in less time than it would have taken actually to carry out the proposed experiment. When this shall have been done I will say that man has a complete understanding of his physical environment. Others may ask more; with this I am satisfied.

The Philosophical Concepts of Modern Physics, Mathematical Models in Modern Physics  
*Journal of the Franklin Institute*, Volume 225, Number 3, March 1938 (p. 257)

“All is fair in love and war” and, I might add, in theoretical physics.

*Selected Popular Writings of E.U. Condon*  
Mathematical Models in Modern Physics (p. 96)  
Springer-Verlag. New York, New York, USA. 1991

**Crease, Robert P.**

Science historian

**Mann, Charles C.**

American journalist and science writer

On August 2, 1932, Anderson obtained a stunningly clear photograph that shocked both men. Despite Millikan’s protestations, a particle had indeed shot up like a Roman candle from the floor of the chamber, slipped through the plate, and fallen off to the left. From the size of the track, the degree of the curvature, and the amount of momentum lost, the particle’s mass was obviously near to that of an electron. But the track curved the wrong way. The particle was positive. Neither electron, proton, or neutron, the track came from something that had never been discovered before. It was, in fact, a “hole,” although Anderson did not realize it for a while.... Anderson called the new particle a “positive electron”; positron was the name that stuck. Positrons were the new type of matter — antimatter — Dirac had been forced to predict by his theory. (The equation, he said later, had been smarter than he was.)

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*  
Uncertainty and Complementarity (p. 78)  
Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Cropper, William N.**

No biographical data available

Physics builds from observations. No physical theory can succeed if it is not confirmed by observations, and a theory strongly supported by observations cannot be denied.

*Great Physicists*  
I, Mechanics (p. 3)  
Oxford University Press, Inc. New York, New York, USA. 2001

**Darrow, Karl Kelchner** 1891–1982

American physicist

...it does not take an idea so long to become “classical” in physics as it does in the arts.

*Bell System Technical Journal*  
Some Contemporary Advances in Physics V, Electrical Solids, Volume 3, 1924 (p. 621)

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Physics is the most pretentious of all the sciences, for it purports to address all of physical reality. The physicist may confess ignorance about a particular system — a snowflake, a living organism, a weather pattern — but he will never concede that it lies outside the domain of physics in principle. The physicist believes that the laws of physics, plus knowledge of the relevant boundary conditions, are sufficient to explain, in principle, every phenomenon in the universe. Thus the entire universe, from the smallest fragment of matter to the largest assemblage of galaxies, becomes the physicist’s domain — vast natural laboratory for the interplay of lawful forces.

In P.C.W. Davies (ed.)  
*The New Physics*  
The New Physics: A Synthesis (p. 1)  
Cambridge University Press. Cambridge, England. 1989

It is clear that for nature to produce a cosmos even remotely resembling our own, many apparently unconnected branches of physics have to cooperate to a remarkable degree.

*The Accidental Universe* (p. 111)  
Cambridge University Press. Cambridge, England. 1984

It is no exaggeration to say that quantum mechanics had dominated twentieth-century physics and is far and away the most successful scientific theory in existence. It is indispensable for understanding subatomic particles, atoms and nuclei, molecules and chemical bonding, the structure of solids, superconductors and superfluids, the electrical and thermal conductivity of metals and semiconductors, the structure of stars, and much else. It

has practical applications ranging from the laser to the microchip. All this from a theory that at first sight — and second sight — looks absolutely crazy! Neils Bohr, one of the founders of quantum mechanics, once remarked that anybody who is not shocked by the theory hasn't understood it.

In Richard P. Feynman

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

Introduction (p. xv, xvi)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA. 1995

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

**Brown, Julian R.**

No biographical data available

No science is more pretentious than physics, for the physicist lays claim to the whole universe as his subject matter.

*Superstrings: A Theory of Everything*

Introduction (p. 1)

Cambridge University Press, Cambridge, England. 1988

**de Morgan, Augustus** 1806–71

English mathematician and logician

Among the mere talkers, so far as mathematics are concerned, are to be ranked three out of four of those who apply mathematics to physics, who, wanting a tool only, are very impatient of everything which is not of direct aid to the actual methods which are in their hands.

In Robert Graves

*Life of Sir William Rowan Hamilton* (Volume 3) (p. 348)

Hodges, Figgis & Company, Dublin, Ireland. 1882–89

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

I accept no principles of physics which are not also accepted in mathematics...

*Principles of Philosophy*

Part III, 4

Reidel, Dordrecht, Netherlands. 1983

I should consider that I know nothing about physics if I were able to explain only how things might be, and were unable to demonstrate that they could not be otherwise. For, having reduced physics to mathematics, the demonstration is now possible, and I think that I can do it within the small compass of my knowledge.

In A. C. Crombie

Descartes

*Scientific American*, Volume 201, Number 4, October 1959 (p. 160)

**Deutsch, David** 1953

Physicist

Anything that seems incomprehensible is regarded by science merely as evidence that there is something we have not yet understood, be it a conjuring trick, advanced technology or a new law of physics.

*The Fabric of Reality*

Chapter 6 (p. 138)

Penguin Books Ltd, London, England. 1998

**Dilorenzo, Kirk**

No biographical data available

Physics is the interrelationship of everything.

*The Physics Teacher*, Volume 14, Number 5, May 1976 (p. 315)

**Dirac, Paul Adrian Maurice** 1902–84

English theoretical physicist

Only questions about the results of experiments have a real significance and it is only such questions that theoretical physics has to consider.

*The Principles of Quantum Mechanics* (2<sup>nd</sup> edition)

Chapter I, Section 2 (p. 5)

At The Clarendon Press, Oxford, England. 1935

The present stage of physical theory is merely a steppingstone towards the better stages that we will have in the future. One can be quite sure that there will be better stages simply because of the difficulties that occur in the physics of today.

The Evolution of the Physicist's Picture of Nature

*Scientific American*, Volume 208, Number 5, May 1963 (p. 48)

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

The development of physics incites a continual struggle between “nature that does not tire of providing” and reason that does not wish “to tire of conceiving.”

*The Aim and Structure of Physical Theory*

Part I, Chapter II (p. 23)

Princeton University Press, Princeton, New Jersey, USA. 1954

Physics is not a machine one can take apart; one cannot try each piece in isolation and wait, to adjust it, until its solidity has been minutely checked. Physical science is a system that must be taken as a whole. It is an organism no part of which can be made to function without the remotest parts coming into play, some more, some less, but all in some degree.

*Essays in the History and Philosophy of Science* (p. 284)

Hackett Publishing Company, Indianapolis, Indiana, USA. 1996

...physics makes progress because experiment constantly causes new disagreements to break out between laws and facts, and because physicists constantly touch up and modify laws in order that they may more faithfully represent the facts.

*The Aim and Structure of Physical Theory*

Part II, Chapter V (p. 177)

Princeton University Press, Princeton, New Jersey, USA. 1954

A “Crucial Experiment” is Impossible in Physics.

*The Aim and Structure of Physical Theory*  
Part II, Chapter VI (p. 188)  
Princeton University Press. Princeton, New Jersey, USA. 1954

**Dyson, Freeman J.** 1923–  
American physicist and educator

Physics is littered with the corpses of dead unified field theories.

In John D. Barrow  
*The World Within the World* (p. 184)  
Clarendon Press. Oxford, England. 1988

I am acutely aware of the fact that the marriage between mathematics and physics, which was so enormously fruitful in past centuries, has recently ended in divorce.

Missed Opportunities  
*Bulletin of the American Mathematical Society*, Volume 78, 1972

...we have seen particle physics emerge as the playground of group theory.

In Joseph A. Gallian  
*Contemporary Abstract Algebra*  
Chapter 3 (p. 55)  
D.C. Heath and Company. Lexington, Massachusetts, USA. 1994

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The external world of physics has become a world of shadows.

*The Nature of the Physical World*  
Introduction (p. xvi)  
The Macmillan Company. New York, New York, USA. 1930

Distance and duration are the most fundamental terms in physics; velocity, acceleration, force, energy, and so on, all depend on them; and we can scarcely make any statement in physics without direct or indirect reference to them.

In Ronald W. Clark  
*Einstein: The Life and Times*  
Part Two, Chapter 4 (p. 93)  
The World Publishing Company. New York, New York, USA. 1971

I have not suggested that religion and free will can be deduced from modern physics...

*New Pathways in Science*  
Chapter XIII, Section VI (p. 306)  
The Macmillan Company. New York, New York, USA. 1935

I am afraid the knockabout comedy of modern atomic physics is not very tender towards our aesthetic ideals. The stately drama of stellar evolution turns out to be more like the hair-breadth escapades in the films. The music of the spheres has a painful suggestion of — jazz.

*Stars and Atoms*  
Lecture I (p. 27)  
Yale University Press. London, England. 1927

In the world of physics we watch a shadowgraph performance of familiar life. The shadow of my elbow rests on the shadow table as the shadow ink flows over the

shadow paper... The frank realisation that physical science is concerned with a world of shadows is one of the most significant of recent advances.

*The Nature of the Physical World*  
Introduction (p. xi)  
The Macmillan Company. New York, New York, USA. 1930

It is impossible to trap modern physics into predicting anything with perfect determinism because it deals with probabilities from the outset.

In James R. Newman (ed.)  
*The World of Mathematics* (Volume 2)  
Causality and Wave Mechanics (p. 1056)  
Simon & Schuster. New York, New York, USA. 1956

**Edelstein, Ludwig** 1902–65  
German scholar and historian of medicine

Physics...in antiquity remained closely connected with philosophy, and was predominantly concerned with the philosophical category of the “why,” rather than the scientific category of the “how.”

In Philip P. Wiener and Aaron Noland  
*Roots of Scientific Thought*  
Recent Trends in the Interpretation of Ancient Science (pp. 94–95)  
Basic Books, Inc. New York, New York, USA. 1957

**Ehrenfest, Paul** 1880–1933  
Austrian physicist

Physics is simple, but subtle.

In Victor F. Weisskopf  
*Physics in the Twentieth Century: Selected Essays*  
My Life as a Physicist (p. 3)  
The MIT Press. Cambridge, Massachusetts, USA. 1972

**Einstein, Albert** 1879–1955  
German-born physicist

Today we know that no approach which is founded on classical mechanics and electrodynamics can yield a useful radiation formula.

In B.L. van der Waerden  
*Sources of Quantum Mechanics*  
*On the Quantum Theory of Radiation* (p. 63)  
Dover Publications. New York, New York, USA. 1968

What would physics look like without gravitation?

In Jean-Pierre Luminet  
*Black Holes* (p. 114)  
Cambridge University Press. New York, New York, USA. 1992

Physics constitutes a logical system of thought which is in a state of evolution, whose basis cannot be distilled, as it were, from experience by an inductive method, but can only be arrived at by free invention.

*Out of My Later Years*  
Physics and Reality, Summary  
Thames & Hudson. London, England. 1950

Physics is the attempt at the conceptual construction of a model of the real world and its lawful structure.

In Gerald Holton



*Thematic Origins of Scientific Thought: Kepler to Einstein*  
 Letter of November 28, 1930 to M. Schlick (p. 243)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1973

Physics too deals with mathematical concepts; however, these concepts attain physical content only by the clear determination of their relation to the objects of experience.

*Out of My Later Years*  
 The Theory of Relativity (p. 41)  
 Thames & Hudson. London, England. 1950

That this insecure and contradictory foundation was sufficient to enable a man of Bohr's unique instinct and sensitivity to discover the principal laws of the spectral lines and of the electron shell of the atoms, together with their significance for chemistry appeared to me as a miracle — and appears to me a miracle even today.

Translated by Paul Arthur Schlipp  
*Albert Einstein: Autobiographical Notes* (p. 43)  
 Open Court. La Salle, Illinois, USA. 1979

Reality is the real business of physics.

In Nick Herbert  
*Quantum Reality: Beyond the New Physics*  
 Chapter 1 (p. 4)  
 Anchor Press. Garden City, New York, USA. 1985

Experience, of course, remains the sole criterion for the serviceability of mathematical constructions for physics, but the truly creative principle resides in mathematics.

In Philipp Frank  
*Modern Science and Its Philosophy*  
 Chapter 16 (p. 297)  
 Harvard University Press, Cambridge, England. 1952

But in physics I soon learned to scent out the paths that led to the depths, and to disregard everything else, all the many things that clutter up the mind, and divert it from the essential. The hitch in this was, of course, the fact that one had to cram all this stuff into one's mind for the examination, whether one liked it or not.

In Robert H. March  
*Physics for Poets*  
 Chapter 9 (p. 101)  
 McGraw-Hill Book Company, Inc. New York, New York, USA. 1996

I still lose my temper dutifully about physics. But I no longer flap my wings — I only ruffle my feathers. The majority of fools remain invincible.

In Sachi Sri Kantha  
*An Einstein Dictionary* (p. 96)  
 Greenwood Press, Publishers. Westport, Connecticut, USA. 1996

I have become an evil renegade who does not wish physics to be used on probabilities.

In Sachi Sri Kantha  
*An Einstein Dictionary* (p. 96)  
 Greenwood Press, Publishers. Westport, Connecticut, USA. 1996

In speaking here of "comprehensibility," the expression is used in its most modest sense. It implies: the production

of some sort of order among sense impressions, this order being produced by the creation of general concepts, relations between these concepts and sense experience. It is in this sense that the world of our sense experiences is comprehensible. The fact that it is comprehensible is a miracle.

*Out of My Later Years*  
 Physics and Reality, Section 1  
 Thames & Hudson. London, England. 1950

In the matter of physics, the first lesson should contain nothing but what is experimental and interesting to see. A pretty experiment is in itself often more valuable than twenty formulae extracted from our minds; it is particularly important that a young mind that has yet to find its way about in the world of phenomena should be spared from formulae altogether. In [this mind] physics they play exactly the same weird and fearful part as the figures of dates in Universal History.

In A.P. French  
*Einstein: A Centenary Volume*  
 Chapter 11 (p. 220)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1979

If the basis of theoretical physics cannot be an inference from experience, but must be free invention, have we any right to hope that we shall find the correct way? Still more — does this correct approach exist at all, save in our imagination? To this I answer with complete assurance, that in my opinion there is the correct path; moreover, that it is in our power to find it.

In Philipp Frank  
 Einstein's Philosophy of Science  
*Review of Modern Physics*, Volume 21, Number 3, July 1949 (p. 354)

...the development of physics has shown that at any given moment, out of all conceivable constructions, a single one has always proved itself decidedly superior to all the rest. Nobody who has really gone deeply into the matter will deny that in practice the world of phenomena uniquely determines the theoretical system, in spite of the fact that there is no logical bridge between phenomena and their theoretical principles; this is what Leibnitz described so happily as a "pre-established harmony."

*Ideas and Opinions*  
 Principles of Research (p. 224)  
 Crown Publishers, Inc. New York, New York, USA. 1954

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

The axioms of physics translate the laws of ethics.

*Ralph Waldo Emerson: Essays and Lectures*  
 Nature: Addresses, and Lectures  
 Language (p. 24)  
 The Library of America. New York, New York, USA. 1983

On the platform of physics we cannot resist the contracting influences of so-called science.

*The Complete Works of Ralph Waldo Emerson* (Volume 33)

Essays: Second Series  
Chapter II (p. 52)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

How calmly and genially the mind apprehends one after another the laws of Physics!

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Discipline (p. 27)

The Library of America. New York, New York, USA. 1983

## Faust

Fictional character

I have — alas — learned Valence Chemistry,  
Theory of Groups, of the Electric Field,  
And Transformation Theory as revealed  
By Sophus Lie in eighteen-ninety-three.

Yet here I stand, for all my lore,

No wiser than I was before.

*BLEGDAMSVEJ FAUST*

Part First, Copenhagen Spring Conference, 1932

## Ferguson, Arthlyn

No biographical data available

Bouncing a ball, flying a kite, blowing up a balloon — to a child it's play; to a scientist it's physics.

What's Physics?

*The Physics Teacher*, Volume 14, Number 5, May 1976 (p. 315)

## Feynman, Richard P. 1918–88

American theoretical physicist

What do we mean by “understanding something?” We can imagine that this complicated array of moving things which constitutes “the world” is something like a great chess game being played by the gods, and we are observers of the game. We do not know what the rules of the game are: all we are allowed to do is to watch the playing. Of course, if we watch long enough we may eventually catch on to a few of the rules. The rules of the game are what we mean by fundamental physics. Even if we knew every rule, however, we might not be able to understand why a particular move is made in the game, merely because it is too complicated...

In P.C.W. Davies and J. Brown

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2–1 (p. 2–1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

The fact that I beat a drum has nothing to do with the fact that I do theoretical physics. Theoretical physics is a human endeavor, one of the higher developments of human beings — and this perpetual desire to prove that people who do it are human by showing that they do other things that a few other humans do (like playing bongo drums) is insulting to me. I'm human enough to tell you to go to hell.

In James Gleick

*Genius: The Life and Science of Richard Feynman*

Caltec (p. 364)

Pantheon Books. New York, New York, USA. 1992

The electron does anything it likes. It goes in any direction at any speed, forward or backward in time, however it likes...

In James Gleick

*Genius: The Life and Science of Richard Feynman*

Cornell (p. 250)

Pantheon Books. New York, New York, USA. 1992

Physics is to mathematics what sex is to masturbation.

In Lawrence M. Krauss

*Fear of Physics: A Guide for the Perplexed*

Chapter 2 (p. 27)

Basic Books, Inc. New York, New York, USA. 1993

In order for physics to be useful to other sciences in a theoretical way, other than in the invention of instruments, the science in question must supply to the physicist a description of the object in a physicist's language.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

The Relation of Physics to Other Sciences (p. 64)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

...the behavior of things on a small scale is so fantastic, so wonderfully and marvelously different than anything on a large scale! You can say, “Electrons behave like waves” — no, they don't, exactly; “they act like particles” — no, they don't exactly; “they act like a kind of fog around the nucleus” — no, they don't, exactly. Well, if you would like to get a clear, sharp picture of an atom, so that you can tell correctly how it's going to behave — have a good image of reality, in other words — I don't know how to do it, because that image has to be mathematical. Strange!

I don't know how it is that we can write mathematical expressions and calculate what the thing is going to do without actually being able to picture it. It would be something like having a computer where you put some numbers in, and the computer can do the arithmetic to figure out what time a car will arrive at different destinations but it cannot picture the car.

In Christopher Sykes (ed.)

*No Ordinary Genius: The Illustrated Richard Feynman*

Chapter Six (p. 149)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

## Feynman, Richard P. 1918–88

American theoretical physicist

## Leighton, Robert B. 1919–97

American physicist

In its efforts to learn as much as possible about nature, modern physics has found that certain things can never be “known” with certainty. Much of our knowledge must

always remain uncertain. The most we can know is in terms of probabilities.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 6–5 (pp. 6–11)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...the existence of the positive charge, in some sense, distorts, or creates a “condition” in space, so that when we put the negative charge in, it feels a force. This potentiality for producing a force is called an electric field.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2–2 (p. 2–4)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

### Franklin, W. S.

No biographical data available

Physics is the science of the ways of taking hold of things and pushing them.

In R.B. Lindsay

The Broad Point of View in Physics

*The Scientific Monthly*, February 1932 (p. 115)

### Fraser, Julius Thomas 1923–

No biographical data available

The task of asking nonliving matter to speak and the responsibility for interpreting its reply is that of physics.

*Time: The Familiar Stranger*

From the Diaries of a Timesmith (p. 358)

The University of Massachusetts Press. Amherst, Massachusetts, USA. 1987

### Gamow, George 1904–68

Russian-born American physicist

I remember that once, walking with him to the institute, I mentioned Pascual Jordan’s idea of how a star can be created from nothing, since at the point zero its negative gravitational mass defect is numerically equal to its positive rest mass. Einstein stopped in his tracks, and, since we were crossing a street, several cars had to stop to avoid running us down.

*My World Line: An Informal Autobiography*

Afterword (p. 150)

The Viking Press. New York, New York, USA. 1979

### Gardner, Martin 1914–

American writer and mathematics games editor

In physics and chemistry, like all other branches of science, there is never a sharp line separating pseudo-scientific speculation from the theories of competent men.

*Fads and Fallacies in the Name of Science*

Chapter 7 (p. 80)

Dover Publications, Inc., New York, New York, USA; 1957

### Gay-Lussac, Joseph Louis 1778–1850

French chemist and physicist

In the study of physics, we see what are called individual facts but which are by no means isolated and which are not independent of each other; on the contrary they are related to each other by laws which the physicist devotes all his attention to discovering. It is this which is a measure of the true progress of the science.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 3 (p. 70)

Cambridge University Press. Cambridge, England. 1978

### Geordi

Fictional character

Suddenly it’s like the laws of physics went right out the window.

*Star Trek: The Next Generation*

True Q

Television program

Season 6, 1992

### Goeppert-Mayer, Maria 1906–72

German-American physicist

Mathematics began to seem too much like puzzle solving. Physics is puzzle solving, too, but of puzzles created by nature, not by the mind of man.

In J. Dash

*A Life of One’s Own*

Maria Goeppert-Mayer (p. 252)

Harper & Row, Publishers. New York, New York, USA. 1973

### Greene, Brian 1963–

American physicist

To open our eyes to the true nature of the universe has always been one of physics’ primary purposes.

*The Fabric of the Cosmos*

Chapter 1 (p. 12)

Alfred A. Knopf. New York, New York, USA. 2004

The arrow of time, through the defining role it plays in everyday life and its intimate link with the origin of the universe, lies at a singular threshold between the reality we experience and the more refined reality cutting-edge science seeks to uncover.

*The Fabric of the Cosmos*

Chapter 1 (p. 20)

Alfred A. Knopf. New York, New York, USA. 2004

Physicists generally do not spend their working days contemplating flowers in a state of cosmic awe and reverie. Instead, we devote much of our time to grappling with complex mathematical equations scrawled across well-scored chalkboards. Progress can be slow. Promising ideas, more often than not, lead nowhere. That’s the nature of scientific research.

*The Fabric of the Cosmos*

Chapter 1 (p. 21)

Alfred A. Knopf. New York, New York, USA. 2004

Physicists spend a large part of their lives in a state of confusion. It's an occupational hazard. To excel in physics is to embrace doubt while walking the road to clarity.

*The Fabric of the Cosmos*

Chapter 16 (p. 470)

Alfred A. Knopf. New York, New York, USA. 2004

Space and time capture the imagination like no other scientific subject. For good reason. They form the arena of reality, the very fabric of the cosmos.

*The Fabric of the Cosmos*

Preface (p. ix)

Alfred A. Knopf. New York, New York, USA. 2004

It took the brashness of a Newton to plant the flag of modern scientific inquiry and never turn back.

*The Fabric of the Cosmos*

Chapter 1 (p. 22)

Alfred A. Knopf. New York, New York, USA. 2004

Nature does weird things. It lives on the edge. But it is careful to bob and weave from the fatal punch of logical paradox.

*The Fabric of the Cosmos*

Chapter 7 (p. 185)

Alfred A. Knopf. New York, New York, USA. 2004

Black holes have the universe's most inscrutable poker faces.

*The Fabric of the Cosmos*

Chapter 16 (p. 477)

Alfred A. Knopf. New York, New York, USA. 2004

...because observations are all we have, we take them seriously. We choose hard data and the framework of mathematics as our guides, not unrestrained imagination or unrelenting skepticism, and seek the simplest yet most wide-reaching theories capable of explaining and predicting the outcome of today's and future experiments.

*The Fabric of the Cosmos*

Preface (p. ix)

Alfred A. Knopf. New York, New York, USA. 2004

### **Gross, David** 1941

American particle physicist

Progress in physics depends on the ability to separate the analysis of a physical phenomenon into two parts. First, there are the initial conditions that are arbitrary, complicated, and unpredictable. Then there are the laws of nature that summarize the regularities that are independent of the initial conditions.

*Proceedings of the National Academy of Science USA*

The Role of Symmetry in Fundamental Physics, Volume 93, Number 25, December 10, 1996

### **Hanson, Norwood Russell** 1924–67

American philosopher of science

Physics is not applied mathematics. It is a natural science in which mathematics can be applied.

*Patterns of Discovery*

Chapter IV (p. 72)

At The University Press. Cambridge, England. 1958

### **Hasselberg, K. B.**

No biographical data available

...as for physics, it has developed remarkably as a precision science, in such a way that we can justifiably claim that the majority of all the greatest discoveries in physics are very largely based on the high degree of accuracy which can now be obtained in measurements made during the study of physical phenomena.... [Accuracy of measurement] is the very root, the essential condition, of our penetration deeper into the laws of physics — our only way to new discoveries.

*Nobel Lectures, Physics 1901–1921*

Presentation Speech to Michelson 1907 Nobel Award (p. 159)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

### **Heidegger, Martin** 1889–1976

German philosopher

Modern physics is not experimental physics because it applies apparatus to the questioning of nature. Rather the reverse is true. Because physics, indeed already as pure theory, sets nature up to exhibit itself as a coherence of forces calculable in advance, it therefore orders its experiments precisely for the purpose of asking whether and how nature reports itself when set up in this way.

*The Question Concerning Technology and Other Essays*

Part I. The Question Concerning Technology (p. 21)

Harper & Row, Publishers. New York, New York, USA. 1977

### **Heinlein, Robert A.** 1907–88

American science fiction writer

Physics doesn't have to have any use. It just is.

*Time for the Stars* (p. 138)

Charles Scribner's Sons. New York, New York, USA. 1956

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

When I was a boy, my grandfather, who was a hand-craftsman and knew how to do practical things, once met me when I put a cover on a wooden box.... He saw that I took the cover and I took a nail and I tried to hammer this one nail down to the bottom. "Oh", he said, "that is quite wrong what you do there, nobody can do it that way and it is a scandal to look at." I did not know what the scandal was, but then he said, "I will show you how you could do it." He took the cover and he took one nail, put it just a little bit through the cover into the box, and then the next nail a little bit, the third nail a little bit, and so on until all the nails were there. Only when everything was clear, when one could see, that all the nails would fit, then he would start to put the nails really into the box. So, I think this is a good description of how one should proceed in theoretical physics.

In International Centre for Theoretical Physics  
*From a Life of Physics. Evening Lectures at the International Centre  
 For Theoretical Physics*  
 Theory, Criticism and a Philosophy, My General Philosophy (p. 46)

Questions and answers, observations and determinations, are no longer directed at a general, metaphysical and theological understanding, but are delimited with modesty.... This modesty was largely lost during the nineteenth century. Physical knowledge was considered to make assertions about nature as a whole. Physicists wished to turn philosophers.... Today physics is undergoing a basic change, the most characteristic trait of which is a return to its original self-limitation.

*The Physicist's Conception of Nature*  
 Chapter 4 (p. 105)  
 Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

Like all the other natural sciences, Physics advances by two distinct roads. On the one hand it operates empirically, and thus is enabled to discover and analyse a growing number of phenomena — in this instance, of physical facts; on the other hand it also operates by theory, which allows it to collect and assemble the known facts in one consistent system, and to predict new ones from the guidance of experimental research.

*The Physicist's Conception of Nature*  
 Chapter 6 (p. 158)  
 Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

I remember discussions with Bohr which went through many hours till very late at night and ended almost in despair, and when at the end of the discussion I went alone for a walk in the neighboring park I repeated to myself again and again the question: "Can nature possibly be as absurd as it seemed to us in these atomic experiments?"

*Physics and Philosophy: The Revolution in Modern Science*  
 Chapter II (p. 42)  
 Harper & Row, Publishers. New York, New York, USA. 1958

## Heyl, Paul R.

American Scientist

Physics is a state of mind.

In R.B. Lindsay  
 The Broad Point of View in Physics  
*The Scientific Monthly*, February 1932 (p. 115)

## Hilbert, David

1862–1943  
 German mathematician

Physics...is much too hard for physicists.

In Constance Reid  
*Hilbert — Courant*  
 Hilbert (p. 127)  
 Springer-Verlag. New York, New York, USA. 1986

## Hoyle, Sir Fred

1915–2001  
 English mathematician and astronomer

## Hoyle, Geoffrey

1942–  
 English science fiction writer

"In physics," he said, "we plan. We plan months ahead, years ahead.... You astronomers don't plan, you rush around like a chicken without a head. Observe and observe and all shall be revealed unto you."

*The Inferno* (p. 87)  
 Harper & Row, Publishers. New York, New York, USA. 1973

## Huebner, Jay S.

No biographical data available

Physics is what a group of people who call themselves physicists do.

What's Physics?  
*The Physics Teacher*, Volume 14, Number 5, May 1976 (p. 315)

## Huxley, Thomas Henry

1825–95  
 English biologist

...nothing can be more incorrect than the assumption one sometimes meets with, that physics has one method, chemistry another, and biology a third.

*Collected Essays* (Volume 1)  
*Method and Result*  
 The Progress of Science (p. 60)  
 Macmillan & Company Ltd. London, England. 1904

## Icke, Vincent

1946–  
 No biographical data available

Physics is not difficult; it's just weird.... Physics is weird because intuition is false. To understand what an electron's world is like, you've got to be an electron, or jolly nearly. Intuition is forged in the hellish fires of the everyday world, which makes it so eminently useful in our daily struggle for survival. For anything else, it is hopeless.

*The Force of Symmetry*  
 Preface (p. xiii)  
 Cambridge University Press. Cambridge, England. 1995

Fiction writers worry about first as well as last sentences, but I don't have to do that: in the book of physics, there never is a final sentence.

*The Force of Symmetry*  
 Chapter 14 (p. 294)  
 Cambridge University Press. Cambridge, England. 1995

## Jeans, Sir James Hopwood

1877–1946  
 English physicist and mathematician

The classical physics seemed to bolt and bar the door leading to any sort of freedom of the will; the new physics hardly does this; it almost seems to suggest that the door may be unlocked — if only we could find the handle. The old physics showed us a universe which looked more like a prison than a dwelling place. The new physics shows us a universe which looks as though it might conceivably form a suitable dwelling place for free men, and not a

mere shelter for brutes — a home in which it may at least be possible for us to mould events to our desires and live lives of endeavor and achievement.

*Physics and Philosophy*

Chapter VII (p. 216)

Dover Publications, Inc. New York, New York, USA. 1981

Kronecker is quoted as saying that in arithmetic God made the integers and man made the rest; in the same spirit we may perhaps say that in physics God made the mathematics and man made the rest.

*Physics and Philosophy*

Chapter I (p. 16)

Dover Publications, Inc. New York, New York, USA. 1981

...the tendency of modern physics is to resolve the whole material universe into waves, and nothing but waves. These waves are of two kinds: bottled-up waves, which we call matter, and unbottled waves, which we call radiation or light.

*The Mysterious Universe*

Chapter III (p. 77)

The Macmillan Company. New York, New York, USA. 1932

...physics tries to discover the pattern of events which controls the phenomena we observe. But we can never know what this pattern means or how it originates; and even if some superior intelligence were to tell us, we should find the explanation unintelligible.

*Physics and Philosophy*

Chapter I (p. 16)

Dover Publications, Inc. New York, New York, USA. 1981

### **Koyré, Alexandre** 1892–1964

Russian-born French philosopher

Good physics is made a priori. Theory precedes fact. Experience is useless because, before any experience, we are already in possession of the knowledge we are seeking for. Fundamental laws of motion (and of rest), laws that determine the spatio-temporal behavior of material bodies, are laws of a mathematical nature. Of the same nature as those which govern relations and laws of figures and numbers. We find and discover them not in Nature, but in ourselves, in our mind, in our memory, as Plato long ago has taught us.

Galileo and the Scientific Revolution of the Seventeenth Century

*The Philosophical Review*, Volume 52, Number 3, July 1943 (p. 347)

### **Larrabee, Eric** 1922–90

Historian

Some people think that physics was invented by Sir Francis Bacon, who was hit by an apple when he was sitting under a tree one day writing Shakespeare.

*Humor from Harper's*

Easy Road to Culture, Sort Of (p. 89)

Harper. New York, New York, USA. 1961

### **Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Without a parable modern physics speaks not to the multitudes.

In John D. Barrow

*The World Within the World* (p. 238)

Clarendon Press. Oxford, England. 1988

### **Lewis, Edwin Herbert** 1866–1938

American rhetorician, novelist, and poet

To Marvin the advance of physics and chemistry was the most exciting thing on earth. The researchers were watching each other, checking each other, helping each other, bound to tell the exact truth no matter where it led. The two sciences were steadily becoming one science, and the great advance continued day by day as if one infinite reluctant mind were slowly revealing itself.

*White Lightning*

Chapter 56 (p. 242)

Covici-McGee. Chicago, Illinois, USA. 1933

### **Liebson, Morris**

No biographical data available

“What will I learn here?” you might query.

You'll learn some math and Einstein's Theory.

Ask Teacher for an illustration.

He'll explain, “It's time dilation.

Length gets less. Mass gets more.

Time decreases. That's the law.

When things go so very, very fast.

Classical physics is of the past,

And to find what's really true,

We must seek the physics new.

Learning this is lots of fun

In our course called Physics 1.

Physics Inspires the Muses

*The Physics Teacher*, Volume 16, Number 9, December 1978 (p. 636)

### **Lindley, David** 1956–

English astrophysicist and author

Physics may be complex, mathematical, and arcane, but it is not capricious. The inventors of strings and twenty-six dimensional spaces did not think up these things at random, simply to give themselves a new set of toys. There is a line of rational thinking that leads from the billiard-ball atoms of classical physics to the intangible mathematical entities of today. Physics is complicated because the world is complicated.

*The End of Physics: The Myth of a Unified Theory*

Prologue (p. 19)

Basic Books, Inc. New York, New York, USA. 1993

If particle physics is a mess, it is because that is the way the world appears to work.

*The End of Physics: The Myth of a Unified Theory*

Part I, Chapter 4 (p. 124)

Basic Books, Inc. New York, New York, USA. 1993

**Lodge, Sir Oliver** 1851–1940

English physicist

When a thing behaves as if it were alive, physics loses interest in it and hands it over to another section; for it is incompetent to deal with motions attributable to spontaneity and free will.

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 722)

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Physics is experience, arranged in economical order.

In John N Shive and Robert L. Weber

*Similarities in Physics*

Preface (p. xi)

John Wiley & Sons, Inc. New York, New York, USA. 1982

I only seek to adopt in physics a point of view that need not be changed the moment our glance is carried over into the domain of another science; for ultimately, all must form one whole.

Translated by C.M. Williams

*Analysis of Sensations and the Relation of the Physical to the Psychological*

Chapter 1 (p. 30, fn 1)

Dover Publications, Inc. New York, New York, USA. 1959

**Maimonides, Moses** 1135–1204

Spanish-born philosopher, jurist, and physician

...he who wishes to attain to human perfection, must therefore first study Logic, next the various branches of Mathematics in their proper order, then Physics, and lastly Metaphysics.

*The Guide for the Perplexed*

Part I, Chapter XXXIV

E.P. Dutton & Company. New York, New York, USA. 1904

**Maritain, Jacques** 1882–1973

French philosopher

Few spectacles are as beautiful and moving for the mind as that of physics thus advancing toward its destiny like a huge throbbing ship.

Translated by Gerald B. Phelan

*Distinguish to Unite or the Degrees of Knowledge*

Chapter IV, section 12 (p. 165)

University of Notre Dame Press. Notre Dame, Indiana, USA. 1995

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

...it is now quite lawful for a Catholic woman to avoid pregnancy by a resort to mathematics, though she is still forbidden to resort to physics and chemistry.

*Minority Report: H.L. Mencken's Notebooks*

No. 62 (p. 52)

Alfred A. Knopf. New York, New York, USA. 1956

**Mephisto**

Can no one laugh?

Will no one drink?

I'll teach you Physics in a wink....

*BLEGDAMSVEJ FAUST*

Part First, Copenhagen Spring Conference, 1932

Beware alone of Reason and of Science,

Man's highest powers, unholy in alliance.

You let yourself, through dazzling witchcraft, yield

To all temptations of the Quantum field.

Listen! As now the obstacles abate,

You'll know the fair Neutrino for your fate!

*BLEGDAMSVEJ FAUST*

Part First, Copenhagen Spring Conference, 1932

**Millikan, Robert Andrews** 1868–1953

American physicist

Physics has opened the eyes of mankind so that it can now see in a very new truth new worlds — a marvelous world of electrons, already quite well explored, which underlies our former world of atoms and molecules, a world of quanta, not yet well understood, which lies perhaps behind the ether.

*Science and Life*

Chapter IV (p. 67)

The Pilgrim Press. Boston, Massachusetts, USA. 1924

**Mohapatra, Rabindra**

Theoretical physicist

Most people who haven't been trained in physics probably think of what physicists do as a question of incredibly complicated calculations, but that's not really the essence of it. The essence of it is that physics is about concepts, wanting to understand the concepts, the principles by which the world works.

In Michio Kaku

*Hyperspace: A Scientific Odyssey Through Parallel Universes, Time*

*Warpes, and the 10<sup>th</sup> Dimension*

Chapter 7 (p. 152)

Oxford University Press, Inc. New York, New York, USA. 1995

If you want to do serious physics, sometime you just have to learn it.

As reported by Ernest Barreto, student

Quantum field theory class. 1994

**Morgan, Thomas Hunt** 1866–1945

American zoologist and geneticist

Physics has progressed because, in the first place, she accepted the uniformity of nature; because, in the next place, she early discovered the value of exact measurements; because, in the third place, she concentrated her attention on the regularities that underlie the complexities of phenomena as they appear to us; and lastly, and not the least significant, because she emphasized the importance of the experimental method of research. An

ideal or crucial experiment is a study of an event, controlled so as to give a definite and measurable answer to a question — an answer in terms of specific theoretical ideas, or better still an answer in terms of better understood relations.

The Relation of Biology to Physics

*Science*, Volume 65, Number 1679, March 4, 1927 (p. 217)

**Morrow, James** 1947–

American author

Her eyes sprang fully opened, and she beheld Howard's rickety bookshelves. P-h-y-s-i-c-s. A coil of radiant energy shot from the word, flooding into her skull like a sunbeam passing through glass. She closed her eyes. Her dendrites danced. Her synapses sparkled.

*Only Begotten Daughter* (p. 90)

Harcourt Incorporated. Orlando, Florida, USA. 1990

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

I do not define time, space, place, and motion, as being well known to all. Only I must observe, that the common people conceived those quantities under not other notions but from the relation they bear to sensible objects.... Absolute space, in its own nature, without relation to anything external remains always similar and immovable.

In *Great Books of the Western World* (Volume 34)

*Mathematical Principles of Natural Philosophy*

Definitions, Scholium (p. 8)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is indeed a matter of great difficulty to discover, and effectually to distinguish, the true motions of particular bodies from the apparent; because the parts of that immovable space, in which those motions are performed, do by no means come under the observation of our senses.

In *Great Books of the Western World* (Volume 34)

*Mathematical Principles of Natural Philosophy*

Definitions, Scholium (p. 12)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nietzsche, Friedrich** 1844–1900

German philosopher

We...want to become...human beings who are new, unique, incomparable, who give themselves laws, who create themselves. To that end we must become the best learners and discoverers of everything that is lawful and necessary in the world: we must become physicists in order to be able to be creators in this sense — while hitherto all valuations and ideals have been based on ignorance of physics or were constructed so as to contradict it. Therefore: long live physics! And even more so that which compels us to turn to physics — our honesty!

*The Gay Science*

Fourth Book, Aphorism 335

Cambridge University Press. Cambridge, England. 2001

**Noll, Ellis D.**

No biographical data available

Physics is the science whose treehouse rests on the trunk of immutable physical law.

What's Physics?

*The Physics Teacher*, Volume 14, Number 5, May 1976 (p. 315)

**Oman, John** 1860–1939

English Presbyterian theologian

Beauty...is the goal of physics as it seeks to construe the order of the universe...

*The Natural and the Supernatural*

Value and Validity (p. 211)

The Macmillan Company. New York, New York, USA. 1931

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Time and experience have clarified, refined and enriched our understanding of these notions. Physics has changed since then. It will change even more. But what we have learned so far, we have learned well. If it is radical and unfamiliar and a lesson that we are not likely to forget, we think that the future will be only more radical and not less, only more strange and not more familiar, and that it will have its own new insights for the inquiring human spirit.

In Lucienne Felix

*The Modern Aspect of Mathematics* (p. 31)

Basic Books, Inc. New York, New York, USA. 1960

The only thing that we can say about the properties of the ultimate particles is that we know nothing whatever about them.

In Cecilia Payne-Gaposchkin

*Introduction to Astronomy*

Chapter XIII, Section 5 (p. 339)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1954

As you undoubtedly know, theoretical physics — what with the haunting ghosts of neutrinos, the Copenhagen conviction, against all evidence, that cosmic rays are protons, Born's absolutely unquantizable field theory, the divergence difficulties with the positron, and the utter impossibility of making a rigorous calculation of anything at all — is in a hell of a way.

In Alice Smith and Charles Weiner

*Robert Oppenheimer, Letters and Reflections*

Letter to F. Oppenheimer, 4 June 1934 (p. 181)

Harvard University Press. Cambridge, Massachusetts, USA. 1980

**Pagels, Heinz R.** 1939–88

American physicist and science writer

Bohr wondered how we could even talk about the atomic world — it was so far removed from human experience.



He struggled with this problem — how can we use ordinary language developed to cope with everyday events and objects to describe atomic events? Perhaps the logic inherent in our grammar was inadequate for the task. ... The end of determinism meant not the end of physics but the beginning of a new vision of reality.

In T. Ferris (ed.)

*World Treasury of Physics, Astronomy, and Mathematics*

Uncertainty and Complementarity (p. 103, 110)

Little, Brown & Company. Boston, Massachusetts, USA. 1991

### **Pais, Abraham** 1918–2000

Dutch-born physicist

It was a wonderful mess at that time. Wonderful! Just great! It was so confusing — physics at its best, when everything is confused and you know something important lies just around the corner.

In Robert Crease

*The Second Creation: Makers of the Revolution in 20<sup>th</sup> Century Physics*

Chapter 9 (p. 177)

The Macmillan Company. New York, New York, USA. 1986

...the state of particle physics...is...not unlike the one in a symphony hall before the start of a concert. On the podium one will see some but not all of the musicians. They are tuning up. Short brilliant passages are heard on some of the instruments; improvisations elsewhere; some wrong notes too. There is a sense of anticipation for the moment when the concert starts.

Particles

*Physics Today*, Volume 21, Number 2, May 1968 (p. 28)

### **Pines, David**

No biographical data available

The central task of theoretical physics in our time is no longer to write down the ultimate equations but rather to catalog and understand emergent behavior in its many guises...

In George Johnson

Challenging Particle Physics as Path to Truth

*The New York Times*, F5, Columns 2 and 3, Tuesday, December 4, 2001

### **Planck, Max** 1858–1947

German physicist

The chief law of physics, the pinnacle of the whole system is, in my opinion, the principle of least action.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Place of Modern Physics in the Mechanical View of Nature (p. 41)

Methuen & Company Ltd. London, England. 1925

Physics would occupy an exceptional position among all the other sciences if it did not recognize the rule that the most far-reaching and valuable results of investigation can only be obtained by following a road leading to a goal which is theoretically unobtainable. This goal is the apprehension of true reality.

*The Universe in the Light of Modern Physics*

Section 1 (p. 15)

Unwin Brothers Ltd. London, England. 1937

Physics is an exact Science and hence depends upon measurement, while all measurement itself requires sense-perception. Consequently all the ideas employed in Physics are derived from the world of sense-perception.

*The Universe in the Light of Modern Physics*

Section 1 (p. 7)

Unwin Brothers Ltd. London, England. 1937

Since Galileo's time, physics has achieved its greatest success by rejecting all teleological methods.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Principle of Least Action (p. 73)

Methuen & Company Ltd. London, England. 1925

Modern Physics impresses us particularly with the truth of the old doctrine which teaches that there are realities existing apart from our sense-perceptions, and that there are problems and conflicts where these realities are of greater value for us than the richest treasures of the world of experience.

*The Universe in the Light of Modern Physics* (p. 107)

George Allen & Unwin Ltd. London, England. 1931

In endeavoring to claim your attention for a short time, I would remark that our science, Physics, cannot attain its object by direct means, but only gradually along numerous and devious paths, and that therefore a wide scope is provided for the individuality of the worker. One works at one branch, another at another, so that the physical universe with which we are all concerned appears in different lights to different workers.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Unity of the Physical Universe (p. 1)

Methuen & Company Ltd. London, England. 1925

...the second law of thermodynamics appears solely as a law of probability, entropy as a measure of the probability, and the increase of entropy is equivalent to a statement that more probable events follow less probable ones.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Relation Between Physical Theories (p. 86)

Methuen & Company Ltd. London, England. 1925

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The science of physics does not only give us [mathematicians] an opportunity to solve problems, but helps us to discover the means of solving them, and it does this in two ways: it leads us to anticipate the solution and suggests suitable lines of argument.

*The Foundations of Science*

The Value of Science

The Science Press. New York, New York, USA. 1913

**Quine, Willard Van Orman** 1908–2000

American logician and philosopher

Physics investigates the essential nature of the world, and biology describes a local bump. Psychology, human psychology, describes a bump on the bump.

*Theories and Things*

Chapter 10 (p. 93)

Harvard University Press. Cambridge, Massachusetts, USA. 1981

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

I think that physics should be the central study in all schools. I don't mean physics as it is usually taught — very badly, as a bunch of tricks — but, rather, an appreciation of what it means, and a feeling for it. I don't want to turn everybody into a scientist, but everybody has to be enough of a scientist to see the world in the light of science — to be able to see the world as something that is tremendously important beyond himself, to be able to appreciate the human spirit that could discover these things, that could make instruments to inquire and advance into its own nature. I rate this so highly [because] with this education people would find something above their religious affiliations, and find a basic unity in the spirit of man.

In Jeremy Bernstein

*Experiencing Science*

Part 1. Two Faces of Physics. Chapter 2. Rabi: The Modern Age (p. 126)

Basic Books, Inc. New York, New York, USA. 1978

I think physics is infinite. You don't have to try to exhaust it in your generation, or in your lifetime.

In Jeremy Bernstein

*Experiencing Science*

Part 1 Two Faces of Physics Chapter 2 Rabi: The Modern Age (p. 56)

Basic Books, Inc. New York, New York, USA. 1978

**Raman, Chandrasekhar Venkata** 1888–1970

Indian physicist

The purpose of scientific study and research is to obtain an ever deeper understanding of the workings of nature. To the physicist falls the task of discovering the ultimate units or entities that constitute the material universe and of ascertaining the principles which govern their behavior.

*The New Physics: Talks on Aspects of Science*

Chapter II (p. 9)

Philosophical Library, New York. 1951

**Reichenbach, Hans** 1891–1953

German philosopher of science

If one knows physics for a distance only, if he hears merely strange names and mathematical formulae in it, he will, indeed, come to believe that it is an affair of the learned alone — ingeniously and wisely constructed,

but without significance for men of other interests and problems.

*Atoms and Cosmos*

Chapter 19 (p. 293)

The Macmillan Company. New York, New York 1933

**Richardson, Owen Willans** 1879–1959

English physicist

The trouble with Physics at the present time is that there are so many workers making discoveries so fast, and important discoveries too, that it is difficult for any one worker to keep a balanced view of the state of the subject.

*Lex Prix Nobel. The Nobel Prizes in 1928*

Nobel banquet speech for award received in 1928

Nobel Foundation. Stockholm, Sweden. 1929

**Roberts, Michael**

No biographical data available

**Thomas, E. R.**

No biographical data available

The most brilliant discoveries in theoretical physics are not discoveries of new laws, but of terms in which the law can be discovered.

*Newton and the Origin of Colours*

Chapter I (p. 6)

G. Bell & Sons Ltd. London, England. 1934

**Röntgen, Wilhelm Conrad** 1845–1923

German physicist

To my view there are two methods of research, the apparatus and the calculation. Whoever prefers the first method is an experimenter; otherwise, he is a mathematical physicist. Both of them set up theories and hypotheses...

In Otto Glasser

*Dr. W.C. Röntgen*

Chapter II (p. 24)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

Physics is a science which must be proved with honest effort. One can, perhaps, present a subject in such a manner that an audience of laymen may be convinced erroneously that it has understood the lecture. This, however, means a furthering a superficial knowledge, which is worse and more dangerous than none at all.

In Otto Glasser

*Dr. W.C. Röntgen*

Chapter VIII (p. 119)

Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The aim of physics, consciously or unconsciously, has always been to discover what we may call the causal skeleton of the world.

*The Analysis of Matter*

Chapter XXXVII (p. 391)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

Physics is mathematical not because we know so much about the physical world, but because we know so little: it is only its mathematical properties that we can discover.

In John D. Barrow

*The World Within the World* (p. 278)

Clarendon Press. Oxford, England. 1988

Physics must be interpreted in a way which tends toward idealism, and perception in a way which tends toward materialism.

*The Analysis of Matter*

Chapter I (p. 7)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

Naive realism leads to physics, and physics, if true, shows that naive realism is false. Therefore naive realism, if true, is false; therefore it is false.

In John D. Barrow

*The World Within the World* (p. 144)

Clarendon Press. Oxford, England. 1988

Broadly speaking, traditional physics has collapsed into two portions, truisms and geography.

*The ABC of Relativity*

Chapter XV

George Allen & Unwin Ltd. London, England. 1958

I come now to the statistical part of physics, which is concerned with the study of large aggregates. Large aggregates behave almost exactly as they were supposed to do before quantum theory was invented, so that in regard to them the older physics is very nearly right. There is, however, one supremely important law which is only statistical; this is the second law of thermodynamics. It states, roughly speaking, that the world is growing continuously more disorderly.

*Scientific Metaphysics*

The Scientific Outlook (p. 92)

George Allen & Unwin Ltd. London, England. 1931

It is obvious that a man who can see, knows things that a blind man cannot know; but a blind man can know the whole of physics.

*The Analysis of Matter*

Chapter XXXVII (p. 389)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

**Sandage, Allan** 1926–

American astronomer

It is such a strange conclusion...it cannot really be true.

In Robert Jastrow

*God and the Astronomers*

Chapter 6 (p. 113)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Schlegel, Friedrich** 1772–1829

German poet

It is in fact wonderful how physics — as soon as it is concerned not with technical purposes but with general results — without knowing it gets into cosmogony, astrology, theosophy, or whatever you wish to call it, in short, into a mystic discipline of the whole.

Translated by Ernst Behler and Roman Struc

*Dialogue on Poetry and Literary Aphorisms*

Talk on Mythology (p. 90)

The Pennsylvania State University Press. University Park, Pennsylvania, USA. 1968

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

Schrödinger: “Surely you realize the whole idea of quantum jumps is bound to end in nonsense...if the jump is sudden, Einstein’s idea of light quanta will admittedly lead us to the right wave number, but them we must ask ourselves how precisely the electron behaves during the jump. Why does it not emit a continuous spectrum, as electromagnetic theory demands? And what law governs its motion during the jump? In other words, the whole idea of quantum jumps is sheer fantasy.”

Niels Bohr: “What you say is absolutely correct. But it does not prove that there are no quantum jumps. It only proves that we cannot describe them, that the representational concepts with which we describe events in daily life and experiments in classical physics are inadequate when it comes to describing quantum jumps.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (pp. 73–74)

Harper & Row, Publishers. New York, New York, USA. 1971

Research in physics has shown beyond the shadow of a doubt that in the overwhelming majority of phenomena whose regularity and invariability have led to the formulation of the postulate of causality, the common element underlying the consistency observed is chance.

*What Is Natural Law*

Clarendon Press. Oxford, England. 1988

**Scotty**

Fictional character

[To Captain Kirk on innumerable occasions] But I cannot change the laws of physics, Captain!

*Star Trek*

Television program

**Smith, Henry J. S.** 1826–83

Irish mathematician

So intimate is the union between mathematics and physics that probably by far the larger part of the accessions to our mathematical knowledge have been obtained by the efforts of mathematicians to solve the problems set to them by experiment, and to create “for each successive class of phenomena, a new calculus or a new geom-

etry, as the case might be, which might prove not wholly inadequate to the subtlety of nature.” Sometimes, indeed, the mathematician has been before the physicists, and it has happened that when some great and new question has occurred to the experimentalist or the observer, he has found in the armory of the mathematician the weapons which he has needed ready made to his hand. But, much oftener, the questions proposed by the physicist have transcended the utmost powers of the mathematics of the time, and a fresh mathematical creation has been needed to supply the logical instrument requisite to interpret the new enigma.

Presidential Address British Association for the Advancement of Science *Nature*, Section A, Volume 8, Number 204, September 25, 1873 (p. 450)

**Snow, Charles Percy** 1905–80  
English novelist and scientist

He then gave me an explanation which I could not understand, although I had heard plenty of the jargon of nuclear physics from him and Luke. “Fission.” “Neutrons.” “Chain reaction.” I could not follow. But I could gather that at last the sources of nuclear energy were in principle open to be set loose; and that it might be possible to make an explosive such as no one had realistically imagined.

*The New Men* (p. 11)  
Charles Scribner’s Sons. New York, New York, USA. 1955

I now believe that if I had asked an even simpler question — such as, What do you mean by mass, or acceleration, which is the scientific equivalent of saying, Can you read? — not more than one in ten of the highly educated would have felt that I was speaking the same language. So the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their neolithin ancestors would have had.

*The Two Cultures: And a Second Look*  
Chapter I (p. 15)  
At The University Press. Cambridge, England. 1964

**Standen, Anthony**  
Anglo-American science writer

“[T]he extraordinary degree of dullness that pervades the laboratory periods of physics courses...[is] so acute that for many people it is the bitterest experience of their education.”

*Science Is a Sacred Cow*  
Chapter III (p. 83)  
Dutton. New York, New York, USA. 1950

Physics is not about the real world, it is about “abstractions” from the real world, and this is what makes it so scientific.

*Science Is a Sacred Cow*  
Chapter III (p. 61)  
Dutton. New York, New York, USA. 1950

**Sullivan, John William Navin** 1886–1937  
Irish mathematician

The present tendency of physics is toward describing the universe in terms of mathematical relations between unimaginable entities.

*The Bases of Modern Science* (p. 226)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1929

**Teilhard de Chardin, Pierre** 1881–1955  
French Jesuit, paleontologist, and biologist

The time has come to realise that an interpretation of the universe — even a positive one — remains unsatisfying unless it covers the interior as well as the exterior of things; mind as well as matter. The true physics is that which will, one day, achieve the inclusion of man in his wholeness in a coherent picture of the world.

*The Phenomenon of Man*  
Forward (pp. 35–36)  
Harper & Brothers. New York, New York, USA. 1959

## The X-Files

MULDER: [I]n most of my work, the laws of physics rarely seems to apply.

*Pilot*  
Television program  
Season 1, 1993

**Truesdell, Clifford** 1919–2000  
American mathematician, natural philosopher, historian of mathematics

Pedantry and sectarianism aside, the aim of theoretical physics is to construct mathematical models such as to enable us, from the use of knowledge gathered in a few observations, to predict by logical processes the outcomes in many other circumstances. Any logically sound theory satisfying this condition is a good theory, whether or not it be derived from “ultimate” or “fundamental” truth. It is as ridiculous to deride continuum physics because it is not obtained from nuclear physics as it would be to reproach it with lack of foundation in the Bible.

In Clifford Truesdell and Walter Noll  
*The Non-Linear Field Theories of Mechanics* (2<sup>nd</sup> edition) (pp. 2–3)  
Springer-Verlag. Berlin, Germany. 1992

**Ulam, Stanislaw** 1909–84  
Polish-born mathematician

I should add here for the benefit of the reader who is not a professional physicist that the last thirty years or so have been a period of kaleidoscopically changing explanations of the increasingly strange world of elementary particles and of fields of force. A number of extremely talented theorists vie with each other in learned and clever attempts to explain and order the constant flow of experimental results which, or so it seems to me, almost perversely cast doubts about the just completed theoretical formulations.

*Adventures of a Mathematician*

Chapter 13 (p. 261)

Charles Scribner's Sons. New York, New York, USA. 1976

**van Sant, Gus** 1952–

American film editor

Like a disc jockey from Paradise, Howard flips Marie over and plays her B side. Every now and then she reaches for Sissy to include her, but the laws of physics insist on being obeyed.

*Even Cowgirls Get the Blues*

Screenplay (p. 34)

Faber & Faber Ltd. London, England. 1993

**von Bayer, Hans Christian** 1938–

German-born physicist and author

When [an electron] is passing through the slits, it is a wave, when it is caught, it is a particle.... An atom, according to Bohr, represents a different reality from that of the ordinary world of our sense perceptions, and it is unreasonable to insist on forcing the language of our familiar macroscopic surroundings onto that alien mode of existence.

*Taming the Atom*

Chapter 13 (p. 197)

Random House, Inc. New York, New York, USA. 1992

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Physics must be sharply distinguished from mathematics. The former must stand in clear independence, penetrating into the sacred life of nature in common with all the forces of love, veneration and devotion. The latter, on the other hand, must declare its independence of all externality, go its own grand spiritual way, and develop itself more purely than is possible so long as it tries to deal with actuality and seeks to adapt itself to things as they really are.

*Werke*

Schriften zur Naturwissenschaft, XXXIX (p. 92)

Temple-Verlag. Berlin, Germany. 1963

**von Weizsäcker, Carl Friedrich (Baron)** 1912–2007

German theoretical physicist and philosopher

Physics begins by facing a mystery. It transforms the mystery into a puzzle. It solves the puzzle. And it finds itself facing a new mystery.

In Pekka Lahti and Peter Mittelstaedt

*Symposium on the Foundations of Modern Physics: 50 Years of the Einstein–Podolsky–Rosen Gedankenexperiment*

Quantum Theory and Space-Time (p. 237)

**Weinberg, Steven** 1933–

American nuclear physicist

Our job in physics is to see things simply, to understand a great many complicated phenomena, in terms of a few simple principles.

In Robert K. Adair

*The Great Design* (p. 325)

Oxford University Press, Inc. New York, New York, USA. 1987

I think that is one of the great things about physics, that it is sufficiently precise that it makes predictions which can be disproved by observation, and which occasionally are. And, when you have that experience, you know that there is something out there that is not all just coming out of your closed society of fellow physicists. It's, I think, one of the things that I love so much about physics, the dialogue with nature; and this dialogue is not one in which nature always agrees with the physicists.

*Does Physics Describe Reality?*

The Challenge of the Universe

From Hypermind CD-ROM

Physics is not a finished logical system. Rather, at any moment it spans a great confusion of ideas, some that survive like folk epics from the heroic periods of the past, and others that arise like utopian novels from our dim premonitions of a future grand synthesis.

*Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity*

Part I, Chapter 1 (p. 3)

John Wiley & Sons, Inc. New York, New York, USA. 1972

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The science of physics is even more tantalizing than it was half a century ago, and, above the level of an elementary introduction, optics, acoustics and the rest, even less teachable. The more brilliant investigators rocket off into mathematical pyrotechnics and return to common speech with statements that are, according to the legitimate meanings of words, nonsensical.

*Experiment in Autobiography*

Chapter 5, Section 2 (p. 176)

The Macmillan Company. New York, New York, USA. 1934

**Wheeler, John Archibald** 1911–

American physicist and educator

No point is more central than this, that empty space is not empty. It is the seat of the most violent physics.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II, Chapter 8 (p. 274)

Simon & Schuster. New York, New York, USA. 1982

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Physics refers to ether, electrons, molecules, intrinsically incapable of direct observation.

*The Principle of Relativity with Application to Physical Science* (p. 62)

The University Press. Cambridge, England. 1922

...in the present-day reconstruction of physics, fragments of the Newtonian concepts are stubbornly retained. The

result is to reduce modern physics to a sort of mystic chant over an unintelligible universe.

*Modes of Thought*

Chapter III, Lecture VII (p. 185)

The Macmillan Company. New York, New York, USA. 1938

### Whyte, A. Gowans

Scottish writer

The progress of human thought is through metaphysics to physics.

The Triumph of Physics

*The Rationalist Annual*, 1931 (p. 28)

### Wiener, Norbert 1894–1964

American mathematician

Physics — or so it is generally supposed — takes no account of purpose...

*God and Golem, Inc.: A Comment on Certain Points Where Cybernetics*

*Impinges on Religion*

Chapter I (p. 5)

The MIT Press. Cambridge, Massachusetts, USA. 1964

### Wigner, Eugene Paul 1902–95

Hungarian-born American physicist

We have ceased to expect from physics an explanation of all events, even of the gross structure of the universe, and we aim only at the discovery of the laws of nature, that is the regularities, of the events.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1963

Events, Laws of Nature, and Invariance Principles (p. 9)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

Physics does not endeavor to explain nature. In fact, the great success of physics is due to the restriction of its objectives: it endeavors to explain the regularities in the behavior of objects. The renunciation of the broader aim, and the specification of the domain for which an explanation can be sought, now appears to us as an obvious necessity. In fact, the specification of the explainable may have been the greatest discovery of physics so far.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1963

Events, Laws of Nature, and Invariance Principles (p. 2)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

### Wilczek, Frank 1951–

American theoretical physicist

In physics, you don't have to go around making trouble for yourself — nature does it for you.

*Longing for the Harmonies*

How Asymptotic Freedom Discovered Me (p. 208)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

### Ziman, John M. 1925–2005

English physicist

Physics defines itself as the science devoted to discovering, developing and refining those aspects of reality that are amenable to mathematical analysis.

*Reliable Knowledge*

Chapter 2 (p. 28)

Cambridge University Press. Cambridge, England. 1978

The most astonishing achievements of science, intellectually and practically, have been in physics, which many people take to be the ideal type of scientific knowledge. In fact, physics is a very special type of science, in which the subject matter is deliberately chosen so as to be amenable to quantitative analysis.

*Reliable Knowledge*

Chapter 1 (p. 9)

Cambridge University Press. Cambridge, England. 1978

In the education of a physicist, we recount the bold voyages of great explorers — Newton and Einstein, Faraday and Bohr — in search of new laws of nature. They found and charted the continents on which we have built our cities of the mind and of art. Does anyone really suppose that similar vast and fertile territories are still waiting to be discovered and colonized? The unaccustomed rules that govern black holes and quasars in the cosmic deeps affect our lives no more than the icy crags of the Himalayas or the conjunctions of the planets.

*Physics Bulletin*, Volume 25, 1974 (p. 280)

Think of physics simply as the “fundamental” science and it is oversubscribed almost to bankruptcy. But define it as the science whose aim is to describe natural phenomena in the most mathematical or numerical language, and you will understand its past and have confidence in its future. The task of the modern physicist is to determine the mathematically comprehensible characteristics of the natural world and of human artifacts...

*Physics Bulletin*, Volume 25, 1974 (p. 280)

### Zukav, Gary

American spiritual teacher

Unfortunately, when most people think of “physics”, they think of chalkboards covered with undecipherable symbols of an unknown mathematics. The fact is that physics is not mathematics. Physics, in essence, is simple wonder at the way things are and a divine (some call it compulsive) interest in how that is so. Mathematics is the tool of physics. Stripped of mathematics, physics becomes pure enchantment.

*The Dancing Wu Li Masters: An Overview of the New Physics*

Part One

Wu Li?

Chapter I (p. 31)

William Morrow. New York, New York, USA. 1979

**PHYSIOGNOMY**

**Miller, Hugh** 1802–56  
Scottish geologist and theologian

Physiognomy is no idle or doubtful science in connection with geology. The physiognomy of a country indicates almost invariably its geological character.

*The Old Red Sandstone*

Chapter XI (p. 201)

J.M. Dent & Sons Ltd. London, England. 1922

**PHYSIOLOGIST**

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

A physiologist...can certainly offer a definition of life; but this will only be an interim report on the progress of physiology to date. For him, as for the beginner, it is the nature of physiology that is relatively certain; it is the nature of life that is relatively vague.

*The New Leviathan: Or Man, Society, Civilization and Barbarism*

Part I, Chapter I. Aphorism L.47 (p. 3)

At The Clarendon Press. Oxford, England. 1942

**Mayo, Charles Horace** 1865–1939  
American physician

Disease at times creates experiments that physiology completely fails to duplicate, and the wise physiologist can obtain clues to the resolution of many problems by studying the sick.

La funcion del higado en relacion con la cirugia

*Annals de Circulation*, Volume 2, April 1930

**Pirenne, M. H.**

No biographical data available

The soul, the mind, consciousness, thought, sensation, being nonmaterial, are not observable in physiological investigation like, say, nerve excitation or muscle contraction. Physiology gives no direct experimental evidence for them. Yet like all men, physiologists no doubt believe they have minds. Hence a dilemma.

*British Journal for the Philosophy of Science*, Volume 1, 1950/1951

**PHYSIOLOGY**

**Gee, Samuel** 1839–1911  
Physician

Physiology owes more to medicine than medicine to physiology. Nature in disease performs vivisections for us. The greater and better part of what we know concerning the functions of the many organs of the body is derived from pathological observation and not from physiological experiment.

*Medical Lectures and Aphorisms* (p. 227)  
Smith, Elder. London, England. 1902

**Huxley, Thomas Henry** 1825–95  
English biologist

There is no side of the human mind which physiological study leaves uncultivated. Connected by innumerable ties with abstract science, Physiology is yet in the most intimate relation with humanity, and by teaching us that law and order, and a definite scheme of development, regulate even the strangest and wildest manifestations of individual life, she prepares the student to look for a goal even amidst the erratic wanderings of mankind, and to believe that history offers something more than an entertaining chaos — a journal of a toilsome, tragi-comic march nowhither.

*Collected Essays* (Volume 33)

*Science and Education*

On the Educational Value of the Natural History of Science (p. 59)

Macmillan & Company Ltd. London, England. 1904

A thorough study of Human Physiology is, in itself, an education broader and more comprehensive than much that passes under that name. There is no side of the intellect which it does not call into play, no region of human knowledge into which either its roots, or its branches, do not extend; like the Atlantic between the Old and the New Worlds, its waves wash the shores of the two worlds of matter and of mind; its tributary streams flow from both; through its waters, as yet unfurrowed by the keel of any Columbus, lies the road, if such there be, from the one to the other; far away from that North-west Passage of mere speculation, in which so many brave souls have been hopelessly frozen up.

*Collected Essays* (Volume 33)

*Science and Education*

Universities: Actual and Ideal (p. 220)

Macmillan & Company Ltd. London, England. 1904

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

It is perfectly clear that the horizon of medical observation of life is immeasurably wider than the sphere of vital phenomena which the physiologists have before their eyes in their laboratories. Hence the permanent incongruity between that which medicine knows, sees and empirically applies, and that which physiology can reproduce and explain.

*Experimental Psychology and Other Essays*

Concerning Trophic Innervation (p. 74)

Philosophical Library. New York, New York, USA. 1957

The outer limit of physiological knowledge, its goal, is to express this infinitely complex interrelationship of the organism with the surrounding world in the form of an exact scientific formula.

In Daniel P. Todes

*Pavlov's Physiology Factory: Experiment, Interpretation, Laboratory Enterprise*  
Chapter 5 (p. 153)  
The Johns Hopkins University Press. Baltimore, Maryland, USA. 2002

**Starling, Ernest Henry** 1866–1927  
English physiologist

In physiology, as in all other sciences, no discovery is useless, no curiosity misplaced or too ambitious, and we may be certain that every advance achieved in the quest of pure knowledge will sooner or later play the part in the service of man.

*The Linacre Lecture on the Law of the Heart* (p. 147)  
Publisher undetermined

## PI

**Beckmann, Petr** 1924–93  
Physicist

The digits beyond the first few decimal places are of no practical or scientific value. Four decimal places are sufficient for the design of the finest engines; ten decimals are sufficient to obtain the circumference of the earth to within a fraction of an inch if the earth were a smooth sphere...

*A History of Pi*  
Chapter 10 (p. 100)

St. Martin's Press. New York, New York, USA. 1974

**Chudnovsky, David**  
Mathematician

Maybe in the eyes of God pi looks perfect.

In Richard Preston  
*The Mountains of Pi*  
*The New Yorker* March 2, 1992

**de Morgan, Augustus** 1806–71  
English mathematician and logician

...mysterious 3.14159...comes in at every door and window, and down every chimney.

*A Budget of Paradoxes*  
Cyclometry (p. 393)

Longmans, Green. London, England. 1872

**Duffin, R. J.**

No biographical data available

God created the world and the integers, all in seven days. He then ordered two of his biotechnicians, James and Francis, to construct a genetic code for the fractional numbers. Moreover, they were to give special prominence to His favorite number, pi.

The Patron Saint of Mathematics

*The Mathematical Intelligencer*, Volume 15, Number 1, 1993 (p. 52)

**Graham, L. A.**

No biographical data available

Fiddle de dum, fiddle de dee,  
A ring round the moon is pi times D;  
But if a hole you want repaired,  
You use the formula  $\pi r^2$ .

*Ingenious Mathematical Problems and Methods*  
Mathematical Nursery Rhyme Number 1  
Dover Publications, Inc. New York, New York, USA. 1959

Little Jack Horner sat in a corner,  
Trying to evaluate pi.

He disdained rule of thumb,  
Found an infinite sum,  
And exclaimed "It's REAL, nary an I."

*Ingenious Mathematical Problems and Methods*  
Mathematical Nursery Rhyme Number 9  
Dover Publications, Inc. New York, New York, USA. 1959

**Kac, Mark** 1914–84  
Polish mathematician

Steinhaus, with his predilection for metaphors, used to quote a Polish proverb, "*Fortunny kolem sie toczy*" (Luck runs in circles), to explain why pi, so intimately connected with circles, keeps cropping up in probability theory and statistics, the two disciplines which deal with randomness and luck.

*Enigmas of Chance: An Autobiography*  
The Search for the Meaning of Independence (p. 55)  
Harper & Row, Publishers. New York, New York, USA. 1985

**Morgan, Robert**

No biographical data available

The secret relationship  
of line and circle, progress  
and return, is always known,  
transcendental and yet  
a commonplace. And though  
the connection is written  
it cannot be written out  
in full, never perfect, but  
is exact and constant, is  
eternal and everyday  
as orbits of electrons,  
chemical rings, noted here  
in one brief sign as gateway  
to completed turns and  
the distance inside circles,  
both compact and infinite.

*Poetry*

Pv. clxi, Number 4 (January, 1993) (p. 204)

**Preston, Richard**

No biographical data available

The digits of pi march to infinity in a predestined yet unfathomable code: they do not repeat periodically, seeming to pop up by blind chance, lacking any perceivable order, rule, reason, or design — "random" integers, ad infinitum.



The Mountains of Pi  
*The New Yorker*, March 2, 1992

...pi is not the solution to any equation built from a less than infinite series of whole numbers. If equations are trains threading the landscape of numbers, then no train stops at pi.

The Mountains of Pi  
*The New Yorker*, March 2, 1992

**PILL**

**Crichton-Browne, Sir James** 1840–1938  
 English physician

If you want fame and fortune, invent a pill.  
*The Doctor's After Thoughts* (p. 14)  
 E. Benn Ltd. London, England. 1932

**Fuller, Thomas** 1608–61  
 English clergyman and author

If the pills were pleasant, they would not want gilding.  
*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings. Ancient and Modern, Foreign and British*  
 No. 2711  
 Printed for Thomas and Joseph Allman. London, England. 1816

**Herrick, Robert** 1591–1674  
 English poet

When his potion and his pill  
 His, or none, or little skill  
 Meet for nothing, but to kill;  
 Sweet Spirit comfort me!!  
 In J. Max Patrick (ed.)  
*The Complete Poetry of Robert Herrick*  
 His Litanie, to the Holy Spirit (p. 132)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Jerrold, Douglas William** 1803–57  
 English playwright, journalist, and humorist

A pill that the present moment is daily bread to thousands.  
*The Catspaw: A Comedy in Five Acts*  
 Act I, Scene I  
 Published at the Punch Office. London, England. 1850

**Molière (Jean-Baptiste Poquelin)** 1622–1673  
 French playwright and actor

My lord Jupiter knows how to gild the pill.  
*Amphitryon*  
 Act III, Scene X, l. 24  
 Harcourt, Brace & Company. New York, New York, USA. 1995

**Ray, John** 1627–1705  
 English naturalist

Apothecaries would not give pills in sugar unless they were bitter.  
*A Complete Collection of English Proverbs* (p. 2)  
 Printed for G. Cowie. London, England. 1813

**Shakespeare, William** 1564–1616  
 English poet, playwright, and actor

When I was sick, you gave me bitter pills.  
 In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
 The Two Gentlemen of Verona  
 Act II, Scene iv, l. 149  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Stumpf, LaNore**  
 No biographical data available

How is it that a little pill  
 Without a pair of eyes to see  
 Can travel down, and round and round  
 And figure out what's wrong with me?  
 Needed: Remote Control  
*American Journal of Nursing*, April 1969 (p. 902)

**PLANET**

**Author undetermined**

The discovery of a new planet in a new way, by first finding where a planet ought to be, has given a fresh impulse to the enthusiasm of astronomers. All are looking to see if the motions of heavenly bodies in some other direction does not indicate that there are more weights in the scale on that side than have yet been seen.  
*Scientific American*, Volume 2, Issue 26, March 20, 1847 (p. 203)

A new planet, it is said, has lately been discovered. This is not correct. The planet is as “old as the hills.”  
*Scientific American*, Volume 2, Issue 9, November 21, 1846 (p. 68)

**Banks, Sir Joseph** 1743–1820  
 English explorer and naturalist

Some of our astronomers here incline to the opinion that it is a planet and not a comet; if you are of that opinion it should forthwith be provided with a name [or] our nimble neighbors, the French, will certainly save us the trouble of Baptizing it.  
 In Constance A. Lubbock  
*The Herschel Chronicle* (p. 95)  
 The Macmillan Company. New York, New York, USA. 1933

**Blackmore, Sir Richard** 1650–1729  
 English physician and writer

All these Illustrious Worlds, and many more,  
 Which by the Tube Astronomers explore;  
 And Millions which the Glass can ne'er descry,  
 Lost in the Wilds of vast Immensity,  
 Are Suns, are Centers, whose Superior Sway  
 Planets of various Magnitude obey.  
*The Poetical Works of Sir R. Blackmore: Containing Creation: A Philosophical Poem, in Seven Books*  
 Book II, l. 536–541  
 Printed for C. Cooke. London, England. 1797

In beauteous Order all the Orbs advance,  
 And in their mazy complicated Dance,  
 Not in one part of all the Pathless Sky  
 Did any ever halt, or step awry.

*The Poetical Works of Sir R. Blackmore: Containing Creation: A Philosophical Poem, in Seven Books*  
 Book II, l. 91–94  
 Printed for C. Cooke. London, England. 1797

**Burroughs, John** 1837–1921  
 American naturalist and writer

The earth is not alone, it is not like a single apple on a tree; there are many apples on the tree, and there are many trees in the orchard.

*The Breath of Life*  
 Chapter XII (p. 289)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**Chapman, Clark R.**  
 Astronomer and asteroid researcher

Planets are like living creatures. They are born, full of life and activity. They mature, consume energy, and settle into established ways. Finally, they run down, become dormant, and die. On a human time scale planetary lives are virtually eternal. We see only a snapshot of each planet and can only surmise its evolution.

*The Inner Planets: New Light on the Rocky Worlds of Mercury, Venus, Earth, the Moon, Mars, and the Asteroids*  
 Chapter 6 (pp. 88–89)  
 Charles Scribner's Sons. New York, New York, USA. 1977

**Chaucer, Geoffrey** 1343–1400  
 English poet

The seven bodies I'll describe anon:  
 Sol, gold is, Luna's silver, as we see,  
 Mars iron, and quicksilver's Mercury,  
 Saturn is lead, and Jupiter is tin,  
 And Venus copper, by my father's kin!

In *Great Books of the Western World* (Volume 22)  
*The Canterbury Tales*  
 Canon Yeoman's Tale (p. 476)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**de Bergerac, Cyrano** 1619–55  
 French dramatist

For my part, I...believe the Planets are Worlds about the Sun, and that the Fixed Stars are also Suns which have Planets about them, that's to say, Worlds which because of their smallness, and that their borrowed light can-not reach us, are not discernible by Men in this World...

In Roger A MacGowan and Frederick I. Ordway, III  
*Intelligence in the Universe*  
 The Comical History of the States and Empires of the World and of the Sun (p. 1)  
 Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1966

**de Fontenelle, Bernard le Bovier** 1657–1757  
 French author

...you must go a great way to prove that the Earth may be a Planet, the Planets so many Earths, and all the Stars Worlds.

In Roger A MacGowan and Frederick I. Ordway, III  
*Intelligence in the Universe* (p. 75)  
 Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1966

**Doyle, Sir Arthur Conan** 1859–1930  
 Scottish writer

“But the Solar System!” I protested.

“What the deuce is it to me?” [Sherlock Holmes] interrupted impatiently: “You say that we go round the sun. If we went round the moon it would not make a pennyworth of difference to me...”

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
 A Study in Scarlet, Chapter 2 (p. 154)  
 Wings Books. New York, New York, USA. 1967

**Dudley Manlove**  
 Fictional character

Do you still believe it impossible we exist? You didn't actually think you were the only inhabited planet in the universe. How can any race be so stupid?

*Plan 9 from Outer Space*  
 Film (1959)

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

If the planets of the solar system should fail us, there remain some thousands of millions of stars which we have been accustomed to regard as suns ruling attendant systems of planets. It has seemed a presumption, bordering almost on impiety, to deny them life of the same order of creation as ourselves. It would indeed be rash to assume that nowhere else has Nature repeated the strange experiment which she has performed on the earth.

Man's Place in the Universe  
*Harper's Magazine*, October 1928 (p. 573)

**Eiseley, Loren C.** 1907–77  
 American anthropologist, educator and author

Things get odder on this planet, not less so.

*The Unexpected Universe*  
 Chapter Ten (p. 232)  
 Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

He who knows what sweets and virtues are in the ground, the waters — the planets, the heavens, and how to come at these enchantments, is the rich and royal man.

*Ralph Waldo Emerson: Essays and Lectures*  
 Essays: Second Series  
 Nature (p. 543)  
 The Library of America. New York, New York, USA. 1983

**Feynman, Richard P.** 1918–88

American theoretical physicist

...what makes planets go around the sun? At the time of Kepler some people answered this problem by saying that there were angels behind them beating their wings and pushing the planets around in orbit. As you will see, the answer is not very far from the truth. The only difference is that the angels sit in a different direction and their wings push inwards.

*The Character of Physical Law*  
Chapter 1 (p. 18)  
BBC. London, England. 1965

**Hammond, Allen Lee**

No biographical data available

With the beginning of direct exploration of the solar system, planetary science has revived to become not only respectable but one of the active, forefront areas of research. How active can be gauged by the assessment, widely agreed on, that the rate of new discoveries and the rate of obsolescence of old ideas have never been so rapid as at present. Investigators are now confronted with such an overwhelming array of new observations and theories that what amounts to a revolution in understanding the solar system is in progress.

Exploring the Solar System(s): An Emerging New Perspective  
*Science*, Volume 186, Number 4165, 22 November 1974 (p. 720)

**Herschel, Friedrich Wilhelm** 1738–1822

English astronomer

It has generally been supposed that it was a lucky accident that brought this new star to my view; this is an evident mistake. In the regular manner I examined every star of the heavens, not only of that magnitude but many far inferior, it was that night its turn to be discovered.

In Constance A. Lubbock  
*The Herschel Chronicle* (pp. 78–79)  
The Macmillan Company. New York, New York, USA. 1933

**Hey, Nigel S.** 1936–

American science writer

Each of us is part of an endless drama that started billions of years ago, when a gargantuan cloud of cosmic gas and dust began to collect within the firmament. Then our galaxy, the Milky Way, came to be, and, within it, our solar system. The Sun is the great nucleus of this little cell, radiating incredible amounts of energy to its daughter planets, furnishing all the ingredients of life and all the analogues of life that manifest themselves as simple movement and change.

*Solar System*  
Chapter 1 (p. 11)  
Weidenfield & Nicolson. London, England. 2002

I used to wonder, why bother? The other planets and moons are too inhospitable for us ever to visit, let alone

colonize. But this is shallow thinking. Our destiny is in space. We will always want to explore new frontiers, even when separated physically by great gulfs of space and time. The need is in our genes. And who knows what wonders we may find out there.

*Solar System*  
Introduction (p. 8)  
Weidenfield & Nicolson. London, England. 2002

**Homer (Smyrns of Chios)** fl. 750 BCE

Greek poet

The thick tresses of gold with which Vulcan had crested the helmet floated round it, and as the evening star that shines brighter than all others through the stillness of night, even such was the gleam of the spear which Achilles poised in his right hand, fraught with the death of noble Hector.

In *Great Books of the Western World* (Volume 4)  
*The Iliad of Homer*  
Book XXII, l. 317 (p. 158)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

At length as the Morning Star was beginning to herald the light which saffron-mantled Dawn was soon to suffuse over the sea, the flames fell and the fire began to die.

In *Great Books of the Western World* (Volume 4)  
*The Iliad of Homer*  
Book XXIII, l. 226 (p. 163)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

...the rest of the Planets have their Dress and Furniture, nay and their Inhabitants too as well as this Earth of ours.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*  
Book the First (p. 2)  
Printed for T. Childe. London, England. 1698

**Lockyer, Joseph Norman** 1836–1920

English astronomer and physicist

The work of the true man of Science is a perpetual striving after a better and closer knowledge of the planet on which his lot is cast, and of the universe in the vastness of which that planet is lost.

*Studies in Spectrum Analysis*  
Chapter I (p. 1)  
D. Appleton & Company. New York, New York, USA. 1878

**Marcy, Geoffrey**

American astronomer

Look at how perfect this thing is. It's like a jewel. You've got circular orbits. They're all in the same plane. They're all going around in the same direction. ... It's perfect, you know. It's gorgeous. It's almost uncanny.

Jumping Jupiter! Is Our Solar System a Rarity?  
*Washington Post*, Monday, February 15, 1999 (p. A3)

**Marlowe, Christopher** 1564–93  
 English poet

...whose faculties can comprehend  
 The wondrous architecture of the world,  
 And measure every wand'ring planet's course...  
*Tamburlaine the Great*  
 Scene VIII  
 Odyssey Press. Indianapolis, Indiana, USA. 1974

**Miller, Hugh** 1802–56  
 Scottish geologist and theologian

The planet which we inhabit is but one vessel in the midst  
 of a fleet sailing on through the vast ocean of space, under  
 convoy of the sun.  
*Geology Versus Astronomy: Or the Conditions and the Periods; Being a  
 View of the Modifying Effects of Geologic Discovery on the Old Astro-  
 nomic Inferences Respecting the Plurality of Inhabited Worlds*  
 Chapter II (p. 14)  
 Glasgow, Scotland. 1857

**Molière (Jean-Baptiste Poquelin)** 1622–1673  
 French playwright and actor

We had a narrow escape, Madame, While asleep;  
 A neighboring planet did pass us close by,  
 Cutting a swathe right through our whirlpool;  
 Had its path led to a collision with mother earth,  
 She would have shattered in pieces like glass.  
*Les Femmes Savantes*  
 Act IV, Scene iii  
 Oxford University Press. Oxford, England. 1974

**Morrow, Jeff** 1907–93  
 American actor

A lifeless planet. And yet, yet still serving a useful pur-  
 pose, I hope. Yes, a sun. Warming the surface of some  
 other world. Giving light to those who may need it.  
*This Island Earth*  
 Film (1955)

**Redfern, Martin**  
 No biographical data available

We are no longer the victims of our planet, we are the  
 custodians of it. Through our inconsiderate greed for  
 land and our disregard for pollution, we bite the hand that  
 feeds us. But we do so at our own peril. We still have our  
 eggs in one basket, all our people in one planet. We need  
 to care for that planet and take responsibility for it. But  
 we also need to progress with the search for new homes  
 and the technology to take us to the stars.  
*The Earth: A Very Short Introduction*  
 Epilogue (p 132)  
 Oxford University Press, Inc. Oxford, England. 2003

**Shapley, Harlow** 1885–1972  
 American astronomer

Millions of planetary systems must exist, and billions  
 is the better word. Whatever the methods of origin, and  
 doubtless more than one type of genesis has operated,  
 planets may be the common heritage of all stars except  
 those so situated that planetary materials would be swal-  
 lowed up by greater masses or cast off through gravita-  
 tional action.  
*Of Stars and Men: Human Response to an Expanding Universe*  
 Chapter 7 (p. 112)  
 Beacon Press. Boston, Massachusetts, USA. 1958

**Siegel, Eli** 1902–78  
 American philosopher, poet, critic and founder of Aesthetic Realism

The planets show grandeur and nicety in their operations;  
 the question is, how did they learn this?  
*Damned Welcome*  
 Aesthetic Realism, Maxims, Part One, #50 (p. 26)  
 Definition Press. New York, New York, USA. 1972

**Standage, Tom**  
 English journalist and author

A planet is, by definition, an unruly object.  
*The Neptune File*  
 Chapter 2 (p. 19)  
 Walker & Company. New York, New York, USA. 2000

**Swedenborg, Emanuel** 1688–1772  
 Swedish scientist, theosophist, and mystic

[There are] many earths, inhabited by man...thousands,  
 yea, ten thousands of earths, all full of inhabitants...not  
 only in this solar system, but also beyond it, in the starry  
 heaven.  
*The Earths in Our Solar System, Which Are Called Planets, and Earths  
 in the Starry Heavens*  
 New Church Board of Publication. New York, New York, USA. 1876

**Tagore, Rabindranath** 1861–1941  
 Indian poet and philosopher

Through millions and millions of years,  
 The stars shine,  
 Fiery whirlpools revolve and rise  
 In the dark ever-moving current of time.  
 In this current  
 The earth is a bubble of mud...  
 Translated by Indu Dutt  
*Our Universe* (p. 43)  
 Jaico Publishing House. Bombay, India. 1969

**Teilhard de Chardin, Pierre** 1881–1955  
 French Jesuit, paleontologist, and biologist

Despite their vastness and splendor the stars cannot carry  
 the evolution of matter much beyond the atomic series:  
 it is only on the very humble planets, on them alone,  
 that the mysterious ascent of the world into the sphere  
 of higher complexity has a chance to take place. How-  
 ever inconsiderable they may be in the history of sidereal

bodies, however accidental their coming into existence, the planets are finally nothing less than the key-points of the Universe. It is through them that the axis of life now passes; it is upon them that the energies of an Evolution principally concerned with the building of large molecules is now concentrated.

*The Future of Man*

Chapter VI, Part I, Section I (p. 114)

Harper & Row, Publishers. New York, New York, USA. 1964

**Tennyson, Alfred (Lord)** 1809–92

English poet

This world was once a fluid haze of light,  
Till toward the centre set the starry tides,  
And eddied into suns, that wheeling cast  
The planets.

*Alfred Tennyson's Poetical Works*

The Princess, Part Second, l. 101–103

Oxford University Press, Inc. London, England. 1953

**Tombaugh, Clyde** 1906–97

American astronomer

Behold the heavens and the great vastness thereof, for a planet could be anywhere therein.

Thou shalt dedicate thy whole being to the search project with infinite patience and perseverance.

Thou shalt set no other work before thee, for the search shall keep thee busy enough.

Thou shalt take the plates [photographs] at opposition time lest thou be deceived by asteroids near their stationary positions.

Thou shalt duplicate the plates of a pair at the same hour angle lest refraction distortions overtake thee.

Thou shalt give adequate overlap of adjacent plate regions lest the planet play hide and seek with thee.

Thou must not become ill at the dark of the moon lest thou fall behind the opposition point.

Thou shalt have no dates except at full moon when long-exposure plates cannot be taken at the telescope.

Many false planets shall appear before thee, hundreds of them, and thou shalt check every one with a third plate.

In David H. Levy

*Clyde Tombaugh: Discoverer of Planet Pluto*

Chapter 12, Ten Special Commandments for a Would-Be Planet Hunter (p. 180)

University of Arizona Press. Tucson, Arizona, USA. 1991

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

It would be very singular that all Nature, all the planets, should obey eternal laws, and there should be a little animal, five feet high who, in contempt of these laws, could act as he pleased, solely according to his caprice.

In John D. Barrow

*The World Within the World* (p. 55)

Clarendon Press. Oxford, England. 1988

**PLANET: EARTH**

**Abbey, Edward** 1927–89

American environmentalist and nature writer

We know so very little about this strange planet we live on, this haunted world where all answers lead only to more mystery.

*The Crooked Word*

*Audubon Magazine*, Volume 77, Number 6, 1975 (p. 24)

We are obliged, therefore, to spread the news, painful and bitter though it may be for some to hear, that all living things on earth are kindred.

*Desert Solitaire*

*The Serpents of Paradise* (p. 24)

Ballantine Books. New York, New York, USA. 1968

Yes. Feet on earth. Knock on wood. Touch stone. Good luck to all.

*Desert Solitaire*

*Bedrock and Paradox* (p. 301)

Ballantine Books. New York, New York, USA. 1968

The earth is not a mechanism but an organism, a being with its own life and its own reasons, where the support and sustenance of the human animal is incidental.

*The Journey Home: Some Words in Defense of the American West*

Chapter 21 (p. 225)

E.P. Dutton. New York, New York, USA. 1977

The world is what it is, no less and no more, and therein lies its entire and sufficient meaning.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 9 (p. 89)

St. Martin's Press. New York, New York, USA. 1989

I am not an atheist but an earthiest. Be true to the earth.

*Desert Solitaire*

*Down the River* (p. 208)

Ballantine Books. New York, New York, USA. 1968

**Ackerman, Diane** 1948–

American writer

Long ago, Earth bunched its granite to form the continents, ground molar Alps and Himalayas, rammed Africa and Italy into Europe, gnashing its teeth, till mountain ranges buckled and churned, and oceans (salty once rivers bled flavor from the seasoned earth) gouged their kelpy graves. And the rest is history...

*The Planets: A Cosmic Pastoral*

Earth, III (p. 36)

William Morrow & Company, Inc. New York, New York, USA. 1976

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

...there was a time when our earth was in a state of igneous fusion, when no ocean bathed it and no atmosphere surrounded it, when no wind blew over it and no rain fell upon it, but an intense heat held all its materials in

solution. In those days the rocks which are now the very bones and sinews of our mother Earth — her granites, her porphyries, her basalts, her syenites — were melted into a liquid mass.

*Geological Structures*

Chapter I (p. 2)

Ticknor & Fields. Boston, Massachusetts, USA. 1866

**Airy, George Biddell** 1801–92

English astronomer

Since Astronomy first assumed the form of a Science, the inquiry into the Figure and dimensions of the Earth has always excited the interest of Philosophers. It can hardly be doubted that in the mind of a reflecting man there would always be a desire to know the nature of the Planet upon which he existed; but without Science of an exalted order, it would be impossible for him to gratify his curiosity.

*Encyclopaedia Metropolitana*, Volume 5, 1845

**Arendt, Hannah** 1906–75

Political philosopher

The earth is the very quintessence of the human condition...

*The Human Condition*

Prologue (p. 2)

The University of Chicago Press. Chicago, Illinois, USA. 1958

**Aristotle** 384 BCE–322 BCE

Greek philosopher

There is much change, I mean, in the stars which are overhead, and the stars seen are different, as one moves northward or southward. Indeed there are some stars seen in Egypt and in the neighborhood of Cyprus which are not seen in the northerly regions; and stars, which in the north are never beyond range of observation, in those regions rise and set. All of which goes to show not only that the earth is circular in shape, but also that it is a sphere of no great size: for otherwise the effect of so slight a change of place would not be so quickly apparent.

*On the Heavens*

Book II, Chapter 14

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Ball, Philip** 1962–

English science writer

What is so special about the Earth, then, is not that it is a world of water, but that the water is marine blue — we have oceans, not just glassy sheets of bright ice. Perhaps, soon after the solar system was formed, blue worlds were commonplace, until one by one they turned pearly or ruddy, or became shrouded in bright acid. And then there we were, a lone blue dot, waiting for life to begin.

*Life's Matrix: A Biography of Water*

Part One, Chapter 4 (p. 111)

Farrar, Straus & Giroux. New York, New York, USA. 2000

**Barrell, Joseph** 1869–1919

American geologist

The scheme of the Universe is more profound and the unknown is a little nearer than it was recently though to be. But such has been the progress of knowledge since man, in the days before the advent of science naively regarded the earth, his home, as firmament, created a few thousand years previously especially for his benefit.

In J.H.F. Umbgrove

*The Pulse of the Earth*

Chapter I (p. 2)

Martinus Nijhoff. The Hague, Netherlands. 1947

**Bellamy, David** 1933–

Botanist, author and broadcaster

The earth has a mass of  $5.97 \times 10^{24}$  kilograms... a big number and one that really matters because that is all the matter we have got.

*Forces of Life: The Botanic Man*

Chapter 2 (p. 24)

Crown Publishers. New York, New York, USA. 1979

**Beston, Henry** 1888–1968

American writer

Touch the earth, love the earth, honour the earth, her plains, her valleys, her hills, and her seas; rest your spirit in her solitary places.

*The Outermost House*

Chapter X (p. 222)

Rinehart & Company. New York, New York, USA. 1928

**Borland, Hal** 1900–78

American writer

I am not quite sure what the earth's business is, but I know it is not the nurturing of *Homo sapiens*, or any one species of animal or plant.

*Borland Country*

Foreword (p. 7)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

The earth, however, never forgets. While men are sleeping she is awake, silently strengthening the cords of her influence. When men make boast of their conquests she is not concerned, for she knows that the limits of human attainment are the limits she chooses to set. When they strut through the kingdom they think they have conquered, she tightens the strings that hold them to her hand.

*Autobiography of Earth*

Chapter XII (p. 331)

Coward-McCann, Inc. New York, New York, USA. 1935

The Earth is a selfish mother who would keep her children forever at her breast.

*Autobiography of Earth*

Chapter XII (p. 331)  
 Coward-McCann, Inc. New York, New York, USA. 1935

**Broad, William** 1951–  
 Science writer

**Wade, Nicholas**  
 British-born scientific writer

The ultimate gatekeeper of science is neither peer reviews, nor referees, nor replication, nor the universalism implicit in all three mechanisms. It is time. In the end, bad theories don't work, fraudulent ideas don't explain the world so well as true ideas do. The ideal mechanisms by which science should work are applied to a large extent in retrospect... Time and the invisible boot that kicks out all useless science are the true gatekeepers of science. But these inexorable mechanisms take years, sometimes more than a millennium, to operate. During the interval, fraud may flourish, particularly if it can find shelter under the mantle of immunity that scientific elitism confers.

*Betrayers of the Truth* (p. 106)  
 Simon & Schuster. New York, New York, USA. 1982

**Burnet, Thomas** 1635–1715  
 English cleric and scientist

We must therefore be impartial where the Truth requires it, and describe the Earth as it is really in it self; and though it be handsome and regular enough to the eye in certain parts of it, single tracts and single Regions; yet if we consider the whole surface of it, or the whole Exterieur Region, 'tis as a broken and confus'd heap of bodies, plac'd in no order to one another, nor with any correspondency or regularity of parts: And such a body as the Moon appears to us, when 'tis look'd upon with a good Glass, rude and ragged; as it is also represented in the modern Maps of the Moon; such a thing would the Earth appear if it was seen from the Moon. They are both in my judgment the image or picture of a great Ruine, and have the true aspect of a World lying in its rubbish.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)  
 Book I, Chapter IX (p. 91)  
 Printed by R. Norton. London. 1691

**Burroughs, William S.** 1914–97  
 American writer

After one look at this planet any visitor from outer space would say 'I WANT TO SEE THE MANAGER.'  
*The Adding Machine: Selected Essays*  
 Women: A Biological Mistake (p. 124)  
 Seaver Books. New York, New York, USA. 1986

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824  
 English Romantic poet and satirist

He saw with his own eyes the moon was round,

Was also certain that the earth was square.  
 Because he had journey'd fifty miles, and found  
 No sign that it was circular anywhere.

*The Complete Poetical Works of Byron*  
 Don Juan  
 Canto V  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Chamberlain, Rollin T.**  
 American geologist

Just as the written life of some famous man properly commences with a portrayal of his family antecedents, so any real history of the earth should begin with the activities of the sun and the origin of its present family of planets.

In H.H. Newman (ed.)  
*The Nature of the World and of Man*  
 The Origin and Early Stages of the Earth (p. 31)  
 The University of Chicago Press. Chicago, Illinois, USA. 1927

**Chief Seattle** ca. 1784–1866  
 Chief of the Duwamish, Suquamish, and allied Indian tribes

You must teach your children that the ground beneath their feet is the ashes of your grandfathers. So that they will respect the land, tell your children that the earth is rich with the lives of our kin. Teach your children what we have taught our children, that the earth is our mother. Whatever befalls the earth befalls the sons of the earth. If men spit upon the ground, they spit upon themselves.

*Catch the Whisper of the Wind: Collected Stories and Proverbs from Native Americans*  
 Attributed to Chief Seattle (p. 41)  
 Health Communications, Inc. Deerfield Beach, Florida, USA. 1995

**Cloos, Hans** 1885–1951  
 German geologist

The earth gives us more knowledge of ourselves than all the books, because it resists us.

*Conversations with the Earth*  
 Chapter VII (p. 99)  
 Alfred A. Knopf. New York, New York, USA. 1953

The earth is large and old enough to teach modesty; and yet it is small enough to be comprehended and to be learned from, as our understanding of it increases.

*Conversation with the Earth*  
 Prologue (p. 8)  
 Alfred A. Knopf. New York, New York, USA. 1953

Earth: beautiful, round, colorful planet. You carry us safely through the emptiness and deadness of space. Graciously you cover the black abyss with air and water. You turn us towards the sun, that we may be warm and content, that we may wander, with open eyes, through your meadows, and look upon your splendor. And then you turn us away from the too fiercely burning sun, that we may rest in the coolness of the night from life's heat and the struggle of the day.

*Conversation with the Earth*

Prologue (p. 3)

Alfred A. Knopf. New York, New York, USA. 1953

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

Earth! Thou mother of numberless children, the nurse  
and the mother,

Sister thou of the stars, and beloved by the Sun, the  
rejoicer!

Guardian and friend of the moon, O Earth, whom the  
comets forget not,

Yea, in the measureless distance wheel round and again  
they behold thee!

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

Hymn to the Earth (p. 328)

The Clarendon Press. Oxford, England. 1912

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

The planet Earth is a doomed ship being blown to inevi-  
table disaster by the winds of universal dynamics, a  
miniscule sacrifice to the attainment of that inscrutable  
destiny held secret by the galaxies as they rush through  
the long darkness of space.

*The Endless Adventure*

Once There Was a Planet (p. 181)

Henry Regnery Company. Chicago, Illinois, USA. 1972

I peer into the endlessness of space. The lights from a host  
of suns leap across the millions of miles of darkness to  
reach this spinning bit of star stuff we call Earth. This out-  
cropping of rock has unknowingly endureth the passage of  
millennia. The footpads of extinct species have pattered  
over it. An Indian in moccasins once stood upon it. Forests  
have appeared, disappeared and reappeared around it. It  
has been washed by floods, buried in ice and baked by the  
sun. Here it will lie through the ages yet to come, silently  
awaiting the next phase of a planet's destiny.

*The Endless Adventure*

Once There Was a Planet (p. 185)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

[We] may say that the earth has a spirit of growth; that  
its flesh is the soil, its bones are the successive strata of  
the rocks which form the mountains, its muscles are the  
tufa stone, its blood the springs of its waters. The lake of  
blood that lies about the heart is the ocean; its breathing  
is by the increase and decrease of the blood in its pulses,  
and even so in the earth is the flow and ebb of the sea.  
And the heat of the spirit of the world is the fire which is  
spread throughout the earth; and the dwelling-place of its  
creative spirit is in the fires, which in diverse parts of the  
earth are breathed out in baths and sulphur mines, and in  
volcanoes...

*Leonardo da Vinci's Note Books* (pp. 130–131)

Duckworth & Company. London, England. 1906

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The incredible beauty of the earth as seen from space  
results largely from the fact that our planet is covered  
with living things. What gives vibrant colors and excit-  
ing variety to the surface of the earth is the fact that it is  
literally a living organism.

*Federal Highway Act of 1970 and Miscellaneous Bills*

United States Congress. Senate. 1970

The spaceship Earth is the cage within and against which  
man has developed in his evolutionary past and continues  
to develop his biological and mental characteristics. As  
the terrestrial environment deteriorates so does human-  
ness and the quality of human life.

*Reason Awake*

Chapter 5 (pp. 191–192)

Columbia University Press. New York, New York, USA. 1970

**Dunlap, Ellen L.**

No biographical data available

The building of the earth was dramatic beyond our  
imagination. The shaping of the continents and the ocean  
depths required titanic convulsions. The Supreme One  
did not shout the Earth into instant being any more than  
an architect would order the instant erection of a sky-  
scraper. The ground work must be laid, and, little by  
little, the job progresses. It required several billions of  
years to make the Earth what it is today, and the job is  
not yet done.

From Aunt Nellie's Notebook

*Nature Magazine*, January 1958 (p. 17)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

My subject [astronomy] disperses the galaxies, but it  
unites the Earth.

In Arthur Beer (ed.)

*Vistas in Astronomy* (Volume 2)

Meeting of the International Astronomical Union, Cambridge, Mas-  
sachusetts, USA., September, 1932 (p. i)

**Ehrenreich, Barbara** 1941–

American social critic and essayist

Some of us still get all weepy when we think about the  
Gaia Hypothesis, the idea that earth is a big furry god-  
dess-creature who resembles everybody's mom in that  
she knows what's best for us. But if you look at the  
historical record — Krakatoa, Mt. Vesuvius, Hurricane  
Charley, poison ivy, and so forth down the ages — you  
have to ask yourself: Whose side is she on, anyway?

*The Worst Years of Our Lives*

The Great Syringe Tide (p. 55)

Pantheon Books. New York, New York, USA. 1981



**Einstein, Albert** 1879–1955  
German-born physicist

There has been an earth for a little more than a billion years. As for the question of the end of it I advise: Wait and see.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 182)  
Birkhäuser. Boston, Massachusetts, USA. 1987

**Ficino, Marsilio** 1433–1499  
Early Italian humanist philosopher

We see the Earth give birth, thanks to varieties of seeds, to a multitude of trees and animals, nourish them, and make them grow; we see her cause even stones to grow as her teeth, vegetable life as hairs, as long as they remain connected to their roots, while if they are removed or unearthed they cease growing. Could we say that the breast of this female lacks life, she who spontaneously gives birth and nourishes so many offspring, who sustains herself and whose back carries teeth and hair?

*Theologica plantonica* (Volume 1) (p. 144)  
Harvard University Press. Cambridge, Massachusetts, USA. 1917

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

For my part, I consider the earth very noble and admirable precisely because of the diverse alterations, changes, generations, etc., that occur in it incessantly. If, not being subject to any change, it were a vast desert of sand or a mountain of jasper, or if at the time of the flood the waters which covered it had frozen, and it had remained an enormous globe of ice where nothing was ever born or ever altered or changed, I should deem it a useless lump in the universe, devoid of any activity and, in a word, superfluous and essentially nonexistent.

*Dialogues Concerning the Two Chief World Systems*  
The First Day (p. 58)  
University of California Press. Berkeley, California, USA. 1953

**Gray, George W.**  
Freelance science writer

Perhaps the Earth is a clod, but if so it is a vibrant clod, responsive to an endless symphony — or cacophony — of cosmic influences.

*The Advancing Front of Science*  
Chapter II (p. 25)  
Whittlesey House. New York, New York, USA. 1937

**Guiterman, Arthur** 1871–1943  
Poet

We dwell within the Milky Way,  
Our Earth, a paltry little mommet,  
Suspended in a grand array  
Of constellation, moon and comet.

*Gaily the Troubadour*  
Outline of the Universe (p. 70)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1936

**Hageman, Samuel M.** 1848–1905  
American clergyman and poet

Earth is but the frozen echo of the silent voice of God.

*Silence*  
Silence, Stanza XIX  
Dodd, Mead and Company. New York, New York, USA. 1877

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

Let me enjoy the earth no less  
Because the all-enacting Might  
That fashioned forth its loveliness  
Had other aims than my delight.

Collected Poems of Thomas Hardy  
Let Me Enjoy the Earth  
Macmillan & Company Ltd. London, England. 1920

**Hillel, Daniel**  
No biographical data available

We have all come out of the earth, and are its children. The earth has always nurtured us, despite our scornful abuse, and we can no longer continue to behave as its ungrateful offspring. It is time for us, as *Homo sapiens curans*, to nurture the earth in return.

*Out of the Earth: Civilization and the Life of the Soil*  
Chapter 30 (p. 283)  
The Free Press. New York, New York, USA. 1991

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

...once a photograph of the Earth, taken from the outside, is available, a new idea as powerful as any in history will be let loose.

In Martin Redfern  
*The Earth: A Very Short Introduction*  
Chapter 1 (p. 1)  
Oxford University Press, Inc. Oxford, England. 2003

**Humphrey, Hubert H.** 1911–78  
38<sup>th</sup> vice-president of the United States

As we begin to comprehend that the earth itself is a kind of manned spaceship hurtling through the infinity of space — it will seem increasingly absurd that we have not better organized the life of the human family.  
Speech, 26 September 1966

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

This globe of the earth is a habitable world; and on its fitness for this purpose, our sense of wisdom in its formation must depend.

*The Theory of the Earth* (Volume 1)  
Part I, Chapter I, Section I (p. 4)  
Messrs. Cadwell, Junior, and Davies. London, England. 1795

When we trace the parts of which this terrestrial system is composed, and when we view the general connection of those several parts, the whole presents a machine of a peculiar construction by which it is adapted to a certain end. We perceive a fabric, erected in wisdom, to obtain a purpose worthy of the power that is apparent in the production of it.

*The Theory of the Earth* (Volume 1)

Part I, Chapter I, Section I (p. 3)

Messrs. Cadwell, Junior, and Davies. London, England. 1795

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

...how vast those Orbs must be, and how inconsiderable this Earth, the Theatre upon which all our mighty Designs, all our Navigations, and all our Wars are transacted, is when compared to them. A very fit Consideration, and matter of Reflection, for those Kings and Princes who sacrifice the Lives of so many People, only to flatter their Ambition in being Masters of some pitiful corner of this small Spot.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Book the Second. The Immense Distance Between the Sun and the Planets Illustrated (pp. 141–142)

Printed for T. Childe. London, England. 1698

**Irwin, James** 1930–91

American astronaut

The Earth reminded us of a Christmas tree ornament hanging in the blackness of space. As we got farther and farther away it diminished in size. Finally it shrank to the size of a marble, the most beautiful marble you can imagine. That beautiful, warm, living object looked so fragile, so delicate, that if you touched it with a finger it would crumble and fall apart. Seeing this has to change a man, has to make a man appreciate the creation of God and the love of God.

In Kevin W. Kelley

*The Home Planet*

With Plate 38

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1988

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Standing on our microscopic fragment of a grain of sand, we attempt to discover the nature and purpose of the universe which surrounds our home in space and time.

*The Mysterious Universe*

Chapter I (p. 3)

The Macmillan Company. New York, New York, USA. 1932

So long as the earth was believed to be the center of the universe the question of life on the other worlds could hardly arise; there are no other worlds in the astronomical sense, although a heaven above and a hell beneath might form adjuncts to this world.

Is There Life on the Other Worlds

*Annual Report of the Board of Regents of the Smithsonian Institution, 1942*

(p. 145)

Government Printing Office. Washington, D.C. 1943

**Jeffers, Robinson** 1887–1962

American poet

It is only a little planet

But how beautiful it is.

*The Beginning and the End and Other Poems*

How Beautiful It Is (p. 29)

Random House, Inc. New York, New York, USA. 1963

**Johnson, Lyndon B.** 1908–73

36<sup>th</sup> president of the United States

Think of our world as it looks from that rocket that's heading toward Mars. It is like a child's globe, hanging in space, the continents stuck to its side like colored maps. We are all fellow passengers on a dot of earth. And each of us, in the span of time, has really only a moment among our companions.

Inaugural Address, January 20, 1965

**Kahn, Fritz** 1888–1958

German-born American writer and conceptual medical illustrator

This is the universe: infinity. Space without beginning, without end, dark, empty, cold. Through the silent darkness of this space more gleaming spheres, separated from each other by inconceivable distances. Around them again inconceivably far away, like bits of dust lost in immensity, circle smaller dark spheres, receiving light and life from their "mother suns." One of these little spheres in the light of one of the countless suns in endless space, is our earth. This is man's home in the universe.

*Design of the Universe*

Chapter One (p. 2)

Crown Publishers. New York, New York, USA. 1954

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Considering the almost certain truth that the earth was built up of meteorites falling together, we may follow in imagination the whole process of shrinking from gaseous nebula to liquid lava and metals, and solidification of liquid from central regions outward.

The Age of the Earth as An Abode Fitted for Life

*Science*, New Series, Volume 9, Number 229, May 19, 1898 (p. 706)

All these reckonings of the history of underground heat, the details of which I am sure you do not wish me to put before you at present, are founded on the very sure assumption that the material of our present solid earth all round its surface was at one time a white-hot liquid.

The Age of the Earth As An Abode Fitted for Life

*Science*, New Series, Volume 9, Number 229, May 19, 1898 (p. 672)

**MacLeish, Archibald** 1892–1982  
American poet and Librarian of Congress

To see the earth as we now see it, small and beautiful in that eternal silence where it floats, is to see ourselves as riders on the earth together, brothers on that bright loveliness in the unending night — brothers who see now they are truly brothers.

*Riders on the Earth*  
Bubble of Blue Air (p. xiv)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1978

**Marvin, Ursula**  
American geologist

In learning about the earth — a most fundamental preoccupation of man — geologists are limited to direct examination of its outermost surface and that of its nearest neighbor, the moon. All knowledge of the deep interior of our planet and of the nature of other planets in the solar system is gathered by remote sensing devices. Characteristically, the signals from these devices are interpreted differently by different scientists and every new advance tends to raise new problems, leaving us acutely aware of the limitations of our knowledge.

*Continental Drift: Evolution of a Concept*  
Postscript (p. 207)  
Smithsonian Institution Press, Washington, D.C. 1973

**Masson, David**  
No biographical data available

Each orb has had its history. For ours,  
It blazed and steamed, cooled and contracted, till,  
Tired of mere vapping within the grasp  
Of ruthless condensation, it assumed  
The present form, proportions, magnitude —  
Our Tidy ball, axeled eight thousand miles.

In Alexander Winchell  
*World-Life or Comparative Geology*  
Chapter III (p. 338)  
S.C. Griggs & Company, Chicago, Illinois, USA. 1883

**Momaday, N. Scott** 1934–  
Native American writer

Once in his life a man ought to concentrate his mind upon the remembered earth, I believe. He ought to give himself up to a particular landscape in his experience, to look at it from as many angles as he can, to wonder about it, to dwell upon it. He ought to imagine that he touches it with his hands at every season and listens to the sounds that are made upon it. He ought to imagine the creatures there and all the faintest motions of the wind. He ought to recollect the glare of noon and all the colors of the dawn and dusk.

*The Way to the Rainy Mountain*  
The Closing, XXIV (p. 83)  
University of New Mexico Press, Albuquerque, New Mexico, USA. 1969

**Montague, C. E.**  
No biographical data available

The earth with no history to it — what it would be if it had all been made only last night and were not a worn ancient face, seamed, stained, and engraved with endless cross-hatching of documentary wrinkles, its mountains the ruins of more wondrous height now all but erased.

In A.C. Seward  
*Plant Life Through the Ages: A Geological and Botanical Retrospect*  
Chapter 1 (p. 1)  
Hafner Publishing Company, New York, New York, USA. 1959

**Morton, Oliver**  
Science and technology editor

If the space age has opened new ways of seeing mere matter, though, it has also fostered a strange return to something reminiscent of the pre-Copernican universe. The life that Lowell and his like expected elsewhere has not appeared, and so the Earth has become unique again. The now-iconic image of a blue-white planet floating in space, or hanging over the deadly deserts of the moon, reinforces the Earth's isolation and specialness. And it is this exceptionalism that drives the current scientific thirst for finding life elsewhere, for finding a cosmic mainstream of animation, even civilization, in which the Earth can take its place. It is both wonderful and unsettling to live on a planet that is unique.

*Mapping Mars: Science, Imagination and the Birth of a World*  
A Point of Warlike Light (p. 14)  
Fourth Estate, London, England. 2002

**Muir, John** 1838–1914  
American naturalist

...when we contemplate the whole globe as one great dewdrop, striped and dotted with continents and islands, flying through space with other stars all singing and shining together as one, the whole universe appears as an infinite storm of beauty.

*Travels in Alaska*  
Chapter I (p. 5)  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1915

**Newman, Joseph S.** 1892–1960  
American poet

This ball was once a glowing mass  
Of mixed and superheated gas  
Which cooled to liquid, shrank in girth,  
Solidified and turned to earth.

*Poems for Penguins and Other Lyrical Lapses*  
Geology  
Greenburg, New York, New York, USA. 1941

**Peattie, Donald Culrose** 1896–1964  
American botanist, naturalist, and author

Old earth is great with her children, the bulb and the grub, and the sleepy mammal and the seed.

*An Almanac for Moderns*

April Sixth (p. 19)

G.P. Putnam's Sons. New York, New York, USA. 1935

### **Platt, John R.**

No biographical data available

The earth is finite, and when we have come to the ends of it, we have come to the ends of it.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1968*

The New Biology and the Shaping of the Future (p. 124)

Encyclopaedia Britannica, Inc. Chicago, Illinois, USA. 1966

### **Pollard, William**

No biographical data available

...the earth with its vistas of breathtaking beauty, its azure seas, beaches, mighty mountains, and soft blanket of forest and steppe is a veritable wonderland in the universe. It is a gem of rare and magic beauty hung in a trackless space filled with lethal radiations and accompanied in its journey by sister planets which are either viciously hot or dreadfully cold, arid, and lifeless chunks of raw rocks. Earth is choice, precious, and sacred beyond all comparison or measure.

In Michael Hamilton (ed.)

*This Little Planet*

God and His Creation (p. 59)

Charles Scribner's Sons. New York, New York, USA. 1970

### **Pupin, Michael**

Physicist

Our terrestrial globe is a celestial casting, and he who like myself learned the language of the foundry in his early youth will ask the human question: What is the mission of this celestial casting, this old celestial wanderer through the mighty stream of chaotic solar radiation? Is it only to receive its final tempering from the solar furnace which gave it its birth, and to smooth out its jagged surface by the erosive action of the waters which solar radiation carries in ceaseless succession of cycles from the oceans to the higher continental elevations? The answer to this human question is obvious; it is this: The highest mission of this celestial casting, which we call affectionately "our mother earth," is to provide a congenial home for a new universe, "the universe of organic life."

*The New Reformation: From Physical to Spiritual Realities*

Chapter VII, Section IV (pp. 235–236)

Charles Scribner's Sons. New York, New York, USA. 1928

### **Robinson, Victor** 1886–1947

Physician

Earth is her own historian, and in every age writes her story in forests and deserts, on rocks and in river-beds.

*The Story of Medicine*

Chapter I (p. 1)

The New York Home Library. New York, New York, USA. 1943

### **Sagan, Carl** 1934–96

American astronomer and author

There are some hundred billion ( $10^{11}$ ) galaxies, each with, on the average a hundred billion stars. In all the galaxies, there are perhaps as many planets as stars,  $10^{11} \times 10^{11} = 10^{22}$ , ten billion trillion. In the face of such overpowering numbers, what is the likelihood that only one ordinary star, the Sun, is accompanied by an inhabited planet? Why should we, tucked away in some forgotten corner of the Cosmos, be so fortunate? To me, it seems far more likely that the universe is brimming over with life. But we humans do not yet know. We are just beginning our explorations. The only planet we are sure is inhabited is a tiny speck of rock and metal, shining feebly by reflected sunlight, and at this distance utterly lost.

*Cosmos*

Chapter I (p. 5, 7)

Random House, Inc. New York, New York, USA. 1980

Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves.

*Pale Blue Dot: A Vision of the Human Future In Space*

Chapter I (p. 9)

Random House, Inc. New York, New York, USA. 1994

If we are to understand the Earth, we must have a comprehensive knowledge of the other planets.

The Solar System

*Scientific American*, Volume 233, Number 3, 1975 (p. 27)

### **Schneider, Herman** 1905–2003

Polish-born American educator and author

### **Schneider, Nina**

No biographical data available

The story of the earth is in a leaf and in a stone; in a cloud and in the sea. The leaf was once a stone; the cloud was once the sea. The earth tells its story over and over again—the leaf will become a stone, the cloud will become the sea again.

*Rocks, Rivers and the Changing Earth: A First Book About Geology*

Part One. A Leaf and A Stone (p. 3)

William R. Scott, Inc. New York, New York, USA. 1952

### **Scrope, George Poulett** 1797–1876

English geologist and political economist

Towards the end of the last century, men of science became convinced of the futility of those crude and fanciful speculations on the original state of the earth, in which cabinet geologists had for some time indulged; and justly perceived that the only sure road to the true history of our planet lies in a minute and practical study of those portions of its surface which are open to our examination, and in their comparison with the results of those changes

and operations which the ever-active hand of Nature is still carrying on upon that surface.

*Memoir on the Geology of Central France*

Preface (p. v)

Longman, Rees, Orme, Brown & Green. London, England. 1827

**Sedgewick Seti** 1854–1913

English geologist

The earth is our cradle,  
The solar system our kindergarten,  
The galaxy our middle-school and  
The universe our university.

Filler material

*Cosmic Search Magazine*, Volume 1, Number 1, January 1979 (p. 24)

**Sexton, Anne** 1928–74

American poet

God owns heaven, but He craves the earth.

*The Awful Rowing Toward God*

The Earth

Houghton Mifflin Company. Boston, Massachusetts, USA. 1975

**Shaler, Nathaniel Southgate** 1841–1906

American geologist

...earth-lore is not a discrete science at all, but is that way of looking at the operations of energy in the physical, chemical and organic series which introduces the elements of space and time into the considerations and which furthermore endeavors to trace the combination of the various trends of action in the stages of the developments of the earth. It is in these peculiarities of geology that we find the basis of its value in education and in the general culture of society.

Relations of Geologic Science to Education

*Bulletin of the American Geological Society*, Volume 7, Number x, 1896 (p. 319)

**Taine, Hippolyte** 1828–93

French critic and historian

Amid this vast and overwhelming space and in these boundless solar archipelagoes, how small is our own sphere, and the earth, what a grain of sand!

Translated by John Durand

*The Ancient Regime*

Book Third, Chapter II (p. 175)

Henry Holt & Company. New York, New York, USA. 1881

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

Without being overawed by the improbable, let us now concentrate our attention on the planet we call Earth. Enveloped in the blue mist of oxygen which its life breathes, it floats at exactly the right distance from the sun to enable the higher chemisms to take place on its surface. We do well to look at it with emotion. Tiny and

isolated though it is, it bears clinging to its flanks the destiny and future of the Universe.

*The Future of Man*

Chapter VI, Part I, Section I (p. 114)

Harper & Row, Publishers. New York, New York, USA. 1964

**Tennyson, Alfred (Lord)** 1809–92

English poet

Many an aeon moulded earth before her highest, man,  
was born,

Many an aeon too may pass when earth is manless and  
forlorn,

Earth so huge and yet so bounded — pools of salt and  
plots of land — Shallow skin of green and azure — chains  
of mountains, grains of sand!

*Alfred Tennyson's Poetical Works*

Locksley Hall, Sixty Years After, Stanza 103

Oxford University Press, Inc. London, England. 1953

**Thomas, Lewis** 1913–93

American physician and biologist

Viewed from the distance of the moon, the astonishing thing about the earth, catching the breath, is that it is alive. The photographs show the dry, pounded surface of the moon in the foreground, dry as an old bone. Aloft, floating free beneath the moist, gleaming, membrane of bright blue sky, is the rising earth, the only exuberant thing in this part of the cosmos.

*The Lives of a Cell: Notes of a Biology Watcher*

The World's Biggest Membrane (p. 145)

The Viking Press. New York, New York, USA. 1974

The word for earth, at the beginning of the Indo-European language thousands of years ago (no one knows for sure how long ago) was *dhghem*. From this word, meaning simply earth, came our word humus, the handiwork of soil bacteria. Also, to teach us the lesson, [came the words] humble, human, and humane. There is the outline of a philological parable here.

In Lynn Margulis and Dorion Sagan

*Microcosmos*

Foreword (p. 12)

Summit Books. New York, New York, USA. 1986

The overwhelming astonishment, the queerest structure we know about so far in the whole universe, the greatest of all cosmological scientific puzzles, confounding all our efforts to comprehend it, is the earth.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*

The Corner of the Eye (p. 16)

Viking Press. New York, New York, USA. 1983

I have been trying to think of the earth as a kind of organism, but it is no go. I cannot think of it this way. It is too big, too complex, with too many working parts lacking visible connections. The other night, driving through a hilly, wooded part of southern New England, I wondered about this. If not like an organism, what is it like, what is

it most like? Then, satisfactorily for that moment, it came to me: it is most like a single cell.

*The Lives of a Cell: Notes of a Biology Watcher*

The Lives of a Cell (p. 5)

The Viking Press. New York, New York, USA. 1974

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The earth is not a mere fragment of dead history, stratum upon stratum like the leaves of a book, to be studied by geologists and antiquaries chiefly, but living poetry like the leaves of a tree, which precede flowers and fruit — not a fossil earth, but a living earth; compared with whose great central life all animal and vegetable life is merely parasitic. Its throes will heave our exuviae from their graves... You may melt your metals and cast them into the most beautiful moulds you can; they will never excite me like the forms which this molten earth flows out into.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter XVII (p. 476)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Vitousek, Peter Mooney**

No biographical data available

**Lubchenco, Harold A.**

No biographical data available

... we are changing Earth more rapidly than we are understanding it.

Human Domination of Earth's Ecosystems

*Science*, Volume 277, Number 5325, July 25, 1997 (p. 498)

**Vizinczey, Stephen** 1933–

Hungarian author

Is it possible that I am not alone in believing that in the dispute between Galileo and the Church, the Church was right and the centre of man's universe is the earth?

*Truth and Lies in Literature: Essays and Reviews*

Rules of the Game (p. 269)

Atlantic Monthly Press. Boston, Massachusetts, USA. 1986

**Voltaire (François-Marie Arouet)** 1694–1778

French writer

“But then to what end?” asked Candide, “was the world formed?”

“To make us mad,” said Martin.

*The Best Known Works of Voltaire*

Candide

Chapter XXI (p. 57)

Blue Ribbon Books. New York, New York, USA. 1940

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Our earth... is a spinning globe. Vast though it seems to us, it is a mere speck of matter in the greater vastness of space.

*The Outline of History* (Volume 1)

Book I, Chapter I, Section 2 (p. 13)

Garden City Books. Garden City, New York, USA. 1961

**Whipple, Fred L.** 1906–2004

Pioneer in comet research

Our Earth seems so large, so substantial, and so much with us that we tend to forget the minor position it occupies in the solar family of planets. Only by a small margin is it the largest of the other terrestrial planets. True, it does possess a moderately thick atmosphere that overlies a thin patchy layer of water and it does have a noble satellite, about 1/4 its diameter. These qualifications of the Earth, however, are hardly sufficient to bolster our cosmic egotism. But, small as is the Earth astronomically, it is our best-known planet and therefore deserves and has received careful study.

*Earth, Moon and Planets*

The Earth (p. 60)

Grosset & Dunlap, Publishers. New York, New York, USA. 1958

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

The earth never tires;

The earth is rude, silent, incomprehensible at first —

Nature is rude and incomprehensible at first —

Be not discouraged — keep on — there are divine things well envelop'd;

I swear to you there are divine things more beautiful than words can tell.

*Complete Poetry and Collected Prose*

Song of the Open Road

The Library of America. New York, New York, USA. 1982

In this broad earth of ours,

Amid the measureless grossness and the slag,

Enclosed and safe within its central heart

Nestles the seed perfection.

*Complete Poetry and Collected Prose*

Song of the Universal

The Library of America. New York, New York, USA. 1982

**Winchell, Alexander** 1824–91

American geologist

The stability of the solid earth is instability itself.

*Walks and Talks in the Geological Field*

Part I, Chapter XVIII (p. 102)

Chautauqua Press. New York, New York, USA. 1890

**Young, Louise B.**

Science writer

Time flows on... the planet continues to spin on its path through the unknown reaches of space. We cannot guess its destination or its destiny. The beautiful blue bubble of

matter holds many wonders still unrealized and a mysterious future waiting to unfold.

*The Blue Planet*

Chapter 14 (p. 266)

Little, Brown & Company, Boston, Massachusetts, USA. 1983

## PLANET: JUPITER

**Ackerman, Diane** 1948–  
American writer

Vibrant as an African trade-bead with bonechips in orbit round it, Jupiter floods the night's black scullery, all those whirlpools and burbling aerosols little changed since the solar-system began.

*The Planets: A Cosmic Pastoral*

Jupiter (p. 81)

William Morrow & Company, Inc. New York, New York, USA. 1976

**Sizzi, Francisco**  
Astronomer

The satellites [Jupiter's moons] are invisible to the naked eye and therefore can have no influence on the earth, and therefore would be useless, and therefore do not exist.

In Oliver Lodge

*Pioneers of Science and the Development of Their Scientific Theories*  
(p. 106)

Dover Publications, Inc. New York, New York, USA. 1926

## PLANET: MARS

**Barnard, Edward Emerson** 1857–1923  
American astronomer

To save my soul I can't believe in the canals as Schiaparelli draws them.... I verily believe...that the canals as depicted by Schiaparelli are a fallacy and that they will be so proved before many oppositions are past.

*NASA Serial Publication*

Letter to Simon Newcomb, September 11, 1894 (p. 6)

Scientific and Information Technical Office, NASA, Washington, D.C. 1962

**Boynton, William**  
No biographical data available

The signal we have been getting loud and clear is there is a lot of ice on Mars.

Evidence of Plentiful Water on Mars

*The Associated Press*, 2 March 2002

**Bradbury, Ray** 1920–  
American writer

We are all...children of this universe. Not just Earth, or Mars, or this System, but the whole grand fireworks. And if we are interested in Mars at all, it is only because we wonder over our past and worry terribly about our possible future.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan and Walter Sullivan

*Mars and the Mind of Man*

Forward (p. x)

Harper & Row, Publishers. New York, New York, USA. 1973

**Cosmo Kramer**  
Fictional character

I've never been to Mars but I imagine it's quite lovely.

*Seinfeld*

TV series

The pilot (1) 1993

**de Fontenelle, Bernard le Bovier** 1657–1757  
French author

Mars, who affords nothing curious that I know of; his day is rather more than half an hour longer than ours, but his year is twice as long, wanting about a month and near a half. He is about four times less than the earth, and the sun seems not altogether so large and so bright to him, as it appears to us. But let us leave Mars, he is not worthy our stay...

*Conversations on the Plurality of Worlds*

The Fourth Evening (pp. 118–119)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

I dare not affirm that I am able to observe the phases of Mars; nonetheless, if I am not mistaken, I believe I have seen that it is not perfectly round.

Letter to Benedetto Castelli, December 30, 1610

Source undetermined

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

I am apt to believe that the Land in Mars is of a blacker Colour than that of Jupiter or the Moon, which is the reason of his appearing of a Copper Colour, and his reflecting a weaker Light than is proportionable to his distance from the Sun.... His Light and Heat is twice, and sometimes three times less than ours, to which I suppose the Constitution of his Inhabitants is answerable.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Section 11, Book 2 (p. 111)

Printed for T. Childe. London, England. 1698

**Kepler, Johannes** 1571–1630  
German astronomer

...[the] motions [of Mars] provide the only possible access to the hidden secrets of astronomy, without which we would remain forever ignorant of those secrets.

*New Astronomy*

Part II, 7 (p. 185)

At The University Press. Cambridge, England. 1992

**Kuiper, Gerard P.** 1905–73

Dutch-born American astronomer

The hypothesis of plant life... appears still the most satisfactory explanation of the various kinds of dark markings and their complex seasonal and secular changes.

In Steven J. Dick

*Life on Other Worlds: The 20<sup>th</sup> Century Extraterrestrial Life Debate*

Chapter 2 (p. 25)

Cambridge University Press. Cambridge, England. 1998

**Leovy, Conway B.**

No biographical data available

Unlike the moon, whose story appears essentially to have ended one or two billion years ago, Mars is still evolving and changing. On Mars, as on the earth, the most pervasive agent of change is the planet's atmosphere, itself the product of the sorting of the planet's initial constituents that began soon after it condensed from the primordial cloud of dust and gas that gave rise to the solar system 4.6 billion years ago.

The Atmosphere of Mars

*Scientific American*, Volume 237, Number 1, July 1977 (p. 34)**Longfellow, Henry Wadsworth** 1807–82

American poet

There is no light in earth or heaven  
But the cold light of stars;  
And the first watch of night is given  
To the red planet Mars.

*The Poetical Works of Henry Wadsworth Longfellow*

The Light of Stars, Stanza 2

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Lowell, Percival** 1855–1916

American astronomer

To account for these phenomena, the explanation that at once suggests itself is, that a direct transference of water takes place over the face of the planet, and that the canals are so many waterways.

*Mars*

Canals (p. 164)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

There are celestial sights more dazzling, spectacles that inspire more awe, but to the thoughtful observer who is privileged to see them well, there is nothing in the sky so profoundly impressive as the canals of Mars.

*Mars as the Abode of Life*

Part II, Notes (p. 228)

The Macmillan Company. New York, New York, USA. 1908

Thus, not only do the observations we have scanned lead to the conclusion that Mars at this moment is inhabited, but they land us at the further one that these denizens are of an order whose acquaintance was worth the making. Whether we ever shall come to converse with them in any more instant way is a question upon which science

at present has no data to provide. More important to us is the fact that they exist, made all the more interesting by their precedence of us in the path of evolution.

*Mars as the Abode of Life*

Part I, Chapter VI (p. 215)

The Macmillan Company. New York, New York, USA. 1908

The struggle for existence in their planet's decrepitude and decay would tend to evolve intelligence to cope with circumstances growing momentarily more and more adverse. But, furthermore, the solidarity that the conditions prescribe would conduce to a breadth of understanding sufficient to utilize it. Intercommunication over the whole globe is made not only possible, but obligatory. This would lead to the easier spreading over it of some dominant creature, — especially were this being of an advanced order of intellect, — able to rise above its bodily limitations to amelioration of the conditions through the exercise of the mind.

*Mars as the Abode of Life*

Part I, Chapter IV (p. 143)

The Macmillan Company. New York, New York, USA. 1908

**Malin, Michael**

Science and technology editor

The Mars we are trying to explore does not exist

In William Sheehan and Stephen James O'Meara

*Mars: The Lure of the Red Planet*

Prometheus Books. Buffalo, New York, USA. 2001

**Morton, Oliver**

Science and technology editor

Yet if the Earth is a single isolated planet, the human world is less constrained. The breakdown of the equation between planets and worlds works both ways. If there can now be planets that are not worlds, then there can be worlds that spread beyond planets — and ours is doing so. Our spacecraft and our imaginations are expanding our world. This projection of our world beyond the Earth is for the most part a very tenuous sort of affair. It is mostly a matter of imagery and fantasy. Mars, though, might make it real — which is why Mars matters.

*Mapping Mars: Science, Imagination and the Birth of a World*

A Point of Warlike Light (p. 14)

Fourth Estate. London, England. 2002

Mars is not an independent world, held together by the memories and meanings of its own inhabitants. But nor is it no world at all. More than any other planet we have seen, Mars is like the Earth. It is not very like the Earth. Its gravity is weak, its atmosphere thin, its surface sealess, its soil poisonous, its sunlight deadly in its levels of ultraviolet, its climate beyond frigid. It would kill you in an instant. But it is earthlike enough that it is possible to imagine some of us going there and experiencing this new part of our human world in the way we've always experienced the old part-from the inside. The fact that



humans could feasibly become Martians is the strongest of the links between Mars and Earth.

*Mapping Mars: Science, Imagination and the Birth of a World*  
A Point of Warlike Light (p. 14)  
Fourth Estate. London, England. 2002

**Murray, Bruce** 1932–  
American planetologist

The Mars we had found was just a big moon with a thin atmosphere and no life. There were no Martians, no canals, no water, no plants, no surface characteristics that even faintly resembled Earth's.

*Journey into Space: The First Three Decades of Space Exploration*  
Chapter 1 (p. 43)  
W.W. Norton & Company, Inc. New York, New York, USA. 1989

Extending out from the chaotic terrain...are some extraordinary channels, which are also found in a number of other localities on the planet. It is hard to look at these channels without considering the possibility that they were cut by flowing water.

Mars from Mariner 9  
*Scientific American*, Volume 228, Number 1, January 1973 (p. 58)

**Schiaparelli, G. V.** 1835–1910  
Italian astronomer

What strange confusion! What can all this mean? Evidently the planet has some fixed geographical details, similar to those of the Earth... Comes a certain moment, all this disappears to be replaced by grotesque polygonations and germinations which, evidently, attach themselves to represent apparently the previous state, but it is a gross mask, and I say almost ridiculous.

*Corrispondenza su Marte* (Volume 2)  
Schiaparelli to Terby, June 8, 1888  
Letter to François Terby, June 8, 1888  
No. 1, 1894  
Domus Galilaiana. Pisa, Italy. 1965

**Sheeham, William**  
No biographical data available

**O'Meara, Stephen James**  
No biographical data available

Who is to say that [Mars] will not — like a hardy seed lying dormant beneath the snow of a long winter — come once more to life, and in so doing once more quicken our fondest hopes of life beyond Earth?

*Mars: The Lure of the Red Planet*  
Epilogue (p. 323)  
Prometheus Books. Amherst, New York, USA. 2001

Mars is but a tiny pinprick in the vast fabric of space-time, a mere mote in the solar beam.

*Mars: The Lure of the Red Planet*  
Chapter 2 (p. 27)  
Prometheus Books. Amherst, New York, USA. 2001

**Swift, Jonathan** 1667–1745  
Irish-born English writer

They have likewise discovered two lesser stars, or satellites, which revolve around Mars, whereof the innermost is distant from the centre of the primary planet exactly three of his diameters, and the outermost five; the former revolves in the space of ten hours, and the latter in twenty-one and a half; so that the squares of their periodical times are very near in the same proportion with the cubes of their distances from the centre of Mars, which evidently shows them to be governed by the same law of gravitation that influences the other heavenly bodies.

In *Great Books of the Western World* (Volume 36)  
*Gulliver's Travels*  
Part III, Chapter III (p. 102)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

The conclusion...is therefore irresistible — that animal life, especially in its higher forms, cannot exist on the planet. Mars, therefore, is not only uninhabited by intelligent beings such as Mr. Lowell postulates, but is absolutely UNINHABITABLE.

*Is Mars Habitable?*  
Chapter VIII (p. 110)  
Macmillan & Company Ltd. London, England. 1907

**Washburn, Mark**  
No biographical data available

The red fire of Mars burns as bright as ever in the night sky and in the hearts of men. Mars has always been much more than just the next planet out from the sun. Mars is the place where dreams and reality meet — and form new dreams for the curious and questing people of the earth to follow.

*Mars At Last!*  
Chapter 14 (p. 277)  
G.P. Putnam's Sons. New York, New York, USA. 1977

## PLANET: MERCURY

**Ackerman, Diane** 1948–  
American writer

A prowling holocaust keeling low in the sky heads westward for another milk run. The Sun never sets on the Mercurian empire: it only idles on each horizon and lurches back, broiling the same arc across the sky.

*The Planets: A Cosmic Pastoral*  
Mercury (p. 15)  
William Morrow & Company, Inc. New York, New York, USA. 1976

**Blackmore, Sir Richard** 1650–1729  
English physician and writer

Mercurius nearest to the Central Sun,

Does in an Oval Orbit circling run:  
But rarely is the Object of our Sight,  
In Solar Glory sunk and more prevailing Light.

*The Poetical Works of Sir R. Blackmore: Containing Creation: A Philosophical Poem, in Seven Books*

Book II, l. 511–514

Printed for C. Cooke. London, England. 1797

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

...Mercury is the bedlam of the universe...

*Conversations on the Plurality of Worlds*

The Fourth Evening (p. 105)

Printed for Peter Wilson. Dublin, Ireland. 1761

## PLANET: NEPTUNE

**Clerke, Agnes Mary** 1842–1907

Irish astronomer

Forever invisible to the unaided eye of man, a sister-globe to our earth was shown to circulate, in frozen exile, at 30 times its distance from the sun. Nay, the possibility was made apparent that the limits of our system were not even thus reached, but that yet profounder abysses of space might shelter obedient, though little favoured members of the solar family, by future astronomers to be recognized through the sympathetic thrillings of Neptune, even as Neptune himself was recognized through the tell-tale deviations of Uranus.

*A Popular History of Astronomy During the Nineteenth Century*

Part I, Chapter IV (p. 82)

A. & C. Black. London, England. 1908

## PLANET: SATURN

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

*Annulo cingitur, tenui, plano, nusquam cohaerente, ad eclipticam inclinato*

[It is surrounded by a thin flat ring, inclined to the ecliptic, and nowhere touches the body of the planet]

*De Saturni luna observatio nova*

The Hague, Netherlands. 1656

**Keill, John** 1671–1721

Scottish mathematician and natural philosopher

...Saturn has an Ornament peculiar to himself, for he is dignified with a Ring which surrounds his middle, and does no where touch his Body; but by an exact Libration and Equiponderancy of all its Parts, sustains it self like an Arch, and being thus suspended by Geometry, it is kept from falling upon his Body.

*An Introduction to the True Astronomy*

Lecture III (p. 25)

Printed for Bernard Lintot. London, England. 1721

**Melville, Herman** 1819–91

American novelist

Seat thyself sultanically among the moons of Saturn.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 107 (p. 343)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pallister, William Hales** 1877–1946

Canadian physician

The planet Saturn, to the naked eye

Appears an oval star; in seeking why

The telescope shows us a startling sight

Which seems some lovely vision on a night

Of dreams. A giant, wide, sunlit, tilted ring,

More strange than any other heavenly thing.

*Poems of Science*

Other Worlds and Ours, Saturn (p. 205)

Playford Press. New York, New York, USA. 1931

**Thayer, John H.**

If you want to see a picture painted as only the hand of God can paint it, go with me to Saturn...

Saturn. *The Wonder of the Worlds*

*Popular Astronomy*, Volume 37, Number 263, March 1919 (p. 175)

## PLANET: URANUS

**Herschel, Friedrich Wilhelm** 1738–1822

English astronomer

In the fabulous ages of ancient times the appellations of Mercury, Venus, Mars, Jupiter, and Saturn were given to the planets as being the names of their principal heroes and divinities. In the present more philosophical era, it would hardly be allowable to have recourse to the same method, and call on Juno, Pallas, Apollo, or Minerva for a name to our new heavenly body... I cannot but wish to take this opportunity of expressing my sense of gratitude, by giving the name Georgium Sidus, to a star [Uranus], which (with respect to us) first began to shine under His auspicious reign.

In James Sime

*William Herschel and His Work*

Chapter V, Letter to Sir Joseph Banks (p. 74)

Charles Scribner's Sons. New York, New York, USA. 1900

## PLANET: VENUS

**Ball, Sir Robert S.** 1840–1913

Astronomer

The lover of nature turns to admire the sunset, as every lover of nature will. In the golden glory of the west a beauteous gem is seen to glitter; it is the evening star — the planet Venus... All the heavenly host — even

Sirius and Jupiter — must pale before the splendid lustre of Venus, the unrivalled queen of the firmament.

*The Story of the Heavens*

Venus (p. 140)

Cassell & Company Ltd. London, England. 1885

**Blackmore, Sir Richard** 1650–1729

English physician and writer

Venus the next, whose lovely Beams adorn  
As well the Dewy Eve, as opening Morn,  
Does her fair Orb in beauteous Order turn.

*The Poetical Works of Sir R. Blackmore: Containing Creation: A Philosophical Poem, in Seven Books*

Book II, l. 515–517

Printed for C. Cooke. London, England. 1797

**Hunter, Robert** 1941–

American lyricist and poet

Counting stars by candlelight, all are dim but one is bright;  
The spiral light of Venus, rising first and shining best,  
Oh, from the northwest corner, of a brand new crescent moon,

crickets and cicadas sing, a rare and different tune...

*Terrapin Station*

Terrapin Station

Arista Records. 1977

**Tennyson, Alfred (Lord)** 1809–92

English poet

For a breeze of morning moves,  
And the planet of love is on high,  
Beginning to faint in the light that she loves  
On a bed of daffodil sky,  
To faint in the light of the sun she loves,  
To faint in his light, and to die.

*Alfred Tennyson's Poetical Works*

Maude, Part I, Section XXII, Stanza II

Oxford University Press, Inc. London, England. 1953

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

An occultation of Venus is not half so difficult as an eclipse of the Sun, but because it comes seldom the world thinks it's a grand thing.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

More Maxims of Mark (p. 945)

The Library of America. New York, New York, USA. 1992

## PLANKTON

**Hyerdahl, Thor** 1914–2002

Norwegian ethnographer and adventurer

Some looked like fringed, fluttering spooks cut out of celophane paper, while others resembled red-beaked birds

with hard shells instead of feathers. There was no end to Nature's extravagant inventions in the plankton world.

Translated by F.H. Lyon

*Kon-Tiki*

Chapter 5 (p. 139)

Rand McNally & Company. Chicago, Illinois, USA. 1950

## PLANT

**Bailey, William Whitman** 1843–1914

American botanist

Beginners almost always collect their plants too young; they have a nervous fear that they will not last.

*The Botanical Collector's Handbook*

Naturalists' Handy Series, Number 3 (p. 29)

Publisher undetermined. Salem, Massachusetts, USA. 1881

No division of the vegetable kingdom has attracted more deserved attention than that of the sea-weeds or sea-mosses. Throughout the world they have found their earnest students and devoted admirers. It is not alone for their intrinsic beauty that they are loved. Their collection involves the visiting of romantic cliffs — of shores strewn with the ocean's debris, of caves, and hollows, and even of the deep sea itself. The pursuit is always fascinating, and sometimes even perilous. A spice of danger does not deter the heroic algologist. Like "one who gathers sapphire, fearful trade!" he hangs suspended from crags, or ventures at low tide upon the slippery rocks over which the spray is dashing. There need not, however, be danger in the study. Many ladies have been successful gatherers of sea-weeds, and in the albums of many a watering-place belle may be seen choice specimens, self-collected. The plants need not be studied at all, if one prefers the simple collection and preservation, but it is always pleasanter to know something of the habits, uses, and even names of the objects which one treasures.

*The Botanical Collector's Handbook*

Naturalists' Handy Series, Number 3 (pp. 46–47)

Publisher undetermined. Salem, Massachusetts, USA. 1881

**Borland, Hal** 1900–78

American writer

There are no idealists in the plant world and no compassion. The rose and the morning glory know mercy. Bindweed, the morning glory, will quickly choke its competitors to death, and the fencerow rose will just as quietly crowd out any other plant that tried to share its roothold. Idealism and mercy are human terms and human concepts.

*Book of Days*

22 July 1976 (pp. 188–189)

Alfred A. Knopf. New York, New York, USA. 1976

**Burroughs, John** 1837–1921

American naturalist and writer

I know of nothing in vegetable nature that seems so really to be born as the ferns. They emerge from the ground rolled up, with a rudimentary and “touch-me-not” look, and appear to need a maternal tongue to lick them into shape. The sun plays the wet-nurse to them, and very soon they are out of that uncanny covering in which they come swathed and take their places with other green things.

*Signs and Seasons*

A Spring Relish (p. 193)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1886

### Clute, Willard N.

American botanist

One of the redeeming features of rubbish heaps, ballast grounds and waste lands is that they furnish a lurking place for numerous wanderers and outcasts of the vegetable kingdom.

A Plant Immigrant

*The American Botanist*, Volume 1, Number 2, August 1901 (p. 18)

### Emerson, Ralph Waldo 1803–82

American lecturer, poet, and essayist

To every plant there are two powers; one shoots down as rootlet, and one upward as tree.

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Chapter I (p. 71)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The root of the plant is not unsightly to science...

*The Complete Works of Ralph Waldo Emerson* (Volume 2)

Essays: First Series

Chapter VI (p. 196)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Plants are the young of the world, vessels of health and vigor; but they grope ever upwards towards consciousness; the trees are imperfect men, and seem to bemoan their imprisonment, rooted in the ground.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

Nature (p. 547)

The Library of America. New York, New York, USA. 1983

### Gatty, M. S. 1809–73

English writer

It was once prettily said by a lady who cultivated flowers, that she had “buried many a care in her garden”; and the sea-weed collector can often say the same of his garden — at the shore; as many a loving disciple could testify, who, having taken up the pursuit originally as a resource against weariness, or a light possible occupation during hours of sickness, has ended by an enthusiastic love, which throws a charm over every sea-place on the coast, however dull and ugly to the world in general; makes every day spent there too short, and every visit

too quickly ended. Only let there be sea, and plenty of low, dark rocks stretching out, peninsular-like, into it; and only let the dinner-hour be fixed for high-water time, — and the loving disciple asks no more of fate.

*British Sea-Weeds: Drawn from Professor Harvey's Phycologia Britannica* (Volume 1)

Introduction (p. vii)

Bell & Daldy. London, England. 1872

### Gerard, John 1545–1612

English botanist

Among the manifold creatures of God (right Honorable, and my singular good Lord) that have all in all ages diversely entertained many excellent wits, and drawne them to the contemplation of the divine wisdom, none have provoked mens' studies more, or satisfied their desires so much as Plants have done, and that upon Just and worthy causes: For if delight may provoke mens' labor, what greater delight is there than to behold the earth appareled with plants, as with a robe of embroidered worke, set with Orient pearles, and garnished with great diversitie of rare and costly jewels?

*The Herball or Generall Historie of Plantes*

The Epistle Dedicatorie

Bonham and I. Norton. London, England. 1597

Although my paines have not been spent (Courteous Reader) in the gracious discoverie of golden mines, nor in the tracing after silver veines, whereby my native country might be enriched with such merchandise as it hath most in request and admiration; yet hath my labour (I trust) been otherwise profitably employed, in descrying of such a harmlesse treasure of herbes, trees, and plants, as the earth frankly without violence offereth unto our most necessarie uses.

*The Herball or Generall Historie of Plantes*

To the Courteous and Well-Willing Reader

Bonham and I. Norton. London, England. 1597

### Gleason, Henry Allan 1882–1975

American botanist

Every species of plant is a law unto itself.

The Individualistic Concepts of the Plant Association

*Bulletin of the Torrey Botanical Club*, Volume 53, 1926 (p. 26)

### Haldane, John Burdon Sanderson 1892–1964

English biologist

The simplest plants, such as the green algae growing in stagnant water or on the bark of trees, are mere round cells. The higher plants increase their surface by putting out leaves and roots. Comparative anatomy is largely the story of the struggle to increase surface in proportion to volume.

In James R. Newman (ed.)

*The World of Mathematics* (Volume 2)

On Being the Right Size (p. 954)

Simon & Schuster. New York, New York, USA. 1956

**Hemans, Felicia D.** 1793–1835

English poet

Oh! Call us not *weeds*, but flowers of the sea,  
 For lovely, and gay, and bright-tinted are we!  
 Our Blush is as deep as the rose of thy bowers,  
 Then call us not *weeds*, we are Ocean's gay flowers.  
 Not nursed like the plants of the summer parterre  
 Whose gales are but sights of an evening air  
 Our exquisite, fragile and delicate forms,  
 Are the prey of the Ocean, when vexed with his storms.

*The Poetical Works of Mrs. Felicia Hemans*  
 Ocean Flowers and Their teachings  
 Crosby, Nichols, Lee & Company. Boston, Massachusetts, USA. 1860

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

For wealth disappears, the most magnificent houses  
 fall into decay, the most numerous family at some time  
 or another comes to an end: the greatest and the most  
 prosperous kingdoms can be overthrown: but the whole  
 of Nature must be blotted out before the race of plants  
 passes away, and he is forgotten who in Botany held up  
 the torch.

*Critica Botanica*

Generic Names (p. 68)

The Ray Society. London, England. 1938

**Muir, John** 1838–1914

American naturalist

Found a lovely lily (*Calochortus albus*) in a shady  
 adenostoma thicket near Coulterville, in company  
 with *Adiantum chilense*. It is white with a faint  
 purplish tinge inside at the base of the petals, a most  
 impressive plant, pure as snow crystal, one of the plant  
 saints...must love and be made so much the purer by  
 every time it is seen. It puts the roughest mountaineer  
 on his good behavior.

*My First Summer in the Sierra*

June 6 (p. 22)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

Well, perhaps I may yet become a proper cultivated plant,  
 cease my wanderings and for it a so called pillar or some-  
 thing in society, but if so, I must, like a revived Meth-  
 odist, care to love what I hate and to hate what I most  
 intensely and devoutly love.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter II, Section 5. Plants and Humans (p. 90)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

The plants are as busy as the animals, every cell in a swirl  
 of enjoyment, humming like a hive, singing the old new  
 song of creation.

*Our National Parks*

Chapter II (p. 70)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

It drapes all the branches from top to bottom, hanging  
 in long silver-gray skeins, reaching a length of not less  
 than eight or ten feet, and when slowly waving in the  
 wind they produce a solemn funereal effect singularly  
 impressive.

*A Thousand Mile Walk to the Gulf*

Chapter IV (p. 68)

Houghton Mifflin Company, Boston Massachusetts, USA. 1916

**Nuttall, Thomas** 1786–1859

English botanist

To acquire a knowledge of the vegetable world, so pleas-  
 ing to all observers, it may not perhaps be amiss to antici-  
 pate the dry detail of technical phrases, which has but too  
 often deterred, at the very portal of Flora's temple, the  
 enquirer into the nature and character of this beautiful  
 and useful tribe of beings, and begin, at once, by exam-  
 ining plants as we naturally find them, in the manner  
 our predecessors must have done, from whom we have  
 received their history.

*An Introduction to Systematic and Physiological Botany*

Part I, Chapter I (p. 1)

Hillard &amp; Brown. Cambridge, England. 1830

**Shelley, Percy Bysshe** 1792–1822

English poet

A Sensitive Plant in a garden grew,  
 And the young winds fed it with silver dew,  
 And it opened its fan-like leaves to the light,  
 And clothed them beneath the kisses of night.

*The Complete Poetical Works of Percy Bysshe Shelley*

The Sensitive Plant, Part I, Stanza 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Turner, William**

No biographical data available

Although (most mighty and Christian Prince) there be  
 many noble and excellent arts and sciences, which no  
 man doubteth, but that almighty God the author of all  
 goodness hath given unto us by the hands of the heathen,  
 as necessary unto the use of mankind, yet is there none  
 among them all which is so openly commended by the  
 verdict of any holy writer in the Bible, as is the knowl-  
 edge of plants, herbs and trees...

In George T.L. Chapman and Marilyn N. Tweddle (eds.)

*A New Herball*

Part I (p. 213)

Cambridge University Press. Cambridge, England. 1995

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American author and humorist

Sage-brush is a very fair fuel, but as a vegetable it is a  
 distinguished failure. Nothing can abide the taste of it but  
 the jackass and his illegitimate child the mule.

*Roughing It* (Volume 1)

Chapter III (p. 32)  
Harper & Brothers Publishers. New York, New York, USA. 1899

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

We will see the entire plant world, for example, as a vast sea which is as necessary to the existence of individual insects as the oceans and rivers are to the existence of individual fish, and we will observe that an enormous number of living creatures are born and nourished in this ocean of plants. Ultimately we will see the whole world of animals as a great element in which one species is created, or at least sustained, by and through another. We will no longer think of connections and relationships in terms of purpose or intention. This is the only road to progress in understanding how nature expresses itself from all quarters and in all directions as it goes about its work of creation.

In D. Miller (ed.)

*Scientific Studies* (Volume 12)

Chapter II (p. 55)

Suhrkamp. New York, New York, USA. 1988

The Primal Plant is going to be the strangest creature in the world, which Nature herself must envy me. With this model and the key to it, it will be possible to go on for ever inventing plants and know that their existence is logical; that is to say, if they do not actually exist, they could, for they are not the shadowy phantoms of a vain imagination, but possess an inner necessity and truth. The same law will be applicable to all other living organisms.

Translated by W.H. Auden and Elizabeth Mayer

*Italian Journey*

Letter to Herder

May 17, 1787 (p. 305)

Pantheon Books. New York, New York, USA. 1962

Anyone who pays a little attention to the growth of plants will readily observe that certain of their external members are sometimes transformed so that they assume — either wholly or in some lesser degree — the form of the members nearest in the series.

Thus, for example, the usual process by which a single flower becomes double, is that, instead of filaments and anthers, petals are developed; these either show a complete resemblance in form and color to the other leaves of the corolla, or they still carry some visible traces of the origin.

If we note that it is in this way possible for the plant to take a step backwards and thus to reverse the order of growth, we shall obtain so much the more insight into Nature's regular procedure; and we shall make the acquaintance of the laws of transmutation, according to which she produces one part from another, and sets before us the most varied forms through modification of a single organ.

An Attempt to Interpret the Metamorphosis of Plants, Introduction Section 1 and Section 3

*Chronica Botanica*, Volume 10, Number 2, Summer 1946 (p. 91)

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

Even the child longs to pass the hills or the seas which enclose his narrow home; yet, when his eager steps have borne him beyond those limits, he pines, like the plant, for his native soil; and it is by this touching and beautiful attribute of man — this longing for that which is unknown, and this fond remembrance of that which is lost — that he is spared from an exclusive attachment to the present.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Conclusion of the Subject (p. 358)

Harper & Brothers. New York, New York, USA. 1869

## PLATE TECTONICS

**Bailey, Edward Battersby** 1881–1965  
English geologist

Even those who have more sympathy with man's endeavor than with the affairs of Nature may take an interest in the Science of Tectonics. Knowledge, after all, is of human creation; and, as a rule, the knowledge of the structure of a mountain chain comes as the reward of glorious struggle, both physical and mental.

*Tectonic Essays*

Introduction (p. 1)

At The Clarendon Press. Oxford, England. 1935

**King, B. C.**

No biographical data available

**King, G. C. P.**

No biographical data available

They [plates] can't curl down; they must curl up

To form a kind of dish

To stop the oceans spilling out

And losing all the fish.

Letters to Nature

*Nature*, Volume 232, Number 5305, July 2, 1971 (p. 37)

**Ovid** 43 BCE–17 AD

Roman poet

I have myself seen what once was solid land changed into sea; and again I have seen land made from the sea.

Translated by Frank Justus Miller

*Metamorphoses* (Volume 2)

Book XV, l. 263 (p. 383)

William Heinemann. London, England. 1916

**Ward, Peter D.**

American paleontologist

**Brownlee, Donald**

American astronomer

Plate tectonics plays at least three crucial roles in maintaining animal life: It promotes biological productivity; it

promotes diversity (the hedge against mass extinction); and it helps maintain equable temperatures, a necessary requirement for animal life. It may be that plate tectonics is the central requirement for life on a planet and that it is necessary for keeping a world supplied with water.

*Rare Earth: Why Complex Life Is Uncommon in the Universe*  
Most Crucial Element of the Rare Earth Hypothesis? (p. 220)  
Springer-Verlag. New York, New York, USA. 2000

**Wilson, John Tuzo** 1908–93

Canadian geologist and geophysicist

Formerly, most scientists of the earth thought of as one rigid body with fixed continents and permanent ocean basins, rather scientists now consider the earth to be broken into six large plates and several smaller ones, which very slowly move and jostle one another like blocks of ice on a river that is breaking up in the spring thaw.... Each continent does not constitute one plate, but rather each is incorporated with the surrounding ocean floor into a plate that is larger than the continent, just as a raft of logs may be frozen into a sheet of ice.

In *Scientific American*

*Readings from Scientific American*

Continents Adrift and Continents Aground

Preface (p. v)

W.H. Freeman & Company. San Francisco, California, USA. 1976

## PMS

**Bates, Rhonda**

No biographical data available

My doctor said “I’ve got good news and I got bad news. The good news is you don’t have Premenstrual Syndrome. The bad news is — you’re a bitch!”

In Roz Warren

*Glibquips* (p. 122)

Crossing Press, Freedom, California. USA. 1994

**Hankla, Susan**

Professional writer

God grant me the serenity to change the things about me and others I cannot stand

And to stand the things about me and others I cannot change

And the insight to know the difference  
Between a PMS day and a normal day

So no one gets hurt.

In Roz Warren

*Glibquips* (p. 122)

Crossing Press, Freedom, California. USA. 1994

## POINT

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

He took out his pocket knife and whittled the end of the stick. Then he tried again.

“What is this?”

“A smaller hole.”

“Point,” said Mr. Fortune suggestively.

“Yes, I mean a smaller point.”

“No, not quite. It is a point. but it is not smaller. Holes may be of different sizes, but no point is larger or smaller than another point.”

*Mr. Fortune’s Maggot*

Mr. Fortune’s Maggot (p. 108)

New York Review of Books. New York, New York, USA. 1927

...if a given point were not in a given place it would not be there at all.

*Mr. Fortune’s Maggot*

Mr. Fortune’s Maggot (p. 110)

New York Review of Books. New York, New York, USA. 1927

## POINT OF VIEW

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

No point of view has absolute, permanent validity. Each has importance only for some given end.

*The Analysis of Sensations and the Relation of the Physical to the Psychological*

Chapter I (p. 37)

The Open Court Publishing Company. Chicago, Illinois, USA. 1914

He who knows only one view or one form of a view does not believe that another has ever stood in its place, or that another will ever succeed; he neither doubts nor tests.

*History and Root of the Principle of the Conservation of Energy*

Chapter I (p. 17)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

## POLLUTION

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Our world is so full of beautiful things: fruit and ideas and women and good men and banjo music and onions with purple skins. A virtual Paradise. But even Paradise can be damned, flooded, overrun, generally mucked up by fools in pursuit of paper profits and plastic happiness.

*Down the River*

Part II, Chapter 8 (p. 233)

E.P. Dutton. New York, New York, USA. 1982

**Ames, Bruce** 1928–

American biochemist

We are living in a sea of chemicals that have not been tested for mutagenicity or carcinogenicity.

In Roger Lewin

Cancer Hazards in the Environment

*New Scientist*, Volume 69, Number 984, January 22, 1976 (p. 168)

**Carson, Rachel** 1907–64

American marine biologist and author

These sprays, dusts, and aerosols are now applied almost universally to farms, gardens, forests, and homes — non-selective chemicals that have the power to kill every insect, the “good” and the “bad,” to still the song of birds and the leaping of fish in the streams, to coat the leaves with a deadly film, and to linger on in soil — all this though the intended target may be only a few weeds or insects. Can anyone believe it is possible to lay down such a barrage of poisons on the surface of the earth without making it unfit for all life? They should not be called “insecticides,” but “biocides.”

*Silent Spring*

Chapter 2 (pp. 7–8)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

For the first time in the history of the world, every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death.

*Silent Spring*

Chapter 3 (p. 15)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

As crude a weapon as a cave man’s club, the chemical barrage has been hurled against the fabric of time.

*Silent Spring*

Chapter 17 (p. 297)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

There are flood and drouth  
Over the eyes and in the mouth,  
Dead water and dead sand  
Contending for the upper hand.  
The parched eviscerate soil  
Gapes at the vanity of toil,  
Laughs without mirth.  
This is the death of earth.

*The Collected Poems and Plays 1909–1950*

Little Gidding, Part II, stanza 2 (p. 140)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Lovelock, James Ephraim** 1919–

English scientist

There is only one pollution...people.

*Gaia: A New Look at Life on Earth*

Chapter 7 (p. 114)

Oxford University Press, Inc. Oxford, England. 2000

**Peacock, Thomas Love** 1785–1866

English writer

They have poisoned the Thames and killed the fish in the river. A little further development of the same wisdom and science will complete the poisoning of the air, and

kill the dwellers on the banks...I almost think it is the destiny of science to exterminate the human race.

*Gryll Grange*

Chapter 1 (p. 11)

Penguin Books. Harmondsworth, England. 1949

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

...this most excellent canopy, the air, look you, this brave o’erhanging firmament, this majestic roof fretted with golden fire, why, it appears no other thing to me than a foul and pestilent congregation of vapours.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Hamlet, Prince of Denmark

Act II, Scene ii, l. 311–315

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Taylor, John**

No biographical data available

Then by the Lords Commissioners, and also  
By my good King (whom all true subjects call so),  
I was commanded with the Water Baylie,  
To see the rivers cleaned, both night and dayly.

Dead Hogges, Dogges, Cates and well flayed Carryon  
Horses,

Their Noysom Corpses soyled the Water Courses;

Both Swines’ and Stable dynges, beasts’ guts and garbage,

Street dirt, with Gardners’ Weeds and Rotten Herbage.

And from those Waters’ filthy putrifaction

Our Meat and Drinke were made, which bred Infection.

Myself and partner, with cost paines and Travell,

Saw all made clean, from Carryon, Mud and Gravell,

And now and then was punisht a Delinquent,

By which good meanes away the filth and stink went.

Unknown, An Echo from the Past

*The American Biology Teacher*, Volume 35, Number 4, April 1973

(p. 208)

**Toffler, Alvin** 1928–

American writer and futurist

...industrial vomit...fills our skies and seas. Pesticides and herbicides filter into our foods. Twisted automobile carcasses, aluminum cans, non-returnable glass bottles and synthetic plastics form immense kitchen middens in our midst as more and more of our detritus resists decay. We do not even begin to know what to do with our radioactive wastes — whether to pump them into the earth, shoot them into outer space, or pour them into the oceans. Our technological powers increase, but the side effects and potential hazards also escalate.

*Future Shock*

Chapter 19 (p. 380)

Random House, Inc. New York, New York, USA. 1979



## POPULATION

**Malthus, Thomas Robert** 1776–1834

English economist and sociologist

Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio. A slight acquaintance with numbers will show the immensity of the first power in comparison of the second.

In E.A. Wrigley and David Souden (eds.)

*The Works of Thomas Malthus* (Volume 1)

An Essay on the Principle of Population (p. 9)

Houghton Mifflin Company, Boston, Massachusetts, USA, 1885–1886

## POSITION

**Ridley, B. K.**

No biographical data available

Imagine a billiard ball as the only inhabitant of the universe. What position does it have? The question has no meaning, for position can only be defined with respect to another position, which we call an origin, and there is nothing to define where the origin is.

*Time, Space and Things*

Chapter 3 (p. 41)

Cambridge University Press, Cambridge, England, 1984

## POSITRON

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

A positron is a hole from which an electron has been removed; it is a bung-hole which would be evened up with its surroundings if an electron were inserted.... You will see that the physicist allows himself even greater liberty than the sculptor. The sculptor removes material to obtain the form he desires. The physicist goes further and adds material if necessary — an operation which he describes as removing negative. He fills up a bung-hole, saying he is removing a positron.

*The Philosophy of Physical Science*

Chapter VIII, Section II (pp. 120–121)

The Macmillan Company, New York, New York, USA, 1939

**Hacking, Ian** 1936–

Canadian-born philosopher of science

Now how does one alter the charge on the niobium ball? “Well at that stage,” said my friend, “we spray it with positrons to increase the charge or with electrons to decrease the charge.” From that day forth I’ve been a scientific realist. So far as I’m concerned, if you can spray them then they are real.

*Representing and Intervening* (p. 23)

Cambridge University Press, Cambridge, England, 1983

## POSSIBILITY

**Armstrong, David Malet** 1926–

Australian philosopher

The Naturalist theory of possibility now to be advanced will be called a Combinatorial theory. It traces the very idea of possibility to the idea of the combinations — all the combinations — of given, actual elements.

*A Combinatorial Theory of Possibility*

Part II, Chapter 3, Section I (p. 37)

Cambridge University Press, Cambridge, England, 1989

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

We know what a masquerade all development is, and what effective shapes may be disguised in helpless embryos. — In fact, the world is full of hopeful analogies and handsome dubious eggs called possibilities.

*Middlemarch*

Book I, Chapter X (p. 82)

Clarendon Press, Oxford, England, 1986

## POSTULATE

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The method of “postulating” what we want has many advantages; they are the same as the advantages of theft over honest toil. Let us leave them to others and proceed with our honest toil.

*Introduction to Mathematical Philosophy*

Chapter VII (p. 71)

Dover Publications, Inc. New York, New York, USA, 1993

## POWER

**Boulton, Matthew** 1728–1809

English engineer

“Ha! Boulton,” said the king. “It is long since we have seen you at court. Pray, what business are you now engaged in?”

“I am engaged, your Majesty, in the production of a commodity which is the desire of kings.”

“And what is that? What is that?”

“POWER, your majesty!”

In Ralph Stein

*The Great Inventions*

The Steam Engine (p. 24)

Playboy Press, Chicago, Illinois, USA, 1976

**Morison, George S.** 1842–1903

Civil engineer

Fire, animal strength, and written language have in turn advanced men and nations; something like a new

capacity was developed with the discovery of explosives and again in the invention of printing; but the capacity of man has always been limited to his own individual strength and that of the men and animals he could control. His capacity is no longer so limited; man has now learned to manufacture power, and with the manufacture of power a new epoch began.

*The New Epoch as Developed by the Manufacture of Power*  
Chapter I (p. 4)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

## PRAYER

**Ayres, Clarence Edwin** 1891–1972

No biographical data available

I believe in atoms, molecules, and electrons, matter of heaven and earth, and electrical energy its only form. I believe in modern science, conceived by Copernicus and borne out by Newton, which suffered under the Inquisition, was persecuted and anathematized, but rose to be the right hand of civilization as a consequence of the fact it rules the quick and the dead. I believe in the National Research Council, the communion of scientists, the publication of discoveries, the control of nature, and progress everlasting. Amen.

*Science: The False Messiah*  
Chapter X (p. 129)  
The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1927

**Conoley, Gillian** 1955–

Poet

I had only prayer, prayer and science.

Beckon  
*American Poetry Review*, Volume 25, Number 2, March-April 1996 (p. 9)

**Fiedler, Edgar R.** 1916–2003

American economist

Thank God for Compensating errors.

*Across the Board*  
The Three R's of Economic Forecasting — Irrational, Irrelevant and Irreverent, June 1977

**Hammond, Kenneth R.**

No biographical data available

**Adelman, Leonard**

No biographical data available

Lord, Please find me a one-armed statistician...so I won't always hear "on the other hand..."

Paraphrasing Edmund Muskie  
Science, Values, and Human Judgment  
*Science*, Volume 194, Number 4263, 22 October 1976 (p. 390)

**Howe, E. W.**

No biographical data available

What is the thing we call Common Sense? It is prayer practically applied, assistance given hope.

*Sinner Sermons: A Selection of the Best Paragraphs of E.W. Howe* (p. 7)  
Girard, Kansas, USA. 1926

**Plato** 428 BCE–347 BCE

Greek philosopher

...I call upon God, and beg him to be our savior out of a strange and unwanted enquiry, and to bring us to the heaven of probability.

In *Great Books of the Western World* (Volume 7)  
*Timaeus*  
Section 48 (p. 456)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Southgate, Theresa**

No biographical data available

I am like a chemical compound in Your Laboratory of Life, O Lord, a compound from which the element Perfection has not yet been isolated, a compound in which the properties of the element Perfection are disguised by combination with earthly vanities. Take me then, O Lord, analyze me according to my good and evil constituents and isolate the pure element Perfection, as a chemist analyzes and separates from a substance all foreign matter. Analyze me that I may learn to know myself and that I may emerge a pure element, worthy to be included in the group of elements already freed from the bonds of their earthy life.

First, grind me in the mortar of childish whims, that I may emerge a composite sample of Your Likeness. Weigh me on the balance of Your generosity and decide how great a sample I shall be in Your Laboratory of Life. Then, ignite me in the furnace of Your love, that the carbon dioxide of earthly vanities be driven off. Cool me with the balm of Your mercy. Dissolve me in Your grace and filter me through the fine mesh of earthly trials so that Imperfections may be banished. Precipitate my evil tendencies with the strong precipitate the gelatinous silicate of earthly attachments which draw me from You. Imprison me in Your love with the mordant of sacrifice. Digest me in the length of my life, that my good deeds will grow and that self-satisfaction shall not be occluded with them. Blast out any impurities that may be introduced and finally, seal me forever, a pure substance in the container of your Eternal Happiness.

A Chemist's Prayer  
*Journal of Chemical Education*, Volume 23, Number 10, October 1946 (p. 507)

**Tukey, John W.** 1915–2000

American statistician

The physical sciences are used to "praying over" their data, examining the same data from a variety of points of view. This process has been very rewarding, and has led

to many extremely valuable insights. Without this sort of flexibility, progress in physical science would have been much slower. Flexibility in analysis is often to be had honestly at the price of a willingness not to demand that what has already been observed shall establish, or prove, what analysis suggests. In physical science generally, the results of praying over the data are thought of as something to be put to further test in another experiment, as indications rather than conclusions.

The Future of Data Analysis

*The Annals of Mathematical Statistics*, Volume 33, Number 1, March 1962 (p. 46)

### **Wheelock, John** 1754–1817

No biographical data available

Oh, Lord, we thank thee for the Oxygen Gas; we thank Thee for the Hydrogen Gas; and for all the gases. We thank Thee for the Cerebrum; we thank Thee for the Cerebellum; and for the Medulla Oblongata. Amen.

Apocryphal

## PRECISION

### **Davy, Sir Humphry** 1778–1829

English chemist

Simplicity and precision ought to be the characteristics of a scientific nomenclature: words should signify things, or the analogies of things, and not opinions.

*Elements of Chemical Philosophy*

Part I, Volume 1, Introduction (p. 46)

Printed for J. Johnson & Company, London, England, 1812

### **Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

[Precision] is the very soul of science; and its attainment afford the only criterion, or at least the best, of the truth of theories, and the correctness of experiments.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part II, Chapter IV, Section 115 (p. 122)

Printed for Longman, Rees, Orme, Brown & Green, London, England, 1831

### **Queneau, Raymond** 1903–76

French poet, novelist, and publisher

In a bus of the S-line, 10 meters long, 3 wide, 6 high, at 3 km 600 m from its starting point, loaded with 48 people, at 12.17 p.m., a person of the masculine sex aged 27 years 3 months and 8 days, 1 m 72 cm tall and weighing 65 kg and wearing a hat 35 cm in height round the crown of which a ribbon 60 cm long, interpolated a man aged 48 years 4 months and 3 days, 1 m 68 cm tall and weighing 77 kg, by means of 14 words whose enunciation lasted 5 seconds and which alluded to some involuntary displacements of from 15 to 20 mm. Then he went and sat down about 1 m 10 cm away. 57 minutes later he

was 10 meters away from the suburban entrance to the gare Saint-Lazare and was walking up and down over a distance of 30 m with a friend aged 28, 1 m 70 cm tall and weighing 71 kg who advised him in 15 words to move by 5 cm in the direction of the zenith a button which was 3 cm in diameter.

*Exercises in Style*

Precision (pp. 37–38)

New Direction Publishing Corporation, New York, New York, USA, 1981

### **Thompson, Sir D'Arcy Wentworth** 1860–1948

Scottish zoologist and classical scholar

Dream apart, numerical precision is the very soul of science.

*On Growth and Form* (Volume 1)

Chapter 1 (p. 2)

At The University Press, Cambridge, England, 1951

## PREDICTION

### **Armstrong, Neil A.** 1930–

American astronaut

Science has not yet mastered prophecy. We predict too much for the next year and yet far too little for the next ten.

Address to Joint Sessions of Congress, September 16, 1969

### **Asimov, Isaac** 1920–92

American author and biochemist

It is one thing to be able to make predictions. It is another to listen to the predictions you have made and to act upon them.

*The Road to Infinity*

Chapter 1 (p. 3)

Avon Books, New York, New York, USA, 1979

### **Bohr, Niels Henrik David** 1886–1962

Danish physicist

It is very difficult to make an accurate prediction, especially about the future.

In Timothy Ferris (ed.)

*The Mind's Sky: Human Intelligence in a Cosmic Context*

The Manichean Heresy (p. 181)

Bantam Books, New York, New York, USA, 1992

### **Comte, Auguste** 1798–1857

French philosopher

The aim of every science is foresight (prevoyance). For the laws of established observation of phenomena are generally employed to foresee their succession. All men, however little advanced make true predictions, which are always based on the same principle, the knowledge of the future from the past.

In Bertrand de Jouvenel

*The Art of Conjecture*

Chapter 11 (p. 111)  
Basic Books, Inc. New York, New York, USA. 1967

**Darwin, Charles Robert** 1809–82  
English naturalist

Anyone who attempts to predict the history of the next ten years is a rash man, and if he attempts to make his forecast for a century he is very properly regarded as too foolhardy as not to be worth listening to at all.

*The Next Million Years*  
Introduction (p. 13)  
Doubleday & Company, Inc. Garden City, New York, USA. 1953

**du Noüy, Pierre Lecomte** 1883–1947  
French scientist

The aim of science is not so much to search for truth, or even truths, as to classify our knowledge and to establish relations between observable phenomena in order to be able to predict the future in a certain measure and to explain the sequence of phenomena in relation to ourselves.

*Between Knowing and Believing*  
The Road to Reason (p. 188)  
McKay. New York, New York, USA. 1967

The aim of science is to foresee, and not, as has often been said, to understand. Science describes facts, objects and phenomena minutely, and tries to join them by what we call laws, so as to be able to predict events in the future.

*Human Destiny*  
Chapter 2 (p. 13)  
Longmans, Green & Company. London, England. 1947

**Dyson, Freeman J.** 1923–  
American physicist and educator

In the long run, qualitative changes always outweigh quantitative ones. Quantitative predictions of economic and social trends are made obsolete by qualitative changes in the rules of the game. Quantitative predictions of technological progress are made obsolete by unpredictable new inventions. I am interested in the long run, the remote future, where quantitative predictions are meaningless. The only certainty in that remote future is that radically new things will be happening.

*Disturbing the Universe*  
Chapter 17 (p. 192)  
Basic Books, Inc. New York, New York, USA. 1979

**Hacking, Ian** 1936–  
Canadian-born philosopher of science

Cutting up fowl to predict the future is, if done honestly and with as little interpretation as possible a kind of randomization. But chicken guts are hard to read and invite flights of fancy or corruption.

*The Emergence of Probability*  
An Absent Family of Ideas (p. 3)  
Cambridge University Press. Cambridge, England. 1975

**Kaplan, Abraham** 1918–93  
American philosopher of science, author, and educator

...if we can predict successfully on the basis of a certain explanation, we have good reason, and perhaps the best of reason, for accepting the explanation.

*The Conduct of Inquiry: Methodology for Behavioral Science*  
Chapter IX, Section 40 (p. 350)  
Chandler Publishing Company. San Francisco, California, USA. 1964

**Kendrew, John** 1917–99  
English biochemist

Scientists cannot predict the future any better than anyone else — even about their own field of research.

*The Thread of Life*  
Chapter 10 (p. 110)  
Harvard University Press. Cambridge, Massachusetts, USA. 1966

**Kluckhohn, Clyde** 1905–60  
American anthropologist

...it is one thing to be able to make some useful predictions as to what is likely to happen.... It is quite another thing to interfere, willfully to introduce new complications into an already tortuous social maze.

*Mirror for Man: The Relation of Anthropology to Modern Life*  
Chapter X (p. 263)  
McGraw-Hill Book. New York, New York, USA. 1949

**Mill, John Stuart** 1806–73  
English political philosopher and economist

Of all truths relating to phenomena, the most valuable to us are those which relate to the order of their succession. On a knowledge of these is founded every reasonable anticipation of future facts, and whatever power we possess of influencing those facts to our advantage. Even the laws of geometry are chiefly of practical importance to us as being a portion of the premises from which the order of the succession of phenomena may be inferred.

*A System of Logic, Rationative and Inductive*  
Book III, Chapter 5, Section 1 (p. 212)  
Longmans, Green, Reader & Dyer. London, England. 1906

**Rowling, J. K.** 1965–  
English author

The consequences of our actions are always so complicated, so diverse, that predicting the future is a very difficult business indeed.

*Harry Potter and The Prisoner of Azkaban*  
Chapter Twenty-Two (p. 426)  
Scholastic Press. New York, New York, USA. 1999

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Science is the attempt to discover, by means of observation, and reasoning based upon it, first, particular facts about the world, and then laws connecting facts with one

another and (in fortunate cases) making it possible to predict future occurrences.

*Religion and Science*

Grounds of Conflict (p. 8)

Henry Holt & Company. New York, New York, USA. 1935

### Samuelson, Paul A.

No biographical data available

Wall Street indexes predicted nine out of the last five recessions!

Science and Stocks

*Newsweek*, September 19, 1966 (p. 92)

### Toulmin, Stephen 1922–

English philosopher

Prediction is all very well; but we must make sense of what we predict. The mainspring of science is the conviction that by honest, imaginative enquiry we can build up a system of ideas about Nature which has some legitimate claim to 'reality'.

*The Philosophy of Science: An Introduction*

Chapter 6 (p. 115)

Indiana University Press. Bloomington, Indiana, USA. 1961

### Wheeler, John Archibald 1911–

American physicist and educator

### Thorne, Kip S. 1940–

American theoretical physicist

The universe starts with a big bang, expands to a maximum dimension, then recontracts and collapses: no more awe-inspiring prediction was ever made. It is preposterous. Einstein himself could not believe his own prediction.

*Gravitation*

Part X, Chapter 44 (p. 1196)

W.H. Freeman & Company. San Francisco, California, USA. 1973

### Young, Louise B.

Science writer

Our most imaginative projections will pale beside the reality that takes shape tomorrow.

*The Unfinished Universe*

Chapter 10 (p. 197)

Simon & Schuster. New York, New York, USA. 1986

## PREHISTORIC MAN

### Aeschylus 525 BCE–426 BCE

Greek playwright

How, first beholding, they beheld in vain,  
And hearing, heard not, but, like shapes in dreams,  
Mixed all things wildly down the tedious time,  
Nor knew to build a house against the sun  
With wickered sides, nor any woodcraft knew,  
But lived, like sily ants, beneath the ground

In hollow caves unsunned.

There, came to them

No steadfast sign of winter, nor of spring

Flower-perfumed, nor of summer full of fruit,

But blindly and lawlessly they did all things...

In Elizabeth Barrett-Browning

*Prometheus Bound and Other Poems*

Prometheus Bound

Scene: At the Rocks

### James, William 1842–1910

American philosopher and psychologist

Bone of our bone and flesh of our flesh are these half-brutish pre-historic brothers. Girdled about with the immense darkness of this mysterious universe even as we are, they were born and died, suffered and struggled. Given over to fearful crime and passion, plunged in the blackest ignorance, preyed upon by hideous and grotesque delusions, yet steadfastly serving the profoundest of ideals in their fixed faith that existence in any form is better than non-existence, they ever rescued triumphantly from the jaws of ever-imminent destruction the torch of life, which, thanks to them, now lights the world for us.

*The Will to Believe, and Other Essays in Popular Philosophy and Human Immortality*

Human Immortality (p. 33)

Dover Publications, Inc. New York, New York, USA. 1956

### Leakey, Richard Erskine 1944–

Kenyan paleoanthropologist and politician

Needless to say, language and consciousness, which are among the most prized features of *Homo Sapiens*, leave no trace in the prehistoric record.

*The Origin of Humankind*

Preface (p. xiv)

Basic Books, Inc. New York, New York, USA. 1994

## PREHISTORY

### Clark, Grahame 1907–95

English archaeologist

The study of prehistory stands in no more need of justification than exploration of the physical nature and mathematical properties of the universe, the investigation of all the multifarious forms of life, or for that matter the practice of the arts or the cultivation of speculative philosophy. Each in its own way enlarges the range of human experience and enriches the quality of human life.

*Aspects of Prehistory*

Chapter 1 (p. 4)

University of California Press. Berkeley, California, USA. 1970

### Dunnell, Robert C. 1942–

American archaeologist

Like its sister discipline, sociocultural anthropology, prehistory has a tendency to invent a term for its own sake and then argue about what it means for twenty years rather than defining the term in the first place.

*Systematics In Prehistory*

Introduction (p. 4)

The Free Press. New York, New York, USA. 1971

**Peale, Rembrandt** 1778–1860

American neoclassical painter

The revolutions which have happened on our earth, by which its original appearance has been successively changed, have, at all times, commanded the attention of the learned, and excited various speculations concerning the time, cause and manner; and although we may never learn much on a subject so extensive, so remote and so wonderful, yet as far as facts will authorize us, we may safely proceed....

*An Historical Disquisition on the Mammoth*

Introduction (p. 1)

Printed for E. Lawrence. London, England. 1803

**Wilson, Sir Daniel** 1816–92

English-born Canadian archaeologist

In the application of the term Prehistoric — introduced, if I mistake not, for the first time in this work, — it was employed originally in reference to races which I then assigned reasons for believing had preceded the oldest historical ones in Britain and Northern Europe. But since then the term has become identified with a comprehensive range of speculative and inductive research, in which the archaeologist labours hand in hand with the geologist and ethnologist, in solving some of the most deeply interesting problems of modern science.

*Prehistoric Annals of Scotland* (Volume 1)

Preface (p. xiv)

Macmillan & Company Ltd. London, England. 1863

## PRESCRIPTION

**Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

What did your uncle die of?

Instead of fifteen Butkin drops, as the doctor prescribed, he took sixteen.

*Note-Book of Anton Chekhov* (p. 37)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Helmuth, William Tod** 1833–1902

American physician

Term pain “neuralgia,” or if the man be stout,  
Cry out, “Dear Sir, you have rheumatic gout.”  
Tap on the chest — some awful sounds they hear,  
Then satisfied, declare, “The case is clear,”  
Draw forth a paper, seize the magic quill,  
And write in mystic signs, “Cathartic pill.”

*Scratches of a Surgeon*

Medical Pomposity (p. 11)

W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Pliny says, in so many words, that the cerates and cataplasms, plasters, collyria, and antidotes, so abundant in his time, as in more recent days, were mere tricks to make money.

*Currents and Counter-Currents in Medical Science*

Address

Massachusetts Medical Society at the Annual Meeting, May 30, 1860

Ticknor & Fields. Boston, Massachusetts, USA. 1861

Part of the blame of over-medication must, I fear, rest with the profession, for yielding to the tendency to self-delusion, which seems inseparable from the practice of the art of healing.

*Currents and Counter-Currents in Medical Science*

Address

Massachusetts Medical Society at the Annual Meeting, May 30, 1860

Ticknor & Fields. Boston, Massachusetts, USA. 1861

**Latham, Peter Mere** 1789–1875

English physician

To bring many important remedies together, and unite them by a lucky combination, and compress them within a small compass, and so place them within the common reach, all this gives a facility of prescribing which is hurtful to the advance of medical experience. The facility of prescribing is a temptation to prescribe; and, under this temptation, there is a lavish expenditure continually going on of important remedies in the mass, of which the prescribers have made no sufficient experiment in detail. In William B. Bean

*Aphorisms From Latham* (p. 60)

Prairie Press. Iowa City, Iowa, USA. 1962

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

There are sure to be two prescriptions diametrically opposite. Stuff a cold and starve a cold are but two ways.

*The Writings of Henry David Thoreau* (Volume 1)

*A Week on the Concord and Merrimac Rivers*

Wednesday (p. 338)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

It would be a good thing for the world at large, however unprofessional it might be, if medical men were required by law to write out in full the ingredients named in their prescriptions. Let them adhere to the Latin, or Fejee, if they choose, but discard abbreviations, and form their

letters as if they had been to school one day in their lives, so as to avoid the possibility of mistakes on that account.

Damages Awarded

*San Francisco Morning Call*, 10/1/1864

### Wynter, Dr.

No biographical data available

Tell me from whom, fat-headed Scot,  
Thou didst thy system learn;  
From Hippocrates thou hadst it not,  
Nor Celsus, not Pitcairn.  
Suppose that we own that milk is good,  
And say the same of grass;  
The one for babes is only food,  
The other for an ass.  
Doctor! our new prescription try  
(A friend's advice forgive);  
Eat grass, reduce thyself, and die;-  
Thy patients then may live.

In William Davenport Adams

*English Epigrams*

On Doctor Cheyne, the Vegetarian, cclxxvi

G. Routledge. London, England. 1878

## PRESENT

### Dillard, Annie 1945–

American poet, essayist, novelist, and writing teacher

Catch it if you can. The present is an invisible electron; its lightning path traced faintly on a blackened screen is fleet, and fleeing, and gone.

*Pilgrim at Tinker Creek*

Chapter 6, 1 (p. 79)

Harper's Magazine Press. New York, New York, USA. 1974

### General Motors

The present is but an instant between an infinite past and a hurrying future.

General Motors 1964 Futurama

Audio narration accompanying the ride

## PRESERVATION

### Linnaeus, Carl (von Linné) 1707–78

Swedish botanist

To perpetuate the established course of nature in a continued series, the divine wisdom has thought fit, that all living creatures should constantly be employed in producing individuals, that all natural things should contribute and lend a helping hand towards preserving every species, and lastly that the death and destruction of one thing should always be subservient to the restitution of another.

Translated by B. Stillingfleet

*Miscellaneous Tracts Relating to Natural History, Husbandry, and Physick* (p. 32)

R. and J. Dodsley. London, England. 1759

## PRIME NUMBER

### Auster, Paul 1947–

American writer

Prime numbers. It was all so neat and elegant. Numbers that refuse to cooperate, that don't change or divide, numbers that remain themselves for all eternity.

*The Music of Chance*

Chapter 4 (pp. 73–74)

Viking Penguin. New York, New York, USA. 1990

### Bombieri, Enrico 1940–

Italian mathematician

To me, that the distribution of prime numbers can be so accurately represented in a harmonic analysis is absolutely amazing and incredibly beautiful. It tells of an arcane music and a secret harmony composed by the prime numbers.

*The Sciences*

Prime Territory: Exploring the Infinite Landscape at the Base of the

Number System, Sept/Oct 1992

### Crandall, Robert W. 1940–

Economist

### Pomerance, Carl

Number theorist

Prime numbers belong to an exclusive world of intellectual conceptions. We speak of those marvelous notions that enjoy simple, elegant description, yet lead to extreme — one might say unthinkable — complexity in the details. The basic notion of primality can be accessible to a child, yet no human mind harbors anything like a complete picture. In modern times, while theoreticians continue to grapple with the profundity of the prime numbers, vast toil and resources have been directed toward the computational aspect, the task of finding, characterizing, and applying the primes in other domains.

*Prime Numbers: A Computational Perspective*

Chapter 1 (p. 1)

Springer-Verlag. New York, New York, USA. 2001

### Davis, Philip J. 1923–

American mathematician

### Hersh, Reuben 1927–

American mathematician

Some order begins to emerge from this chaos when the primes are considered not in their individuality but in the aggregate; one considers the social statistics of the primes and not the eccentricities of the individuals.

*The Mathematical Experience*

The Prime Number Theorem (p. 213)  
Birkhäuser. Boston, Massachusetts, USA. 1981

**Doxiadis, Apostolos** 1953–  
Writer

The seeming absence of any ascertained organizing principle in the distribution of the succession of the primes had bedeviled mathematicians for centuries and given Number Theory much of its fascination. Here was a great mystery indeed, worthy of the most exalted intelligence: since the primes are the building blocks of the integers and the integers the basis of our logical understanding of the cosmos, how is it possible that their form is not determined by law? Why isn't "divine geometry" apparent in their case?

*Uncle Petros and Goldbach's Conjecture* (p. 84)  
Faber & Faber Ltd. London, England. 2000

**du Sautoy, Marcus**  
English mathematician and writer

...despite their apparent simplicity and fundamental character, prime numbers remain the most mysterious objects studied by mathematicians. In a subject dedicated to finding patterns and order, the primes offer the ultimate challenge.

*The Music of the Primes*  
Chapter 1 (p. 5)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

The primes have been a constant companion in our exploration of the mathematical world yet they remain the most enigmatic of all numbers. Despite the best efforts of the greatest mathematical minds to explain the modulation and transformation of this mystical music, the primes remain an unanswered riddle.

*The Music of the Primes*  
Chapter 12 (pp. 314–315)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

The search for the secret source that fed the primes had been going on for over two millennia. The yearning for this elixir had made mathematicians all too susceptible to Bombieri's [April Fools announcement of a proof of the Riemann Hypothesis in 1997]. For years, many had simply been too frightened to go anywhere near this notoriously difficult problem.

*The Music of the Primes*  
Chapter 1 (p. 13)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

We have all this evidence that the Riemann zeros are vibrations, but we don't know what's doing the vibrating.

*The Music of the Primes*  
Chapter 11 (p. 280)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

[The Riemann] zeros did not appear to be scattered at random. Riemann's calculations indicated that they were

lining up as if along some mystical ley line running through the landscape.

*The Music of the Primes*  
Chapter 4 (p. 99)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

Prime numbers present mathematicians with one of the strangest tensions in their subject. On the one hand a number is either prime or it isn't. No flip of a coin will suddenly make a number divisible by some smaller number. Yet there is no denying that the list of primes looks like a randomly chosen sequence of numbers. Physicists have grown used to the idea that a quantum die decides the fate of the universe, randomly choosing at each throw where scientists will find matter. But it is something of an embarrassment to have to admit that these fundamental numbers on which mathematics is based appear to have been laid out by Nature flipping a coin, deciding at each toss the fate of each number. Randomness and chaos are anathema to the mathematician. Despite their randomness, prime numbers — more than any other part of our mathematical heritage — have a timeless, universal character. Prime numbers would be there regardless of whether we had evolved sufficiently to recognise them.

*The Music of the Primes*  
Chapter 1 (p. 6)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

Riemann's insight followed his discovery of a mathematical looking-glass through which he could gaze at the primes. Alice's world was turned upside down when she stepped through her looking-glass. In contrast, in the strange mathematical world beyond Riemann's glass, the chaos of the primes seemed to be transformed into an ordered pattern as strong as any mathematician could hope for. He conjectured that this order would be maintained however far one stared into the never-ending world beyond the glass. His prediction of an inner harmony on the far side of the mirror would explain why outwardly the primes look so chaotic. The metamorphosis provided by Riemann's mirror, where chaos turns to order, is one which most mathematicians find almost miraculous. The challenge that Riemann left the mathematical world was to prove that the order he thought he could discern was really there.

*The Music of the Primes*  
Chapter 1 (p. 9)  
HarperCollins Publisher, Inc. New York, New York, USA. 2003

Riemann had found a passageway from the familiar world of numbers into a mathematics which would have seemed utterly alien to the Greeks who had studied prime numbers two thousand years before. He had innocently mixed imaginary numbers with his zeta function and discovered, like some mathematical alchemist, the mathematical treasure emerging from this admixture of elements that generations had been searching for. He had



crammed his ideas into a ten-page paper, but was fully aware that his ideas would open up radically new vistas on the primes.

*The Music of the Primes*

Chapter 2 (p. 58)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Armed with his prime number tables, Gauss began his quest. As he looked at the proportion of numbers that were prime, he found that when he counted higher and higher a pattern started to emerge. Despite the randomness of these numbers, a stunning regularity seemed to be looming out of the mist.

*The Music of the Primes*

Chapter 2 (p. 47)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Gauss had heard the first big theme in the music of the primes, but it was one of his students, Riemann, who would truly unleash the full force...of the hidden harmonies that lay behind the cacophony of the primes.

*The Music of the Primes*

Chapter 2 (p. 58)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

For centuries, mathematicians had been listening to the primes and hearing only disorganised noise. These numbers were like random notes wildly dotted on a mathematical stave with no discernible tune. Now Riemann had found new ears with which to listen to these mysterious tones. The sine-like waves that Riemann had created from the zeros in his zeta landscape revealed some hidden harmonic structure.

*The Music of the Primes*

Chapter 4 (p. 93)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

The revelation that the graph appears to climb so smoothly, even though the primes themselves are so unpredictable, is one of the most miraculous in mathematics and represents one of the high points in the story of the primes. On the back page of his book of logarithms, Gauss recorded the discovery of his formula for the number of primes up to  $N$  in terms of the logarithm function. Yet despite the importance of the discovery, Gauss told no one what he had found. The most the world heard of his revelation were the cryptic words, "You have no idea how much poetry there is in a table of logarithms."

*The Music of the Primes*

Chapter 2 (p. 50)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

The primes are jewels studded throughout the vast expanse of the infinite universe of numbers that mathematicians have explored down the centuries. For mathematicians they instill a sense of wonder: 2, 3, 5, 7, 11, 13, 17, 19, 23... — timeless numbers that exist in the same world independent of our physical reality. They are Nature's gift to the mathematician.

*The Music of the Primes*

Chapter 1 (p. 5)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

It seems paradoxical that the fundamental objects on which we build our order-filled world of mathematics should behave so wildly and unpredictably.

*The Music of the Primes*

Chapter 2 (p. 45)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Maybe we have become so hung up on looking at the primes from Gauss's and Riemann's perspective that what we are missing is simply a different way to understand these enigmatic numbers. Gauss gave an estimate for the number of primes, Riemann predicted that the guess is at worst the square root of  $N$  off its mark, Littlewood showed that you can't do better than this. Maybe there is an alternative viewpoint that no one has found because we have become so culturally attached to the house that Gauss built.

*The Music of the Primes*

Chapter 12 (p. 312)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Littlewood wrote to Hardy about [Ramanujan]: "it is not surprising that he would have been [misled], unsuspecting as he presumably is of the diabolical malice inherent in the primes."

*The Music of the Primes*

Chapter 6 (p. 139)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Littlewood's proof...revealed that prime numbers are masters of disguise. They hide their true colours in the deep recesses of the universe of numbers, so deep that witnessing their true nature may be beyond the computational power of humankind. Their true behavior can be seen only through the penetrating eyes of abstract mathematical proof.

*The Music of the Primes*

Chapter 5 (p. 130)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

...Gauss liked to call [number theory] "the Queen of Mathematics." For Gauss, the jewels in the crown were the primes, numbers which had fascinated and teased generations of mathematicians.

*The Music of the Primes*

Chapter 2 (p. 22)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

## **Erdős, Paul** 1913–96

Hungarian mathematician

God may not play dice with the universe, but something strange is going on with the prime numbers.

In D. Mackenzie

Homage to an Itinerant Master

*Science*, Volume 275, Number 5301, 7 February, 1997 (p. 759)

**Euler, Leonhard** 1707–83  
Swiss mathematician and physicist

Mathematicians have tried in vain to this day to discover some order in the sequence of prime numbers, and we have reason to believe that it is a mystery into which the human mind will never penetrate. To convince ourselves, we have only to cast a glance at tables of primes, which some have taken the trouble to compute beyond a hundred thousand, and we should perceive at once that there reigns neither order nor rule.

*Collected Works*

Serial 1, Volume 2 (p. 241)

Publisher undetermined

**Gardner, Martin** 1914–  
American writer and mathematics games editor

The primes...[are] exasperating, unruly integers that refuse to be divided...by any integers except themselves and one.

In Eli Maor

*To Infinity and Beyond: A Cultural History of The Infinite* (p. 21)

Birkhäuser. Boston, Massachusetts, USA. 1987

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

The problem of distinguishing prime numbers from composite numbers and of resolving the latter into their prime factors is known to be one of the most important and useful in arithmetic. It has engaged the industry and wisdom of ancient and modern geometers to such an extent that it would be superfluous to discuss the problem at length.... Further, the dignity of the science itself seems to require that every possible means be explored for the solution of a problem so elegant and so celebrated.

*Disquisitiones Arithmeticae*

Article 329 (p. 326)

Yale University Press. New Haven, Connecticut, USA. 1965

**Gonek, S.**  
Mathematician

If there are lots of zeros off the line — and there might be — the whole picture is just horrible, horrible, very ugly. It's an Occam's razor sort of thing, you either have absolutely beautiful behavior of prime numbers, they behave just like you want them to behave, or else it's really bad.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 8 (p. 135)

Farrar, Straus & Giroux. New York, New York, USA. 2002

**Gowers, Timothy** 1963–  
English mathematician

Although the prime numbers are rigidly determined, they somehow feel like experimental data.

*Mathematics: A Very Short Introduction*

Chapter 7 (p. 121)

Oxford University Press, Inc. Oxford, England. 2002

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

...317 is a prime, not because we think so, or because our minds are shaped in one way rather than another, but because it is so, because mathematical reality is built that way.

*A Mathematician's Apology*

Chapter 24 (p. 130)

Cambridge University Press. Cambridge, England. 1967

**Jutila, M.**

No biographical data available

I sometimes have the feeling that the number system is comparable with the universe that the astronomer is studying... The number system is something like a cosmos.

In K. Sabbagh

*Beautiful Mathematics*

*Prospect*, January 2002

**Motohashi, Yoichi**

No biographical data available

[Primes] are full of surprises and very mysterious... They are like things you can touch.... In mathematics most things are abstract, but I have some feeling that I can touch the primes, as if they are made of a really physical material. To me, the integers as a whole are like physical particles.

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 1 (p. 22)

Farrar, Straus & Giroux. New York, New York, USA. 2002

**Queneau, Raymond** 1903–76

French poet, novelist, and publisher

When One made love to Zero  
spheres embraced their arches  
and prime numbers caught their breath...

*Pounding the Pavement, Beating the Bush, and Other Paraphysical Poems*

Sines

Unicorn Press. Greensboro, North Carolina, USA. 1985

**Sagan, Carl** 1934–96

American astronomer and author

Do we know what the sequence of numbers is? Okay, here, we can do it in our heads...fifty-nine, sixty-one, sixty-seven...seventy-one.... Aren't these all prime numbers? A little buzz of excitement circulated through the control room. Ellie's own face momentarily revealed a flutter of something deeply felt, but this was quickly replaced by a sobriety, a fear of being carried away, an apprehension about appearing foolish, unscientific.

*Contact: A Novel*

Chapter 4 (p. 78)

Simon & Schuster. New York, New York, USA. 1985

**Stewart, Ian** 1945–  
English-mathematician and science writer

Who would have imagined that something as straightforward as the natural numbers (1, 2, 3, 4...) could give birth to anything so baffling as the prime numbers (2, 3, 5, 7, 11...)?

Jumping Champions  
*Scientific American*, Volume 283, Number 6, December 2000 (p. 106)

**Sylvester, James Joseph** 1814–97  
English mathematician

[Tschebycheff] was the only man ever able to cope with the refractory character and erratic flow of prime numbers and to confine the stream of their progression with algebraic limits, building up, if I may so say, banks on either side which that stream, devious and irregular as are its windings, can never overflow.

In E. Kramer  
*The Nature and Growth of Mathematics*  
Chapter 21 (p. 503)  
Hawthorn Books, Inc. New York, New York, USA. 1970

I have sometimes thought that the profound mystery which envelops our conceptions relative to prime numbers depends upon the limitations of our faculties in regard to time, which like space may be in essence poly-dimensional and that this and other such sort of truths would become self-evident to a being whose mode of perception is according to *superficially* as opposed to our own limitation to *linearly* extended time.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 4)  
On Certain Inequalities Relating to Prime Numbers (p. 600)  
University Press. Cambridge, England. 1904–1912

**Tenenbaum, G.**  
No biographical data available

Addition and multiplication equip the set of positive natural numbers  $\{1, 2, 3, \dots\}$  with a double structure of Abelian semigroup. The first is associated with a total order relation, and is generated by the single number 1. The second, reflecting the partial order of divisibility has an infinite number of generators: the prime numbers. Defined since antiquity, this key concept has yet to deliver up all its secrets — and there are plenty of them.

*Introduction to Analytic and Probabilistic Number Theory* (p. 299)  
Cambridge University Press. Cambridge, England. 1995

**Tenenbaum, G.**  
No biographical data available

**France, M. Mendés**  
No biographical data available

One of the remarkable aspects of the distribution of prime numbers is their tendency to exhibit global regularity and local irregularity. The prime numbers behave like the “ideal gases” which physicists are so fond of. Considered

from an external point of view, the distribution is — in broad terms — deterministic, but as soon as we try to describe the situation at a given point, statistical fluctuations occur as in a game of chance where it is known that on average the heads will match the tail but where, at any one moment, the next throw cannot be predicted.

Translated by Philip G. Spain  
*The Prime Numbers and Their Distribution* (p. 51)  
American Mathematical Society. Providence, Rhode Island, USA. 2000

Prime numbers try to occupy all the room available (meaning that they behave as randomly as possible), given that they need to be compatible with the drastic constraint imposed on them, namely to generate the ultra-regular sequence of integers. This idea underpins the majority of conjectures concerning prime numbers: everything which is not trivially forbidden should actually happen.

Translated by Philip G. Spain  
*The Prime Numbers and Their Distribution* (p. 51)  
American Mathematical Society. Providence, Rhode Island, USA. 2000

As archetypes of our representation of the world, numbers form, in the strongest sense, part of ourselves, to such an extent that it can legitimately be asked whether the subject of study of arithmetic is not the human mind itself. From this a strange fascination arises: how can it be that these numbers, which lie so deeply within ourselves, also give rise to such formidable enigmas? Among all these mysteries, that of the prime numbers is undoubtedly the most ancient and most resistant.

Translated by Philip G. Spain  
*The Prime Numbers and Their Distribution* (p. 1)  
American Mathematical Society. Providence, Rhode Island, USA. 2000

**Weyl, Hermann** 1885–1955  
German mathematician

The mystery that clings to numbers, the magic of numbers, may spring from this very fact, that the intellect, in the form of the number series, creates an infinite manifold of well-distinguished individuals. Even we enlightened scientists can still feel it, e.g., in the impenetrable law of the distribution of prime numbers.

*Philosophy of Mathematics and Natural Science*  
Part I, Chapter I (p. 7)  
Princeton University Press. Princeton, New Jersey, USA. 1949

**Zagier D.**  
No biographical data available

I hope that...I have communicated a certain impression of the immense beauty of the prime numbers and the endless surprises which they have in store for us.

The First 50 Million Prime Numbers  
*The Mathematical Intelligencer*, Volume 0 August 1977

...there is no apparent reason why one number is prime and another not. To the contrary, upon looking at these numbers one has the feeling of being in the presence of one of the inexplicable secrets of creation.

The First 50 Million Prime Numbers  
*The Mathematical Intelligencer*, Volume 0 August 1977

## PRIMORDIAL

**de Maupassant, Guy** 1850–93  
 French writer

Nothing is more impressive, nothing more disquieting, more terrifying occasionally, than a fen. Why should a vague terror hang over these low plains covered with water? Is it the low rustling of the rushes, the strange Will-o'-the-wisp light, the silence which prevails on calm nights, the still mists which hang over the surface like a shroud; or is it the almost inaudible splashing, so slight and so gentle, yet sometimes more terrifying than the cannons of men of the thunders of skies, which make these marshes resemble countries which none has dreamed of, terrible countries concealing an unknown and dangerous secret?

No, something else belongs to it — another mystery, profounder and graver, floats amid these thick mists, perhaps the mystery of the creation itself! For was it not in stagnant and muddy water, amid the heavy humidity of moist land under the heat of the sun, that the first germ of life pulsed and expanded to the day?

*A Selection From the Writings of Guy de Maupassant* (Volume 1)  
 Chapter 7, Love  
 President Publishing Company. New York, New York, USA. 1903

**Newman, Joseph S.** 1892–1960  
 American poet

A highly speculative void  
 Divides the germ and anthropoid  
 But we've discovered certain clues  
 In fossilized primordial ooze  
 Where ancient polyps lived and died  
 And countless myriads multiplied.

*Poems for Penguins and Other Lyrical Lapses*  
 Biology  
 Greenburg. New York, New York, USA. 1941

**Shakespeare, William** 1564–1616  
 English poet, playwright, and actor

In the cauldron boil and bake;  
 Eye of newt and toe of frog,  
 Wool of bat and tongue of dog,  
 Adder's fork and blind-worm's sting,  
 Lizard's leg and howlet's wing...

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Macbeth  
 Act IV, Scene i, l. 13–17  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## PRINCIPLE

**Adams, John** 1735–1826  
 2<sup>nd</sup> president of the United States

The reasoning of mathematicians is founded on certain and infallible principles. Every word they use conveys a determinate idea, and by accurate definitions they excite the same ideas in the mind of the reader that were in the mind of the writer. When they have defined the terms they intend to make use of, they premise a few axioms, or self-evident principles, that every one must assent to as soon as proposed. They then take for granted certain postulates, that no one can deny them, such as, that a right line may be drawn from any given point to another, and from these plain, simple principles they have raised most astonishing speculations, and proved the extent of the human mind to be more spacious and capacious than any other science.

*Works* (Volume 2)  
 Diary (p. 21)  
 Boston, Massachusetts, USA. 1850

**Bilaniuk, Oleksa-Myron** 1926–  
 Polish/Ukrainian-American physicist

**Sudarshan, E. C.** 1931–  
 Indian-American physicist

There is an unwritten precept in modern physics, often facetiously referred to as Gell-Mann's totalitarian principle, which states that in physics "anything which is not prohibited is compulsory." Guided by this sort of argument we have made a number of remarkable discoveries, from neutrinos to radio galaxies.

*Particles Beyond the Light Barrier*  
*Physics Today*, Volume 22, Number 5, May 1969 (p. 44)

**Pólya, George** 1887–1985  
 Hungarian mathematician

This principle is so perfectly general that no particular application is possible.

*How to Solve It: A New Aspect of Mathematical Method*  
 Part III. The Traditional Mathematics Professor (p. 208)  
 Princeton University Press. Princeton, New Jersey, USA. 1973

## PROBABILITY

**Adams, Douglas** 1952–2001  
 English author, comic radio dramatist, and musician

TRILLIAN: Five to one against and falling...four to one against and falling...three to one...two...one...Probability factor one to one...we have normality...I repeat we have normality...anything you still can't cope with is therefore your own problem.

*The Original Hitchhiker Radio Script*  
 Fit the Second (p. 42)  
 Harmony Books. New York, New York, USA. 1983

FORD: Arthur, This is fantastic, we've been picked up by a ship with the new Infinite Improbability Drive, this is really incredible, Arthur.... Arthur, what's happening?

ARTHUR: Ford, there's an infinite number of monkeys outside who want to talk to us about this script for Hamlet they've worked out.

*The Original Hitchhiker Radio Script*

Fit the Second (pp. 41–42)

Harmony Books. New York, New York, USA. 1983

**Arbuthnot, John** 1667–1735

Scottish mathematician and physician

The Reader may here observe the Force of Numbers, which can be successfully applied, even to those things, which one would imagine are subject to no Rules. There are very few things which we know, which are not capable of being reduc'd to a Mathematical Reasoning, and when they cannot, its a Sign our Knowledge of them is very small and confus'd; And where mathematical reasoning can be had, its as great folly to make use of any other, as to grope for a thing in the dark, when you have a Candle standing by you. I believe the Calculation of the Quantity of Probability might be improved to a very useful and pleasant Speculation, and applied to a great many Events which are accidental, besides those of Games...

*Of the Laws of Chance*

Preface

Benjamin Motte. London, England. 1692

**Atkins, Russell** 1926–

Poet, composer, editor, and teacher

...dogs are random.

*Probability and Birds in the Yard*

Poem

**Austen, Jane** 1775–1817

English writer

Are no probabilities to be accepted, merely because they are not certainties?

*Sense and Sensibility* (Volume 1)

Chapter 15 (p. 68)

Oxford University Press. Oxford, England. 1980

**Bagehot, Walter** 1826–77

English journalist

Life is a school of probability.

In Rudolf Flesch

*The New Book of Unusual Quotations*

Harper & Row, Publishers. New York, New York, USA. 1966

**Barrow, John D.** 1952–

English theoretical physicist

**Tipler, Frank** 1947–

American physicist

In a randomly infinite Universe, any event occurring here and now with finite probability must be occurring simultaneously at an infinite number of other sites in the Universe. It is hard to evaluate this idea any further, but

one thing is certain: if it is true then it is certainly not original!

*The Anthropic Cosmological Principle*

Chapter 4.6 (p. 249)

Clarendon Press. Oxford, England. 1986

**Barry, Frederick** 1876–1943

Historian of science

In short, these fundamental elements of scientific knowledge assimilate and grow, coalesce and separate and recombine, shrink and wane, die and come to life again; and while they persist they are never more than probable.

*The Scientific Habit of Thought: An Informal Discussion of the Source and Character of Dependable Knowledge* (p. 139)

Columbia University Press. New York, New York, USA. 1927

**Blake, William** 1757–1827

English poet, painter, and engraver

...all is to them a dull round of probabilities and possibilities.

*The Complete Poetry and Prose of William Blake*

The Ancient Britons

University of California Press. Berkeley, California, USA. 1982

**Bleckley, Logan E.** 1827–1907

American lawyer

...it is always probable that something improbable will happen.

Warren v. Purcell, 63 *Georgia Reports* 428, 430 (1879)

**Boole, George** 1815–64

English mathematician

Probability is expectation founded upon partial knowledge. A perfect acquaintance with all the circumstances affecting the occurrence of an event would change expectation into certainty, and leave neither room nor demand for a theory of probabilities.

*Collected Logical Works* (Volume 2)

An Investigation of the Law of Thought, Chapter XVI (p. 258)

The Open Court Publishing Company. La Salle, Illinois, USA. 1952

**Borel, Félix Edouard Justin Emile** 1871–1956

French mathematician

Probabilities must be regarded as analogous to the measurement of physical magnitudes; that is to say, they can never be known exactly, but only within certain approximation.

Translated by Maurice Baudin

*Probabilities and Life*

Chapter Three, Section 6 (pp. 32–33)

Dover Publications. New York, New York, USA. 1962

The principles on which the calculus of probabilities is based are extremely simple and as intuitive as the reasons which lead an accountant through his operations.

Translated by Maurice Baudin

*Probabilities and Life*

Introduction (p. 1)

Dover Publications. New York, New York, USA. 1962

...just as price is not the sole element of our decision when we make a purchase, probability alone must not dictate our decision in the matters of a risk.

Translated by Maurice Baudin

*Probabilities and Life*

Chapter 3, Section 6 (p. 32)

Dover Publications. New York, New York, USA. 1962

**Born, Max** 1882–1970

German-born English physicist

As far as I can see, the only foundation of the doctrine of probability, which (though not satisfactory for a mind devoted to the “absolute”) seems at least not more mysterious than science as a whole, is the empirical attitude: The laws of probability are valid just as any other physical law in virtue of the agreement of their consequences with experience.

*Experiment and Theory in Physics* (pp. 26–27)

Cambridge University Press. Cambridge, England. 1944

If Gessler had ordered William Tell to shoot a hydrogen atom off his son’s head by means of a particle and had given him the best laboratory instruments in the world instead of a cross-bow, Tell’s skill would have availed him nothing. Hit or miss would have been a matter of chance.

In Sir Arthur Stanley Eddington

*New Pathways in Science*

Chapter IV, Section III (p. 82)

The Macmillan Company. New York, New York, USA. 1935

**Bostwick, Arthur Elmore** 1860–1942

American librarian

It is easier to make true misleading statements in the subject of probabilities than anywhere else.

The Theory of Probabilities

*Science*, Volume 3, Number 54, January 10, 1896 (p. 66)**Boswell, James** 1740–95

Scottish biographer and diarist

JOHNSON: “If I am well acquainted with a man, I can judge with great probability how he will act in any case, without his being restrained by my judging. God may have this probability increased to certainty.”

*The Life of Samuel Johnson* (Volume 2)

April 15, 1778 (pp. 209–210)

J.M. Dent &amp; Sons Ltd. London, England. 1938

**Meredith, Owen (Edward Robert****Bulwer-Lytton, 1<sup>st</sup> Earl Lytton)** 1831–91

English statesman and poet

...fate laughs at probabilities!

*Eugene Aram*

Book First, Chapter 10 (p. 72)

John W. Lovell Company. New York, New York, USA. n.d.

**Burney, Fanny** 1752–1840

English novelist and diarist

The play of imagination, in the romance of early youth, is rarely interrupted with scruples of probability.

In Edward A Bloom and Lillian D. Bloom (eds.)

*Camilla, or, A Picture of Youth*

Book II, Chapter V (p. 102)

Oxford University Press. Oxford, England. 1983

**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

If scientific reasoning were limited to the logical processes of arithmetic, we should not get very far in our understanding of the physical world. One might as well attempt to grasp the game of poker entirely by the use of the mathematics of probability.

As We May Think

*Atlantic Monthly*, July 1945**Butler, Joseph** 1692–1752

English bishop and exponent of natural theology

But to us, probability is the very guide to life.

*The Analogy of Religion*

Introduction (p. 76)

Henry G. Bohn. London, England. 1852

**Cardozo, Benjamin N.** 1870–1938

American jurist

...law, like other branches of social science, must be satisfied to test the validity of its conclusions by the logic of probabilities rather than the logic of certainty.

*The Growth of the Law* (p. 33)

Yale University Press. New Haven, Connecticut, USA. 1924

**Coats, R. H.**

No biographical data available

...the electron is just a “smear of probability.”

Science and Society

*Journal of the American Statistical Association*, Volume 34, Number

205, March 1939 (p. 6)

**Cohen, John**

No biographical data available

Unlike almost all mathematics, I agree completely with your statement that every probability evaluation is a probability evaluation, that is, something to which it is meaningless to apply such attributes as right, wrong, rational, etc.

*Chance, Skill, and Luck: The Psychology of Guessing and Gambling*

Chapter 2, Part I (p. 28)

Penguin Books. Baltimore, Maryland, USA. 1960

**Crichton, Michael** 1942–

American novelist

Harry sighed irritably, pulled out a sheet of paper. It's a probability equation? He wrote:  $p = f_p n_h f_i f_c$

"What it means," Harry Adams said, "is that the probability,  $p$ , that intelligent life will evolve in any star system is a function of the probability that the star will have planets, the number of habitable planets, the probability that simple life will evolve on a habitable planet, the probability that intelligent life will evolve from simple life, and the probability that intelligent life will attempt interstellar communication within five billion years. That's all the equation says."

*Sphere: A Novel*

The Briefing (pp. 28–29)

Ballantine Books. New York, New York, USA. 1987

But the point is that we have no facts," Harry said. "We must guess at every single one of these probabilities."

*Sphere: A Novel*

The Briefing (p. 29)

Ballantine Books. New York, New York, USA. 1987

### Crofton, M. W.

British mathematician

The mathematical theory of probability is a science which aims at reducing to calculation, where possible, the amount of credence due to propositions or statements, or to the occurrence of events, future or past, more especially as contingent or dependent upon other propositions or events the probability of which is known.

*Encyclopædia Britannica* (9<sup>th</sup> edition)

Probability

### Dampier-Whetham, William

1867–1952

English scientific writer

Indeed the intellectual basis of all empirical knowledge may be said to be a matter of probability, expressible only in terms of a bet.

*A History of Science*

Chapter III (p. 155)

The Macmillan Company. New York, New York, USA. 1936

### Darwin, Charles Robert

1809–82

English naturalist

As for a future life, every man must judge for himself between conflicting vague probabilities.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter VIII (p. 277)

D. Appleton & Company. New York, New York, USA. 1896

### de Cervantes, Miguel

1547–1616

Spanish novelist, playwright, and poet

...I would reply that fiction is all the better the more it looks like truth, and gives the more pleasure the more probability and possibility there is about it.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part I, Chapter 47 (p. 184)

*Encyclopædia Britannica*, Inc. Chicago, Illinois, USA. 1952

### de Jouvenel, Bertrand

1903–87

French man of letters

We defined the art of conjecture, or stochastic art, as the art of evaluating as exactly as possible the probabilities of things, so that in our judgments and actions we can always base ourselves on what has been found to be the best, the most appropriate, the most certain, the best advised; this is the only object of the wisdom of the philosopher and the prudence of the statesman.

Translated by Nikita Lary

*The Art of Conjecture*

Introduction, 3 (p. 21, note 19)

Basic Books, Inc. New York, New York, USA. 1967

### de Leeuw, A. L.

No biographical data available

The laws of chance tell us what is probable, but not what is certain to happen. They do not predict. They do not tell us what will, but what may happen.

*Rambling Through Science*

Gambling (p. 88)

Whittlesey House. London, England. 1932

### de Moivre, Abraham

1667–1754

French-born mathematician

The Probability of an Event is greater or less, according to the number of chances by which it may happen, compared with the whole number of chances by which it may either happen or fail.

*The Doctrine of Chances: or, A Method of Calculating the Probabilities of Events in Play* (3<sup>rd</sup> edition)

Introduction (p. 1)

Printed for Millar. London, England. 1756

### de Morgan, Augustus

1806–71

English mathematician and logician

No part of mathematics or mathematical physics involves considerations so strange or so difficult to handle correctly, and there is no subject upon which opinions have been more freely hazarded by the ignorant, or rational dissent more unambiguously expressed by the learned.

*Encyclopædia Metropolitana* (Volume 2)

Theory of Probabilities (p. 393)

### Deming, William Edwards

1900–93

American statistician, educator, and consultant

The statistician's report to management should not talk about probabilities. It will merely give outside margins of error for the results of chief importance.

*Sample Design in Business Research* (p. 13)

John Wiley & Sons, Inc. New York, New York, USA. 1960

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...when it is not in our power to determine what is true, we ought to act accordingly to what is most probable...

*Discourse on the Method of Rightly Conducting the Reason and Seeking For Truth in the Sciences*

Part III (p. 67)

Simpson, Marshall, and Company. London, England. 1850

**Diaconis, Persi** 1945–

American mathematician

Our brains are just not wired to do probability problems very well.

The Search for Randomness

*Talk*, March 29, 1989**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

We are coming now rather into the region of guesswork, said Dr. Mortimer.

Say, rather, into the region where we balance probabilities and choose the most likely. It is the scientific use of the imagination, but we have always some material basis on which to start our speculation.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Hound of the Baskervilles, Chapter 4 (p. 24)

Wings Books. New York, New York, USA. 1967

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

There can be no unique probability attached to any event or behavior: we can only speak of “probability in the light of certain given information”, and the probability alters according to the extent of the information.

*The Nature of the Physical World*

Chapter XIV (pp. 314–315)

The Macmillan Company. New York, New York, USA. 1930

But it is necessary to insist more strongly than usual that what I am putting before you is a model — the Bohr model atom — because later I shall take you to a profounder level of representation in which the electron, instead of being confined to a particular locality, is distributed in a sort of probability haze all over the atom...

*New Pathways in Science*

Chapter II, Section III (p. 34)

The Macmillan Company. New York, New York, USA. 1935

In most modern theories of physics probability seems to have replaced aether as “the nominative of the verb ‘to undulate’.”

*New Pathways in Science*

Chapter VI, Section I (p. 110)

The Macmillan Company. New York, New York, USA. 1935

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

The Calculus of Probabilities is an instrument which requires the living hand to direct it.

*Metrelike, or The Method of Measuring Probability and Utility* (p. 18)

Temple. London, England. 1887

Probability may be described, agreeably to general usage, as importing partial incomplete belief.

The Philosophy of Chance

*Mind*, Volume 9, 1884

I hope that you flourish in Probabilities.

Quoted in Stephen M. Stigler

*The History of Statistics*

Letter from Edgeworth to Pearson, 11 September 1893 (p. 326)

It is a useful discipline to walk in a world where, though the objects themselves are fixed, their images are ever vibrating through a large part of their own dimensions. The Calculus of Probabilities...conveys a lesson which is required for the study of social science, the power of contemplating general tendencies through the wavering medium of particulars.

On Methods of Ascertaining Variation in the Rate of Births, Deaths, and Marriages

*Journal of the Royal Statistical Society*, Volume 48, 1885 (p. 633)**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Secrets are rarely betrayed or discovered according to any program our fear has sketched out. Fear is almost always haunted by terrible dramatic scenes, which recur in spite of the best-argued probabilities against them...

*The Mill on the Floss*

Book V, V (p. 317)

J.M. Dent &amp; Sons Ltd. London, England. 1908

Still there is a possibility — even a probability — the other way.

*The George Eliot Letters* (Volume 2) (p. 127)

Yale University Press. New Haven, Connecticut, USA. 1954–1978

But I see no probability of my being able to be with you before your other Midsummer visitors arrive.

*The George Eliot Letters* (Volume 2) (p. 160)

Yale University Press. New Haven, Connecticut, USA. 1954–1978

...ignorance gives one a large range of probabilities.

*Daniel Deronda II*

Book II, Chapter XIII (p. 136)

A.L. Burt Company. New York, New York, USA. 18??

**Evanovich, Janet** 1943–

American writer

I graduated from Douglass College without distinction. I was in the top 98% of my class and damn glad to be there. I slept in the library and daydreamed my way through history lecture. I failed math twice, never fully grasping probability theory. I mean, first off, who cares if you pick a black ball or a white ball out of the bag? And second, if



you're bent over about the color, don't leave it to chance. Look in the damn bag and pick the color you want.

*Hard Eight* (pp. 227–228)

St. Martin's Press. New York, New York, USA. 2002

**Feller, William** 1906–70

Yugoslavian-born American mathematician

Probability is a mathematical discipline with aims akin to those, for example, of geometry or analytical mechanics. In each field we must carefully distinguish three aspects of the theory: (a) the formal logical content, (b) the intuitive background, (c) the applications. The character, and the charm, of the whole structure cannot be appreciated without considering all three aspects in their proper relation.

*An Introduction to Probability Theory and Its Applications* (Volume 1)

Introduction (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1957

All possible “definitions” of probability fall short of the actual practice.

*An Introduction to Probability Theory and Its Applications* (Volume 1)

Chapter I (p. 19)

John Wiley & Sons, Inc. New York, New York, USA. 1957

**Feynman, Richard P.** 1918–88

American theoretical physicist

Nature permits us to calculate only probabilities.

*QED: The Strange Theory of Light and Matter*

Chapter 1 (p. 19)

Princeton University Press. Princeton, New Jersey, USA. 1985

A philosopher once said “It is necessary for the very existence of science that the same conditions always produce the same results.” Well, they do not.

*The Character of Physical Law*

Chapter 6 (p. 147)

BBC. London, England. 1965

**Forbes, J. D.**

No biographical data available

...the ratios or probabilities of which we have been speaking have no absolute signification with reference to an event which has occurred...They represent only the state of expectation of the mind of a person before the event has occurred, or having occurred before he is informed of the results.

On the Alleged Evidence for a Physical Connection Between Stars

Forming Binary or Multiple Groups

*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Third Series, December 1850 (p. 406)

**Freeman, R. Austin** 1862–1943

British physician and mystery novelist

It is a question of probabilities....

*A Certain Dr. Thorndyke*

Thorndyke Makes a Beginning (p. 209)

Dodd, Mead & Company. New York, New York, USA. 1928

**Froude, James Anthony** 1818–94

English historian and biographer

Philosophy goes no further than probabilities, and in every assertion keeps a doubt in reserve.

*Short Studies on Great Subjects* (Volume 2)

Calvinism (p. 51)

Charles Scribner's Sons. New York, New York, USA. 1890

**Fry, Thornton C.**

No biographical data available

But if probability measures the importance of our state of ignorance it must change its value whenever we add new knowledge. And so it does.

*Probability and Its Engineering Uses* (2<sup>nd</sup> edition)

Chapter VI (p. 145)

D. Van Nostrand Company. Princeton, New Jersey, USA. 1965

After all, without the experiment — either a real one or a mathematical model — there would be no reason for a theory of probability.

*Probability and Its Engineering Uses* (2<sup>nd</sup> edition)

Chapter II (p. 23)

D. Van Nostrand Company. Princeton, New Jersey, USA. 1965

**Gay, John** 1685–1732

English poet and dramatist

Let men suspect your tale untrue,

Keep probability in view.

*John Gay: Poetry and Prose*

Fables. The Painter Who Pleas'd Nobody and Everybody, I. 1

At The Clarendon Press. Oxford, England. 1974

**Gibbon, Edward** 1737–94

English historian

Such a fact is probable, but undoubtedly false.

*In Great Books of the Western World* (Volume 40)

*The Decline and Fall of the Roman Empire*

Notes: Chapter XXIV, 116 (p. 794)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gilbert, William** 1544–1603

English scientist and physician

Men are deplorably ignorant with respect to natural things, an modern philosophers, as though dreaming in the darkness, must be aroused and taught the uses of things, the dealing with things; they must be made to quit the sort of learning that comes only from books, and that rests only on vain arguments from probability and upon conjecture.

*In Great Books of the Western World* (Volume 28)

*On the Loadstone and Magnetic Bodies and on the Great Magnet the Earth*

Book First, Chapter 10

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

Of what there is no manner of doubt,  
No probable, possible, shadow of doubt,  
No possible doubt whatever.

*The Complete Plays of Gilbert and Sullivan*

The Gondoliers

Act I (p. 466)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Gissing, George** 1857–1903  
English novelist

Of course, if your work is strong, and you can afford to wait; the probability is that half a dozen people will at last begin to shout that you have been monstrously neglected, as you have.

*New Grub Street*

Interim (p. 411)

The Modern Library. New York, New York, USA. 1926

**Good, I. J.**  
No biographical data available

Although there are at least five kinds of probability, we can get along with just one kind.

Kinds of Probability...

*Science*, Volume 129, 1959

**Gracian, Baltasar** 1601–58  
Spanish philosopher

Whereas wisdom favors the probabilities, folly favors only the possibilities.

In Thomas G. Corvan

*The Best of Gracian* (p. 38)

Philosophical Library. New York, New York, USA. 1964

Wisdom does not trust to probabilities; it always marches in the midday light of reason.

In Rudolf Flesch

*The New Book of Unusual Quotations*

Harper & Row, Publishers. New York, New York, USA. 1966

It is only by mature meditation on the possibilities and probabilities of future events — that we can elude the tortuous troubles of the tomorrows.

In Thomas G. Corvan

*The Best of Gracian* (p. 22)

Philosophical Library. New York, New York, USA. 1964

**Gumperson, R. F.**  
Physicist

The outcome of a given desired probability will be inverse to the degree of desirability.

Gumperson's Law

*Changing Times*, Volume 11, Number 11, November, 1957 (p. 46)

...the contradictory of a welcome probability will assert itself whenever such an eventuality is likely to be most frustrating.

Gumperson's Law

*Changing Times*, Volume 11, Number 11, November, 1957 (p. 46)

**Hamming, Richard W.** 1915–98  
Mathematician

Probability is too important to be left to the experts.

*The Art of Probability for Scientists and Engineers*

Chapter 1 (p. 4)

Westview Press. Boulder, Colorado, USA. 1991

**Hammond, Henry**

The only seasonable inquiry is, Which is of probables the most, or of improbables the least, such.

In Robert Sanderson and Izaak Walton

*Works* (Volume 5)

A Letter to Dr. Sanderson (p. 319)

At The University Press. Oxford, England. 1854

**Harris, Errol E.**  
No biographical data available

Probability is truth in some degree...

*Hypothesis and Perception: The Roots of Scientific Method*

The Logic of Construction (p. 342)

George Allen & Unwin Ltd. London, England. 1970

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

We have a wraithlike quantum world of ghostly waves where all is fully determined and predictable. Yet, when we translate it into our observed world of sensible things and their events, we are limited to the concept of chance and the language of probability. What happens at the interface of the quantum world and the observed world may be this or may be that.

*Masks of the Universe*

Chapter 8 (p. 124)

Macmillan Publishing Company. New York, New York, USA. 1985

**Herbert, Nick**  
American physicist

probability = (possibility)<sup>2</sup>

*Quantum Reality: Beyond the New Physics*

Chapter 6 (p. 96)

Anchor Press. Garden City, New York, USA. 1985

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

No priest or soothsayer that ever lived could hold his own against Old Probabilities.

*Pages from an Old Volume of Life*

Chapter X (p. 327)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Hooker, Richard** 1554–1600  
English writer and theologian

As for probabilities, what thing was there ever set down so agreeable with sound reason but some probable show against it might be made.

In S. Austin Allibone

*Prose Quotations from Socrates to Macaulay*

Probability

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

### Howe, E. W.

No biographical data available

A reasonable probability is the only certainty.

*Sinner Sermons: A Selection of the Best Paragraphs of E.W. Howe* (p. 23)

Girard. Kansas, USA. 1926

### Hume, David 1711–76

Scottish philosopher and historian

...all knowledge resolves itself into probability...

*A Treatise of Human Nature*

Book I, Part IV, Section 1 (p. 232)

Penguin Books. Baltimore, Maryland, USA. 1969

### Hunter, Evan 1926–2005

American writer

Now, your Honor; in much the same way that there are laws governing our society, there are also laws governing chance, and these are called the laws of probability, and it is against these that we must examine the use of an identical division number.

*The Paper Dragon*

Tuesday, Chapter 6

Delacorte Press. New York, New York, USA. 1966

### Huxley, Aldous 1894–1963

English writer and critic

Magic and devils offend our sense of probabilities.

*Proper Studies*

Varieties of Intelligence (p. 7)

Chatto & Windus. London, England. 1957

### Huxley, Thomas Henry 1825–95

English biologist

The scientific imagination always restrains itself within the limits of probability.

*Collected Essays* (Volume 5)

*Science and Christian Traditions*

Science and Pseudo-Science (p. 124)

Macmillan & Company Ltd. London, England. 1904

### Huygens, Christiaan 1629–95

Dutch mathematician, astronomer, and physicist

We know nothing very certainly, but everything only probably, and the probability has degrees that are widely different.

*Oeuvres*

Complètes de Christiaan Huygens (p. 298)

Publisher undetermined

In such noble and sublime Studies as these, 'tis a Glory to arrive at Probability, and the search itself rewards the pains. But there are many degrees of Probable, some nearer Truth than others, in the determining of which lies the chief exercise of our Judgment.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their inhabitants and Productions*

Book the First. Conjectures Not Useless, Because Not Certain (p. 10)

Printed for T. Childe. London, England. 1698

### James, P. D. 1920–

English writer

Juries hate scientific evidence.

They think they won't be able to understand it so naturally they can't understand it. As soon as you step into the box you see a curtain of obstinate incomprehension clanging down over their minds. What they want is certainty. Did this paint particle come from this car body? Answer yes or Number None of those nasty mathematical probabilities we're so fond of.

*Death of an Expert Witness*

Book II, Chapter III (p. 96)

Warner Books, Inc. New York, New York, USA. 1992

### Jefferson, Thomas 1743–1826

3<sup>rd</sup> president of the United States

Perhaps an editor might begin a reformation in some way as this. Divide his paper into four chapters, heading the 1st, Truth. 2d, Probabilities. 3d, Possibilities. 4th, Lies.

*The Writings of Thomas Jefferson* (Volume 9)

Letter to John Norvell, June 11, 1807

G.P. Putnam's Sons. New York, New York, USA. 1898

### Kac, Mark 1914–84

Polish mathematician

To the author the main charm of probability theory lies in the enormous variability of its applications. Few mathematical disciplines have contributed to as wide a spectrum of subjects, a spectrum ranging from number theory to physics, and even fewer have penetrated so decisively the whole of our scientific thinking.

*Lectures in Applied Mathematics* (Volume 1)

Probability and Related Topics in Physical Sciences, Preface (p. ix)

Interscience Publishers, Ltd. London, England. 1959

### Kasner, Edward 1878–1955

American mathematician

### Newman, James Roy 1911–66

Mathematician and mathematical historian

Equiprobability in the physical world is purely a hypothesis. We may exercise the greatest care and the most accurate of scientific instruments to determine whether or not a penny is symmetrical. Even if we are satisfied that it is, and that our evidence on that point is conclusive,

our knowledge, or rather our ignorance, about the vast number of other causes which affect the fall of the penny is so abysmal that the fact of the penny's symmetry is a mere detail. Thus, the statement "head and tail are equiprobable" is at best an assumption.

*Mathematics and the Imagination*

Chance and Chanceability (p. 251)

Simon & Schuster. New York, New York, USA. 1940

**Keynes, John Maynard** 1883–1946

British economist

Probability is, so far as measurement is concerned, closely analogous to similarity.

*A Treatise on Probability*

Chapter III (p. 28)

Harper & Row, Publishers. New York, New York, USA. 1962

It has been pointed out already that no knowledge of probabilities, less in degree than certainty, helps us to know what conclusions are true, and that there is no direct relation between the truth of a proposition and its probability. Probability begins and ends with probability.

*A Treatise on Probability*

Part V (p. 322)

Harper & Row, Publishers. New York, New York, USA. 1962

It is difficult to find an intelligible account of the meaning of "probability," or of how we are ever to determine the probability of any particular proposition; and yet treatises on the subject profess to arrive at complicated results of the greatest precision and the most profound practical importance.

*A Treatise on Probability*

Chapter IV (p. 51)

Harper & Row, Publishers. New York, New York, USA. 1962

...others have suggested seriously a "barometer of probability."

*A Treatise on Probability*

Chapter III (p. 20)

Harper & Row, Publishers. New York, New York, USA. 1962

**Kolmogorov, Andrei N.** 1903–87

Russian physicist and mathematician

The theory of probability as mathematical discipline can and should be developed from axioms in exactly the same way as Geometry and Algebra.

*Foundations of the Theory of Probability*

Chapter 1. Elementary Theory of Probability (p. 1)

Chelsea Publishing Company. New York, New York, USA. 1956

**Kosko, Bart**

American engineer

Which is easier to believe in, probability or God?...The ultimate fraud is the scientific atheist who believes in probability.

*Fuzzy Thinking*

Chapter 3 (p. 50)

Hyperion. New York, New York, USA. 1993

Probability has turned modern science into a truth casino.

*Fuzzy Thinking*

Chapter 1 (p. 12)

Hyperion. New York, New York, USA. 1993

**Kyburg, Jr., H. E.**

No biographical data available

**Smokler, H. E.**

No biographical data available

...there is no problem about probability: it is simply a nonnegative, additive set function, whose maximum value is unity.

*Studies in Subjective Probability*

Introduction (p. 3)

John Wiley & Sons, Inc. New York, New York, USA. 1964

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

One of the great advantages of the calculus of probabilities is to teach us to distrust first opinions.

*A Philosophical Essays on Probabilities*

Chapter XVI (p. 164)

Dover Publications, Inc. New York, New York, USA. 1951

The probability of events serves to determine the hope or the fear of persons interested in their existence.

*A Philosophical Essays on Probabilities*

Chapter IV (p. 20)

Dover Publications, Inc. New York, New York, USA. 1951

The regularity which astronomy shows us in the movements of the comets doubtless exists in all phenomena.

The curve described by a simple molecule or air or vapour is regulated in a manner just as certain as the planetary orbits; the only difference between them is that which comes from our ignorance.

*A Philosophical Essay on Probabilities*

Chapter II (p. 6)

Dover Publications, Inc. New York, New York, USA. 1951

It is remarkable that a science, which commenced with the consideration of games of chance, should be elevated to the rank of the most important subjects of human knowledge.

*A Philosophical Essay on Probabilities*

Chapter XVII (p. 195)

Dover Publications, Inc. New York, New York, USA. 1951

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

...the art of weighing probabilities is not yet even partly explained, though it would be of great importance in legal matters and even in the management business.

*Philosophical Papers and Letters* (Volume 1)

Letter to John Frederick, Duke of Brunswick Hanover (p. 399)

The University of Chicago Press. Chicago, Illinois, USA. 1956

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

We may not be able to get certainty, but we can get probability, and half a loaf is better than no bread.

*Christian Reflections*

Historicism (p. 111)

William B. Eerdmans Publishing. Grand Rapids, Michigan, USA. 1997

**Lewis, Clarence Irving** 1883–1964

American philosopher

There is no such thing as *the* probability of four aces in one hand, or *the* probability of anything else. Given all the relevant data which there are to be known, everything is either certainly true or certainly false.

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter X (p. 330)

Charles Scribner's Sons. New York, New York, USA. 1929

...empirical knowledge is exclusively a knowledge of probabilities...

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter XI (p. 345)

Charles Scribner's Sons. New York, New York, USA. 1929

A “poor evaluation” of the probability of anything may reflect ignorance of relevant data which “ought” to be known...

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter X (p. 331)

Charles Scribner's Sons. New York, New York, USA. 1929

The only knowledge a priori is purely analytic; all empirical knowledge is probable only.

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter X (p. 309)

Charles Scribner's Sons. New York, New York, USA. 1929

**Lincoln, Abraham** 1809–6516<sup>th</sup> president of the United States

The probability that we may fall in the struggle ought not to deter us from the support of a cause we believe to be just; it shall not deter me.

*The Sub-Treasury*

Speech, Springfield, Illinois, December 26, 1839

**Lindley, Dennis V.** 1923–

American statistician

Are we probabilists, believers, or fuzzifiers?

Comment: A Tale of Two Wells

*Statistical Science*, Volume 2, Number 1, February 1987 (p. 38)**Locke, John** 1632–1704

English philosopher and political theorist

Probability is the appearance of agreement upon fallible proofs.

In *Great Books of the Western World* (Volume 35)*An Essay Concerning Human Understanding*

Book IV, Chapter XV, Section 1 (p. 365)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Probability is likeliness to be true...

In *Great Books of the Western World* (Volume 35)*An Essay Concerning Human Understanding*

Book IV, Chapter XV, Section 3 (p. 365)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The mind ought to examine all the grounds of probability, and upon a due balancing the whole, reject or receive it proportionably to the preponderancy of probability on the one side or the other.

In S. Austin Allibone

*Prose Quotations from Socrates to Macaulay*

Probability

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

**Ludlum, Robert** 1927–2001

American author

It was a desperate strategy, based on probabilities, but it was all he had left.

*The Bourne Supremacy*

Chapter 24 (p. 365)

Random House, Inc. New York, New York, USA. 1986

It wasn't a probability anymore, it was a reality.

*The Bourne Supremacy*

Chapter 18 (p. 256)

Random House, Inc. New York, New York, USA. 1986

**Masters, Dexter** 1908–89

American writer

If absolutes had disappeared under the inquiries of science, and apparently they had, ...then the only rational procedure, the only procedure consistent with man's development, was to follow where the probabilities led.

*The Accident*

Part I, Chapter 3 (p. 19)

Alfred A. Knopf. New York, New York, USA. 1955

**Meyer, Agnes** 1887–1970

American author and journalist

We can never achieve absolute truth but we can live hopefully by a system of calculated probabilities. The law of probability gives to natural and human sciences — to human experience as a whole — the unity of life we seek.

*Education for a New Morality*

Chapter 3 (p. 21)

Macmillan Publishing Company. New York, New York, USA. 1957

**Moroney, M. J.**

American statistician

There are certain notions which it is impossible to define adequately. Such notions are found to be those based on universal experience of nature. Probability is such a notion. The dictionary tells me that “probable” means “likely.” Further reference gives the not very helpful information that “likely” means “probable.”

*Facts from Figures*

The Laws of Chance (p. 4)  
Penguin Books Ltd. Harmondsworth, England. 1951

**Muggeridge, Malcolm** 1903–90  
English journalist and social critic

The probability is, I suppose that the Monarchy has become a kind of ersatz religion. Chesterton once remarked that when people [cease] to believe in God they do not believe in nothing, but in anything.

*New Statesman*, 1955

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Probability — Each one can employ it; no one can take it away.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section XIV, 913

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Take away probability, and you can no longer please the world; give probability, and you can no longer displease it.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section XIV, 918

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But is it probable that probability gives assurance?

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section XIV, 908

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pearl, Judea**  
Computer scientist and statistician

Probabilities are summaries of knowledge that is left behind when information is transferred to a higher level of abstraction.

*Probabilistic Reasoning in Intelligent Systems: Network of Plausible Inference*

Chapter 1 (p. 21)

Morgan Kaufmann Publishers, Inc. San Mateo, California, USA. 1988

**Pearson, E. S.** 1895–1980  
English statistician

Hitherto the user has been accustomed to accept the function of probability theory laid down by the mathematicians; but it would be good if he could take a larger share in formulating himself what are the practical requirements that the theory should satisfy in applications.

The Choice of Statistical Test Illustrated on the Interpretation of Data Classed in a  $2 \times 2$  Table

*Biometrika*, Volume 34, Number 35, 1948 (p. 142)

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

This branch of mathematics [probability] is the only one, I believe, in which good writers frequently get results entirely erroneous.

*Writings of Charles S. Peirce* (Volume 3)

The Doctrine of Chances, II (p. 279)

Indiana University Press. Bloomington, Indiana, USA. 1986

The relative probability of this or that arrangement of Nature is something which we should have a right to talk about if universes were as plenty as blackberries, if we could put a quantity of them in a bag, shake them well up, draw out a sample, and examine them to see what proportion of them had one arrangement and what proportion another. But, even in that case, a higher universe would contain us, in regard to whose arrangements the conception of probability could have no applicability.

The Probability of Induction

*Popular Science Monthly*, Volume 12, April 1878 (p. 714)

...it may be doubtful if there is a single extensive treatise on probabilities in existence which does not contain solutions absolutely indefensible.

*Writings of Charles Sanders Peirce* (Volume 3)

The Doctrine of Chances, II (p. 279)

Indiana University Press. Bloomington, Indiana, USA. 1986

**Planck, Max** 1858–1947  
German physicist

Nature prefers more probable to less probable states.... Heat flows from a body of high temperature to a body of lower temperature, because the state of equal temperature is more probable than a state of unequal distribution of temperature.

Translated by R. Jones and D.H. Williams

*A Survey of Physics: A Collection of Lectures and Essays*

The Unity of the Physical Universe (p. 15)

Methuen & Company Ltd. London, England. 1925

**Plato** 428 BCE–347 BCE  
Greek philosopher

I know too well that these arguments from probabilities are impostors, and unless great caution is observed in the use of them, they are apt to be deceptive.

In *Great Books of the Western World* (Volume 7)

*Phaedo*

Section 92 (p. 238)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

No matter how solidly founded a prediction may appear to us, we are never absolutely sure that experiment will not contradict it, if we undertake to verify it.... It is far better to foresee even without certainty than not to foresee at all.

*The Foundations of Science*

Science and Hypothesis, Part IV

Chapter IX (p. 129)  
The Science Press. New York, New York, USA. 1913

The very name calculus of probabilities is a paradox. Probability opposed to certainty is what we do not know, and how can we calculate what we do not know?

*The Foundations of Science*  
Science and Hypothesis, Part IV  
Chapter XI (p. 155)  
The Science Press. New York, New York, USA. 1913

Predicted facts... can only be probable.

*The Foundations of Science*  
Science and Hypothesis, Part IV  
Chapter XI (p. 155)  
The Science Press. New York, New York, USA. 1913

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

I think that we shall have to get accustomed to the idea that we must not look upon science as a “body of knowledge” but rather as a system of hypotheses; that is to say, as a system of guesses or anticipations which in principle cannot be justified, but with which we work as long as they stand up to tests, and of which we are never justified in saying that we know that they are “true” or “more or less certain” or even “probable.”

*The Logic of Scientific Discovery*  
New Appendices, Two Notes on Induction and Demarcation 1933–1934 (p. 317)  
Basic Books, Inc. New York, New York, USA. 1959

The most important application of the theory of probability is to what we may call “chance-like” or “random” events, or occurrences. These seem to be characterized by a peculiar kind of incalculability which makes one disposed to believe — after many unsuccessful attempts — that all known rational methods of prediction must fail in their case. We have, as it were, the feeling that not a scientist but only a prophet could predict them. And yet, it is just this incalculability that makes us conclude that the calculus of probability can be applied to these events.

*The Logic of Scientific Discovery*  
Part II, Chapter VII, Section 49 (p. 150)  
Basic Books, Inc. New York, New York, USA. 1959

**Pratchett, Terry** 1948–

English author

Understanding is the first step towards control. We now understand probability...

*The Dark Side of the Sun* (p. 37)  
St. Martin’s Press. New York, New York, USA. 1976

“You haven’t heard of probability math? You, and tomorrow you become Chairman of the Board of Widdershins and heir to riches untold? Then first we will talk, and then we will eat.”

*The Dark Side of the Sun* (p. 13)  
St. Martin’s Press. New York, New York, USA. 1976

I can’t pretend to understand probability math. But if the universe is so ordered, so — immutable — that the future can be told by a handful of numbers, then why need we go on living?

*The Dark Side of the Sun* (p. 22)  
St. Martin’s Press. New York, New York, USA. 1976

**Prior, Matthew** 1664–1721

English poet and diplomat

In this case probability must atone for want of Truth.

*The Literary Works of Matthew Prior*  
Solomon, Preface (p. 309)  
Clarendon Press. Oxford, England. 1959

**Ramsey, Frank Plumpton** 1903–30

English mathematician

I think I perceive or remember something but am not sure; this would seem to give me some ground for believing it, contrary to Mr. Keynes’ theory, by which the degree of belief in it which it would be rational for me to have is that given by the probability relation between the proposition in question and the things I know for certain.

In R.B. Braithwaite (ed.)  
*The Foundation of Mathematics and Other Logical Essays*  
Truth and Probability (p. 189)  
Kegan, Paul, Trench, Trubner & Company. London, England. 1931

**Redfield, Roy A.**

No biographical data available

Good and bad come mingled always. The long-time winner is the man who is not unreasonably discouraged by persistent streaks of ill fortune, [who is] not at other times made reckless with the thought that he is fortune’s darling. He keeps a cool head and trusts in the mathematics of probability, or as often said, the law of averages.

*Factors of Growth in a Law Practice* (p. 168)  
Callaghan & Company. Mundelein, Illinois, USA. 1962

**Reichenbach, Hans** 1891–1953

German philosopher of science

To say that observations of the past are certain, whereas predictions are merely probable, is not the ultimate answer to the question of induction; it is only a sort of intermediate answer, which is incomplete unless a theory of probability is developed that explains what we should mean by “probable” and on what ground we can assert probabilities.

*The Rise of Scientific Philosophy*  
Chapter 5 (p. 93)  
University of California Press. Berkeley, California, USA. 1951

The study of inductive inference belongs to the theory of probability, since observational facts can make a theory only probable but will never make it absolutely certain.

*The Rise of Scientific Philosophy*  
Chapter 14 (p. 231)  
University of California Press. Berkeley, California, USA. 1951

**Rota, Gian-Carlo** 1932–99

Italian-born American mathematician

The distance between probability and statistical mechanics is diminishing, and soon we won't be able to tell which is which. We will be rid of the handwaving arguments with which mathematically illiterate physicists have been pestering us.

*Indiscrete Thoughts*

Chapter XX (p. 228)

Birkhäuser. Boston, Massachusetts, USA. 1997

Conditional probability tends to be viewed as one technique for calculating probabilities. Actually, there is more to it than meets the eye: it has an interpretation which is ordinarily passed over in silence. Philosophers take notice.

*Indiscrete Thoughts*

Chapter XX (p. 227)

Birkhäuser. Boston, Massachusetts, USA. 1997

According to quantum mechanics, it cannot be known what an atom will do in given circumstances; there are a definite set of alternatives open to it, and it chooses sometimes one, sometimes another. We know in what proportion of cases one choice will be made, in what proportion a second, or a third, and so on. But we do not know any law determining the choice in an individual instance. We are in the same position as a booking-office clerk at Paddington, who can discover, if he chooses, what proportion of travelers from that station go to Birmingham, what proportion to Exeter, and so on, but knows nothing of the individual reasons which lead to one choice in one case and another in another.

*Religion and Science*

Determinism (p. 152)

Henry Holt &amp; Company. New York, New York, USA. 1935

**Sartre, Jean-Paul** 1905–80

French existentialist philosopher and novelist

When we want something, we always have to reckon with probabilities.

*The Philosophy of Existentialism*

Part 1. The Humanism of Existentialism (p. 46)

Philosophical Library, New York, New York, USA; 1965

...all views are only probable, and a doctrine of probability which is not bound to a truth dissolves into thin air. In order to describe the probable, you must have a firm hold on the true. Therefore, before there can be any truth whatsoever, there must be absolute truth.

*The Philosophy of Existentialism*

Part 1 The Humanism of Existentialism (p. 51)

Philosophical Library, New York, New York, USA; 1965

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

...it is better to be satisfied with probabilities than to demand impossibilities and starve.

In Charles Singer (ed.)

*Studies in the History and Method of Science* (Volume 1)

Scientific Discovery and Logical Proof (p. 272)

At The Clarendon Press. Oxford, England. 1917

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

‘Tis pretty, sure, and very probable...

In *Great Books of the Western World* (Volume 26)*The Plays and Sonnets of William Shakespeare* (Volume 1)

As You Like It

Act III, Scene v, l. 11

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sherwood, Thomas**

No biographical data available

It is a nice idea, of course, that numbers must prove something true: after all, one patient is a case-report, two are a series. But all that numbers can do is tell us what is probable, and probability can lead us into terrible mistakes — like Bertrand Russell's chicken. Day in, day out, throughout its life, the chicken got breakfast as the farmer arrived in the morning. Thus it had clearly discovered a highly probable natural law: farmer = food — until, that is, the morning when the farmer very naturally arrived to wring its neck instead.

Science in Radiology

*Lancet*, Volume 1, 1978 (p. 594)**South, Robert**

No biographical data available

That is accounted probable which has better arguments producible for it than can be brought against it.

In S. Austin Alibone

*Prose Quotations from Socrates to Macaulay*

Probability

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

**Stoppard, Tom** 1937–

Czech-born English playwright

If we postulate...that within un-, sub- or supernatural forces the probability is that the law of probability will not operate as a factor, then we must accept that the probability of the first part will not operate as a factor within un-, sub- or supernatural forces. And since it obviously hasn't been doing so, we can take it that we are not held within un-, sub- or supernatural forces after all; in all probability, that is.

*Rosencrantz and Guildenstern Are Dead*

Act One (p. 17)

Grove Press, Inc. New York, New York, USA. 1967

**The Bible**

For our knowledge and our prophecy alike are partial...

*The Revised English Bible*

I Corinthians 13:9

Oxford University Press, Inc. Oxford, England. 1989



**Tillotson, John** 1630–94  
Archbishop of Canterbury

Though moral certainty be sometimes taken for a high degree of probability, which can only produce a doubtful assent, yet it is also frequently used for a firm assent to a thing upon such grounds as fully satisfy a prudent man.

In S. Austin Allibone

*Prose Quotations from Socrates to Macaulay*

Probability

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1903

**Toffler, Alvin** 1928–  
American writer and futurist

The management of changes is the effort to convert certain possibles into probables, in pursuit of agreed-on preferables.

*Future Shock*

Chapter 20 (p. 407)

Random House, Inc. New York, New York, USA. 1979

**Voltaire (François-Marie Arouet)** 1694–1778  
French writer

From generation to generation skepticism increases; and probability diminishes; and soon probability is reduced to zero.

*The Portable Voltaire*

Philosophical Dictionary, Truth (p. 217)

The Viking Press. New York, New York, USA. 1959

He who has heard the thing told by twelve thousand eye-witnesses, has only twelve thousand probabilities, equal to one strong probability, which is not equal to certainty.

*The Portable Voltaire*

Philosophical Dictionary, Truth (p. 217)

The Viking Press. New York, New York, USA. 1959

**von Clausewitz, Carl** 1780–1831  
Prussian soldier

In short, absolute, so-called mathematical factors never find a firm basis in military calculations. From the very start there is an interplay of possibilities, probabilities, good luck and bad that weaves its way throughout the length and breadth of the tapestry. In the whole range the human activities war most closely resembles a game of cards.

*On War*

Chapter 1, 21 (p. 86)

The Modern Library. New York, New York, USA. 1943

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

Whatever must be characterized as mere probability lies beyond the domain of physical description of the universe; science must not wander into the cloudland of cosmological dreams.

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 4)

Conclusion (p. 230)

Harper & Brothers. New York, New York, USA. 1869

**von Mises, Richard** 1883–1953  
Austrian-born American mathematician

The theory of probability can never lead to a definite statement concerning a single event.

*Probability, Statistics, and Truth*

First Lecture (p. 33)

Dover Publications, Inc. New York, New York, USA. 1981

...if one talks of the probability that the two poems known as the Iliad and the Odyssey have the same author, no reference to a prolonged sequence of cases is possible and it hardly makes sense to assign a numerical value to such a conjecture.

*Mathematical Theory of Probability and Statistics* (pp. 13–14)

Academic Press. New York, New York, USA. 1964

**Walker, Marshall John**  
American physicist

One can locate an octopus by giving the coordinates of his beak, but it would be unwise to forget that neighboring coordinates for two or three yards out in all directions have a considerable probability of being occupied by octopus at a given instant.

*The Nature of Scientific Thought*

Chapter V (p. 65)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1963

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

...Positivistic science is solely concerned with observed fact, and must hazard no conjecture as to the future. If observed fact be all we know, then there is no other knowledge. Probability is relative to knowledge. There is no probability as to the future within the doctrine of Positivism.

*Adventures of Ideas*

Chapter VIII (p. 160)

The Macmillan Company. New York, New York, USA. 1956

**Whyte, Lancelot Law** 1896–1972  
Scottish physicist

Only a certain probability remains of a one-to-one association of any spatial feature now with a similar feature a moment later. It is sheer luck, in a sense, that any physical apparatus stays put, for the laws of quantum mechanics allow it a finite, though small, probability of dispersing while one is not looking, or even while one is.

*Essay on Atomism: From Democritus to 1960*

Chapter 2 (pp. 25–26)

Wesleyan University Press. Middletown, Connecticut, USA. 1961

If the universe is a mingling of probability clouds spread through a cosmic eternity of space-time, how is there as much order, persistence, and coherent transformation as there is?

*Essay on Atomism: From Democritus to 1960*

Chapter 2 (p. 27)

Wesleyan University Press. Middletown, Connecticut, USA. 1961

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

GILBERT: No ignoble consideration of probability, that cowardly concession to the tedious repetitions of domestic or public life, effect it ever.

*Complete Writings of Oscar Wilde* (p. 143)

Nottingham Society. New York, New York, USA. 1907

**Wilder, Thornton** 1897–1975

American playwright and novelist

Ashley had no competitive sense and no need for money, but he took great interest in the play of numbers. He drew up charts analyzing the elements of probability in the various games. He had a memory for numbers and symbols.

*The Eighth Day*

II. Illinois to Chile (p. 123)

Harper & Row, Publishers, New York, New York, USA. 1967

**Woodward, Robert Simpson** 1849–1924

American scientist and teacher

The theory of probabilities and the theory of errors now constitute a formidable body of knowledge of great mathematical interest and of great practical importance. Though developed largely through the applications to the more precise sciences of astronomy, geodesy, and physics, their range of applicability extends to all the sciences; and they are plainly destined to play an increasingly important role in the development and in the applications of the sciences of the future. Hence their study is not only a commendable element in a liberal education, but some knowledge of them is essential to a correct understanding of daily events.

*Probability and Theory of Errors*

Author's Preface (p. 4)

John Wiley & Sons, Inc. New York, New York, USA. 1906

## PROBABLE ERROR

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Who ever heard a theologian preface his creed, or a politician conclude his speech with an estimate of the probable error of his opinion.

In Edwin Hubble

*The Nature of Science and Other Lectures*

Part I. The Nature of Science (p. 10)

The Huntington Library. San Marino, California, USA. 1954

**Student (William Sealy Gossett)**

An experiment may be regarded as forming an individual of a “population” of experiments which might be

performed under the same conditions. A series of experiments is a sample drawn from this population. Now any series of experiments is only of value in so far as it enables us to form a judgment as to the statistical constants of the population to which the experiments belong. In a great number of cases the question finally turns on the value of a mean, either directly, or as the mean difference between the two quantities.

The Probable Error of a Mean

*Biometrika*, Volume 6, 1908

## PROBLEM

**Ackerman, Diane** 1948–

American writer

Part of the irony of environmentalism is questing for solutions when you know you're part of the problem.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Insect Love (p. 156)

Vintage Books. New York, New York, USA. 1997

**Agnew, Ralph Palmer**

American mathematician

Working a problem is like cutting down a tree and reading a problem is like looking at a tree. We spend part of our time swinging axes to develop our muscles, and we spend part of our time looking around to keep us from being dolts. The mathematical and scientific forests really are interesting, and we should all enjoy chopping and looking at the scenery.

*Differential Equations*

Chapter 1 (p. 6)

McGraw-Hill Book Company. New York, New York, USA. 1972

**Alger, John R. M.**

American engineer

**Hays, Carl V.**

No biographical data available

...a problem in the stage of being “recognized” is a highly emotional subject.

*Creative Synthesis in Design* (p. 13)

Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1964

**Anderson, Poul** 1926–2001

American science fiction writer

I have yet to see any problem, however complicated, which, when you looked at it in the right way, did not become still more complicated.

In William Thorpe article

Reduction v. Organicism

*New Scientist*, Volume 43, Number 66, 25 September 1969 (p. 638)

**Bahn, Paul**

Archaeologist

It takes very special qualities to devote one's life to problems with no attainable solutions and to poking around in dead people's garbage: words like "masochistic", "nosy", and "completely batty" spring readily to mind.

*Bluff Your Way in Archaeology* (p. 7)

Ravette Books. West Sussex, England. 1989

**Berkeley, Edmund C.** 1909–88

American computer theoretician

Most problems have either many answers or no answer. Only a few problems have a single answer.

*Computers and Automation*

Right Answers — A Short Guide for Obtaining Them, Volume 18, Number 10, September 1969 (p. 20)

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

Too often I have been able to [do] little more than indicate the difficulties likely to be met — yet merely to be forewarned is often help.

*The Art of Scientific Investigation*

Preface (p. ix)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bloch, Arthur** 1948–

American humorist

Inside every large problem is a small problem struggling to get out.

*Murphy's Law*

Hoare's Law of Large Problems (p. 50)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Bragg, Sir William Lawrence** 1890–1971

Australian-born English physicist

I am sure that when the first circumnavigators of the world returned from their voyage they were told by friends that some Greek philosopher...had held that the world was round and that they might have spared their trouble. The world is either round or flat, and endless discussion might have been carried on for ages between opposing schools who held one view or the other. The real contribution to settling the problem was made by the circumnavigators.

The Physical Sciences

*Science*, Volume 79, Number 2046, March 16, 1934 (p. 240)

**Chambers, Robert** 1802–71

Science writer

Man is seen to be an enigma only as an individual; in mass, he is a mathematical problem.

*Vestiges of the Natural History of Creation* (p. 333)

W.R. Chambers. Edinburgh, Scotland. 1884

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

It isn't that they can't see the solution. It is that they can't see the problem.

*The Scandal of Father Brown*

The Point of the Pin (p. 949)

Dodd, Mead & Company. New York, New York, USA. 1935

**Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

In the course of a few bewildering years we have found ourselves the master or indeed the servants of gigantic powers which confront us with problems never known before.

In R. James (ed.)

*Winston S. Churchill — His Complete Speeches 1897–1963*

Volume 8 (p. 8563)

Chelsea House Publishers. New York, New York, USA. 1974

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Sorry to interrupt the festivities, but we have a problem.

*2001: A Space Odyssey*

IV Abyss, Chapter 21 (p. 120)

New American Library, New York, New York, USA. 1968

**Cleaver, Eldridge** 1935–98

American civil rights leader and author

...you're either part of the solution or part of the problem.

Speech

San Francisco, 1968

**Cohen, I. Bernard** 1914–2003

American physicist and science historian

The fundamental postulate of the history of science is that the scientists of the past were just as intelligent as we are and that, therefore, the problems that baffled them would have baffled us too, had we been living then.

*Franklin and Newton*

Chapter Two (p. 39)

Harvard University Press. Cambridge, Massachusetts, USA. 1966

**Collingwood, Robin George** 1889–1943

English historian and philosopher

You can only solve a problem which you recognize to be a problem.

*The New Leviathan; or Man, Society, Civilization and Barbarism*

Part I, Chapter I, aphorism 2.66 (p. 13)

At The Clarendon Press. Oxford, England. 1942

**Commoner, Barry** 1917–

American biologist, ecologist, and educator

The freedom to choose his own problem is often the scientist's most precious possession.

Is Science Getting Out of Hand?

*The Science Teacher*, Volume 30, October 1963

**Compton, Karl Taylor** 1887–1954

American educator and physicist

Neither curiosity nor ingenuity is a modern impulse... The distinctive feature of science and technology at the present time is the accelerated pace of their development. This is partly due to continually improved techniques and organization, and it is partly due to the great accumulation of knowledge and art, because the more information and tools we have at our disposal, the more powerful can be the attack on any new problem.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (pp. 1–2)  
Undergraduate Association, Massachusetts Institute of Technology. Cambridge, Massachusetts, USA. 1955

**Condorcet, Marie Jean** 1743–94  
French philosopher and mathematician

If a scholar poses himself a new problem, he can attack it fortified by the pooled resources of all his predecessors.

In Maurice Daumas  
*Scientific Instruments of the 17<sup>th</sup> and 18<sup>th</sup> Centuries and Their Makers*  
Eulogy for J. de Vaucanson before the Academie of Sciences (p. 119)

**Cross, Hardy** 1885–1959

American professor of civil and structural engineering

In general the problems of civil engineers are given to them by God Almighty. They are the problems of nature. On the other hand mechanical and electrical work has problems which man, to a certain extent, has created for himself.

In Lenox H. Lohr  
*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*  
Professional Aspects of Mechanical Engineering (p. 150)  
Centennial of Engineering, Chicago, Illinois. 1952

**Douglas, A. Vibert** 1894–1988

Canadian astronomer

It is a solemn thought that no man liveth unto himself. It is equally true that no star, no atom, no electron, no ripple of radiant energy, exists unto itself. All the problems of the physical universe are inextricably bound up with one another in the relations of space and time.

From *Atoms to Stars*  
*The Atlantic Monthly*, Volume 144, August 1929 (p. 165)

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Every problem becomes very childish when once it is explained to you...

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 2)  
The Adventure of the Dancing Men (p. 258)  
Wings Books. New York, New York, USA. 1967

“My mind,” he said, “rebels at stagnation. Give me problems, give me work, give me the most abstruse cryptogram, or the most intricate analysis, and I am in my own proper atmosphere.”

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
The Sign of the Four, Chapter 1 (p. 611)  
Wings Books. New York, New York, USA. 1967

In solving a problem of this sort, the grand thing is to be able to reason backwards. That is a very useful accomplishment, and a very easy one, but people do not practice it much. In the every-day affairs of life it is more useful to reason forwards, and so the other comes to be neglected. There are fifty who can reason synthetically for one who can reason analytically.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
A Study in Scarlet, Chapter 14 (p. 231)  
Wings Books. New York, New York, USA. 1967

It is quite a three pipe problem, and I beg that you won't speak to me for fifty minutes.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
The Red-Headed League (p. 428)  
Wings Books. New York, New York, USA. 1967

**du Preez, Peter**

No biographical data available

The reason for the rapid advance of the problem-solving capacity of natural sciences is that scientists are trained to introduce theoretical variations, to test them empirically, and to preserve and propagate those innovations which survive whatever tests have been proposed.

*A Science of Mind: The Quest for Psychological Reality*  
Part II, Chapter 7 (p. 123)  
Academic Press Ltd. London, England. 1991

**Dyson, Freeman J.** 1923–

American physicist and educator

The difference between a text without problems and a text with problems is like the difference between learning to read a language and learning to speak it.

*Disturbing the Universe* (p. 13)  
Harper & Row, Publishers. New York, New York, USA. 1979

**Easton, Elmer C.**

No biographical data available

All of the problems with which engineers are normally concerned have to do with the satisfying of some human want.

An Engineering Approach to Creative Thinking  
*Ceramic Age*, September 1955 (p. 28)

**Ehrenberg, A. S. C.**

No biographical data available

Many problems arise year after year. The answers, if only we knew them, should therefore also be similar year after year.

*Data Reduction*

Chapter 4 (p. 56)

John Wiley & Sons Ltd. London, England. 1975

**Einstein, Albert** 1879–1955

German-born physicist

There are so many unsolved problems in physics. There is so much that we do not know; our theories are far from adequate.

In I. Bernard Cohen

An Interview with Einstein

*Scientific American*, Volume 193, Number 1, July 1955 (p. 69)

**Einstein, Albert** 1879–1955

German-American physicist

**Infeld, Leopold** 1898–1968

Polish physicist

The importance of a problem should not be judged by the number of pages devoted to it.

*The Evolution of Physics*

Preface (p. ix)

Simon & Schuster. New York, New York, USA. 1961

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

“What we know, is a point to what we do not know.” Open any recent journal of science, and weigh the problems suggested concerning Light, Heat, Electricity, Magnetism, Physiology, Geology, and judge whether the interest of natural science is likely to be soon exhausted.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses, and Lectures

Nature, Chapter V (p. 39)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Feynman, Richard P.** 1918–88

American theoretical physicist

No problem can be solved without it dragging in its wake new problems to be solved.

*Selected Papers of Richard Feynman with Commentary*

The Present Status of Quantum Electrodynamics (p. 134)

World Scientific. Singapore. 2000

If we want to solve a problem that we have never solved before, we must leave the door to the unknown ajar.

*What Do You Care What Other People Think?*

The Value of Science (p. 247)

W. W. Norton & Company, Inc. New York, New York, USA. 1988

**Fleming, J. A.**

No biographical data available

Whilst we derive satisfaction from the thought that so much valuable discovery and invention has already rewarded the labors of workers in many lands, we have but to glance around us to see in all directions, in connection with it, unsolved problems, untrodden paths, wide fields of knowledge ripe for harvest in which the sickle of the reaper has never yet been moved.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Recent Contributions to Electric Wave Telegraphy (p. 193)

Government Printing Office. Washington, D.C. 1908

**Flexner, Abraham** 1866–1959

American educator

...science, in the very act of solving problems, creates more of them.

*Universities: American, English, German*

Chapter I, Section v (p. 19)

Oxford University Press, Inc. Oxford, England. 1930

**Frazier, A. W.**

No biographical data available

Often problems not solved earlier have not been posed earlier.

*Hydrocarbon Processing*

The Practical Side of Creativity, Volume 45, Number 1, January 1966

**Fredrickson, A. G.** 1932–

No biographical data available

To be aware that a problem exists is the prerequisite for any attempt to solve the problem.

The Dilemma of Innovating Societies

*Chemical Engineering Education*, Volume 4, Summer 1969 (p. 148)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

...without a commitment to science and rationality in its proper domain, there can be no solution to the problems that engulf us. Still, the Yahoos never rest.

*Ever Since Darwin: Reflections in Natural History*

Chapter 17 (p. 146)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Halmos, Paul R.** 1916–2006

Hungarian-born American mathematician

A teacher who is not always thinking about solving problems — ones he does not know the answer to — is psychologically simply not prepared to teach problem solving to his students.

*I Want to Be a Mathematician*

Chapter 14 (p. 322)

Springer-Verlag. New York, New York, USA. 1985

**Hawkins, D.**

No biographical data available

There are many things you can do with problems besides solving them. First you must define them, pose them. But then of course you can also refine them, depose them, or expose them or even dissolve them! A given problem may send you looking for analogies, and some of these may lead you astray, suggesting new and different problems, related or not to the original. Ends and means can get reversed. You had a goal, but the means you found

didn't lead to it, so you found a new goal they did lead to. It's called play. Creative mathematicians play a lot; around any problem really interesting they develop a whole cluster of analogies, of playthings.

In Necia Grant Cooper (ed.)

*From Cardinals to Chaos*

The Spirit of Play (p. 44)

Cambridge University Press. Cambridge, England. 1988

### Heisenberg, Werner Karl 1901–76

German physicist and philosopher

...only those revolutions in science will prove fruitful and beneficial whose investigators try to change as little as possible and limit themselves to the solution of a particular and clearly defined problem. Any attempt to make a clean sweep of everything or to change things arbitrarily leads to utter confusion.

*Physics and Beyond: Encounters and Conversations*

Chapter 12 (p. 148)

Harper & Row, Publishers. New York, New York, USA. 1971

### Heller, Joseph 1923–99

American writer

He was pinched perspiringly in the epistemological dilemma of the skeptic, unable to accept solutions to problems he was unable to dismiss as unsolvable. He was never without misery and never without hope.

*Catch-22*

Chapter 25 (p. 275)

Dell Publishing Company, Inc. New York, New York, USA. 1985

### Herschel, Sir John Frederick William 1792–1871

English astronomer and chemist

The great problems which offer themselves on all hands for solution, problems which the wants of the age force upon us as practically interesting, and with which its intellect feels itself competent to deal, are far more complex in their conditions, and depend on data which to be of use must be accumulated in far greater masses, collected over an infinitely wider field, and worked upon with a greater and more systematized power than has sufficed for the necessities of astronomy. The collecting, arranging, and duly combining these data are operations which, to be carried out to the extent of the requirements of modern science, lie utterly beyond the reach of all private industry, mean, or enterprise. Our demands are not merely for a slight and casual sprinkling to refresh and invigorate an ornamental or luxurious product, but for a copious, steady, and well-directed stream, to call forth from a soil ready to yield it, an ample, healthful, and remunerating harvest.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Terrestrial Magnetism (pp. 110–111)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

### Herstein, I. N.

No biographical data available

The value of a problem is not so much in coming up with the answer as in the ideas and attempted ideas it forces on the would-be solver.

*Topics in Algebra*

Preface (p. vi)

Xerox College Publishing. Waltham, Massachusetts, USA, 1964

### Hilbert, David 1862–1943

German mathematician

As long as a branch of science offers an abundance of problems, so long is it alive; a lack of problems foreshadows extinction of the cessation of independent development. Just as every human undertaking pursues certain objects, so also mathematical research requires its problems. It is by the solution of problems that the investigator tests the temper of his steel; he finds new methods and new outlooks, and gains a wider and freer horizon.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902

(p. 438)

It is difficult and often impossible to judge the value of a problem correctly in advance; for the final award depends upon the gain which science obtains from the problem.

Mathematical Problems

*Bulletin of the American Mathematical Society*, Volume 8, July 1902

(p. 438)

### Hodnett, Edward 1901–84

Illustration historian

You have to identify the real problem, and you have to identify the total problem.

*The Art of Problem Solving*

Part I, Chapter 2 (p. 12)

Harper & Brothers. New York, New York, USA. 1955

Problems often boil down to the simple form of a dilemma. A dilemma presents a choice of two solutions to a problem, both of which are unsatisfactory.

*The Art of Problem Solving*

Part II, Chapter 8 (p. 63)

Harper & Brothers. New York, New York, USA. 1955

An unstated problem cannot be solved. Many problems go unsolved for centuries for lack of adequate statement.

*The Art of Problem Solving*

Part I, Chapter 3 (p. 19)

Harper & Brothers. New York, New York, USA. 1955

...being able to predict which problems you are not likely to solve is good for your peace of mind.

*The Art of Problem Solving*

Part I, Chapter 1 (p. 6)

Harper & Brothers. New York, New York, USA. 1955

### Hoyle, Sir Fred 1915–2001

English mathematician and astronomer

It is almost a matter of principle that in any difficult unsolved problem the right method of attack has not been found; failure to solve important problems is rarely due to the inadequacy in the handling of technical details.

*Man in the Universe*

Chapter 2 (p. 20)

Columbia University Press. New York, New York, USA. 1966

### **Huxley, Julian** 1887–1975

English biologist, philosopher, and author

The time has gone by when the intelligent public needs to be reminded of the practical utility of science, or of the fact that the investigation of any problem, however apparently remote from everyday life, may be fraught with the most valuable consequences.

*The Century Illustrated Monthly Magazine*

Searching for the Elixir of Life, Volume 103, Number 4, February 1922 (p. 629)

### **Ingle, Dwight J.** 1907–78

Biologist and endocrinologist

When you are trying to solve problems and are searching for new and creative ideas, let your mind be free-wheeling. Enjoy unbridled fancy. After you get an idea that seems important and plausible, it can be tested by evidence and reason.

*Is It Really So?: A Guide to Clear Thinking*

Chapter 18 (p. 129)

The Westminster Press. Philadelphia, Pennsylvania, USA. 1976

### **Kaplan, Abraham** 1918–1993

American philosopher of science, author, and educator

Give a small boy a hammer and he will find that everything he encounters needs pounding. It comes as no particular surprise that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is skilled...

*The Conduct of Inquiry: Methodology for Behavioral Science* (p. 28)

Chandler Publishing Company. San Francisco, California, USA. 1964

### **Kettering, Charles Franklin** 1876–1958

American engineer and inventor

A problem is not solved in a laboratory. It is solved in some fellow's head. All the apparatus is for is to get his head turned around so that he can see the thing right.

In T.A. Boyd

*Professional Amateur*

Part II Chapter XII (pp. 102–103)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

No one should pick a problem, or make a resolution, unless he realizes that the ultimate value of it will offset the inevitable discomfort and trouble that always goes along with the accomplishment of anything worth while. So let us not waste our time and effort on some trivial thing.

*Short Stories of Science and Invention: A Collection of Radio Talks by*

*C.F. Kettering*

Patience (p. 59)

General Motors. Detroit, Michigan, USA. 1955

As long as we try and patiently do our best to solve the problem, although we may not get the answer we are looking for, we always get something — even if it is only the valuable experience.

*Short Stories of Science and Invention: A Collection of Radio Talks by*

*C.F. Kettering*

Purple Dye, Sun Glasses and Malaria (p. 115)

General Motors. Detroit, Michigan, USA. 1955

But in picking that problem be sure to analyze it carefully to see that it is worth the effort. It takes just as much effort to solve a useless problem as a useful one.

*Short Stories of Science and Invention: A Collection of Radio Talks by*

*C.F. Kettering*

Research Is a State of Mind (p. 11)

General Motors, Detroit, Michigan, USA. 1955

I often think we have so many facilities that we lose track of the problem. Problems, as you know, are solved in the mind of some intensely interested person.

*Short Stories of Science and Invention: A Collection of Radio Talks by*

*C.F. Kettering*

Christmas Lecturer (p. 57)

General Motors, Detroit, Michigan, USA. 1955

### **Kiepenheuer, Karl**

No biographical data available

For the astronomer, the inexhaustible store of problems in the world he has set out to conquer remains the real mainspring of all his arduous researches.

*The Sun*

Conclusion (p. 158)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

### **Lewis, Gilbert Newton** 1875–1946

American chemist

Indeed it seems hardly likely that much progress can be made in the solution of the difficult problems relating to chemical combination by assigning in advance definite laws of force between the positive and negative constituents of an atom, and then on the basis of these laws building up mechanical models of the atom.

*The Atom and the Molecule*

*Journal of the American Chemical Society*, Volume 38, Number 1, 1916 (p. 773)

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

There is no problem in all mathematics that cannot be solved by direct counting. But with the present implements of mathematics many operations can be performed in a few minutes which without mathematical methods would take a lifetime.

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 197)  
The Open Court Publishing Company, Chicago, Illinois, USA. 1898

No man should dream of solving a great problem unless he is so thoroughly saturated with his subject that everything else sinks into comparative insignificance.

*Popular Scientific Lectures*

The Part Played by Accident in Invention and Discovery (pp. 273–274)  
The Open Court Publishing Company, Chicago, Illinois, USA. 1898

Every real problem can and will be solved in due course without supernatural divination, entirely by accurate observation and close, searching thought.

*Popular Scientific Lectures*

On Sensations of Orientation (p. 308)

The Open Court Publishing Company, Chicago, Illinois, USA. 1898

**Maddox, John Royden** 1925–

Welsh chemist and physicist

The problems that remain unsolved are gargantuan. They will occupy our children and their children and on and on for centuries to come, perhaps even for the rest of time.

*What Remains to Be Discovered*

Conclusion (p. 378)

The Free Press, New York, New York, USA. 1998

**Michener, James A.** 1907?–97

American novelist

At NACA [fictional space agency] we solve everything eventually. That's our job, and now it's yours.... At NACA...there are no insoluble problems. Only time-consuming ones.

*Space*

Chapter III (p. 175)

Random House, Inc. New York, New York, USA. 1982

**Nehru, Jawaharla** 1889–1969

Former prime minister of India

It is science alone that can solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people.

Speech

*Proceedings of the National Institute of Science of India*, Volume 27, 1960 (p. 564)

**Nietzsche, Friedrich** 1844–1900

German philosopher

There are dreadful people who, instead of solving a problem, complicate it for those who deal with it and make it harder to solve. Whoever does not know how to hit the nail on the head should [be] entreated not [to] hit it at all.

*The Complete Works of Friedrich Nietzsche* (Volume Seven)

Human, All Too Human

The Wanderer and His Shadow, Part Two, Number 326

Macmillan Publishing Company, New York, New York, USA. 1924

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

...we probably have no very good idea today of the range of problems that will be accessible to science.

*The Flying Trapeze: Three Crises for Physicists*

Space and Time (p. 2)

Oxford University Press, Inc. London, England. 1964

**Pallister, William Hales** 1877–1946

Canadian physician

Science solves life's problems, but she must solve them one-at-a-time. Her course and methods are evolutionary. She cannot solve insoluble problems; they must first become soluble. She grows, like every other plant, only from powdered fock, uses only the chemical constituents which are soluble.

*Poems of Science*

The Nature of Things (p. 14)

Playford Press, New York, New York, USA. 1931

**Pearse, A. S.**

No biographical data available

A scientist has his circulating medium in problems. He deals in and develops problems as a broker deals in stocks and bonds. When his problems are completed he "sells" them to the scientific world by publication, usually at his own expense.

Adventure, Romance and Science

*Science*, Volume 58, Number 1492, 3 August, 1923 (p. 78)

**Pendry, John** 1944–

English theoretical physicist

It has been said that tackling a new scientific problem is like going into a darkened room. First you fall over the furniture, then you collide with other people in the room; arguments might develop. With time things settle down, as you learn where most of the furniture is and don't fall over so often. Eventually someone finds the light switch and everything becomes obvious.

Positively Negative

*Nature*, Volume 423, Number 6935, May 1, 2003 (p. 22)

**Poe, Edgar Allan** 1809–49

American short story writer

The great problem is at length solved! The air, as well as the earth and the ocean, has been subdued by science, and will become a common and convenient highway for mankind.

In H. Beaver (ed.)

*The Science Fiction of Edgar Allan Poe*

The Balloon Hoax (p. 11)

Penguin Books, Hammondsworth, England. 1976

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer



To give a complete mechanical explanation of electrical phenomena, reducing the laws of physics to the fundamental principles of dynamics is a problem that has attracted many investigators.... If the problem admitted of only one solution, the possession of this solution, which would be the truth, could not be bought too dearly.

In Frederick Vreeland

*Maxwell's Theory and Wireless Telegraphy. Part 1. Maxwell's Theory and Hertzian Oscillations. Part 2*

Part One, Chapter I (p. 1)

McGraw Publishing Company. New York, New York, USA. 1904

### **Pólya, George** 1887–1985

Hungarian mathematician

Solving problems is a practical art, like swimming, or skiing, or playing a piano; you can learn it only by imitation and practice...

*Mathematical Discovery; or Understanding, Learning, and Teaching*

*Problem Solving* (Volume 1)

Preface (p. v)

John Wiley & Sons, Inc. New York, New York, USA. 1966

### **Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Science never pursues the illusory aim of making its answers final or even probable. Its advance is rather toward an infinite yet attainable aim: that of ever discovering new, deeper, and more general problems.

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (p. 281)

Basic Books, Inc. New York, New York, USA. 1959

...a young scientist who hopes to make discoveries is badly advised if his teacher tells him: "Go round and observe" and...well advised if his teacher tells him: "Try to learn what people are discussing nowadays in science. Find out where difficulties arise, and take an interest in disagreements. These are the questions which you should take up." In other words, you should study the problems of the day. This means that you pick up, and try to continue, a line of inquiry which has the whole background of the earlier development of science behind it.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 4 (p. 129)

Harper & Row, Publishers. New York, New York, USA. 1963

...science should be visualized as progressing from problem to problem — to problems of ever increasing depth.... Problems crop up especially when we are disappointed in our expectations, or when our theories involve us in difficulties, in contradictions; and these may arise either within a theory, or between two different theories, or as the result of a clash between our theories and our observations.... Thus science starts from problems, and not from observations; though observations may give rise to a problem, especially if they are unexpected; that is to say, if they clash with our expectations or theories.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 10, Section VI (p. 222)

Harper & Row, Publishers. New York, New York, USA. 1963

...I think there is only one way to science — or to philosophy, for that matter: to meet a problem, to see its beauty and fall in love with it; to get married to it, and to live with it happily, till death do ye part — unless you should meet another and even more fascinating problem, or unless, indeed, you should obtain a solution. But even if you do obtain a solution, you may then discover, to your delight, the existence of a whole family of enchanting though perhaps difficult problem children for whose welfare you may work, with a purpose, to the end of your days.

*Realism and the Aim of Science*

Preface, 1956 (p. 8)

Rowman & Littlefield. Totowa, New Jersey, USA.

### **Porter, George** 1920–2002

English chemist

To solve a problem is to create new problems, new knowledge immediately reveals new areas of ignorance, and the need for new experiments.

*Nobel Lectures, Chemistry 1963–1970*

Nobel lecture for award received in 1967

Flash Photolysis and Some of Its Applications (p. 261)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

### **Rabinow, Jacob** 1910–99

Inventor

...the creating of the problem is as big an invention as the solving of the problem — sometimes, a much greater invention.

In Daniel V. DeSimone

*Education for innovation*

The Process of Invention (p. 84)

Pergamon Press. New York, New York, USA. 1968

### **Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

The forging of new truth almost always requires severe abstention and renunciation. During the so-called intellectual incubation period, the investigator should ignore everything unrelated to the problem of interest, like a somnambulist attending only to the voice of the hypnotist.

*Advice for a Young Investigator*

Chapter 3 (p. 35)

The MIT Press. Cambridge, Massachusetts, USA. 1999

I believe that excessive admiration for the work of great minds is one of the most unfortunate preoccupations of intellectual youth — along with a conviction that certain problems cannot be attacked, let alone solved, because of one's relatively limited abilities.

*Advice for a Young Investigator*

Chapter 2 (p. 9)  
The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rapoport, Anatol** 1911–  
Russian-born mathematician and biologist

...the problems scientists are called on to solve are for the most part selected by the scientists themselves. For example, our Department of Defense did not one day decide that it wanted an atomic bomb and then order the scientists to make one. On the contrary, it was Albert Einstein, a scientist, who told Franklin D. Roosevelt, a decision maker, that such a bomb was possible.

*Science, Conflict and Society: Readings from Scientific American*  
The Use and Misuse of Games Theory (p. 286)  
W. H. Freeman & Company. San Francisco, California, USA. 1969

**Raymond, Eric S.**  
No biographical data available

Often, the most striking and innovative solutions come from realizing that your concept of the problem was wrong.

*The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*  
The Cathedral and the Bazaar (p. 40)  
O'Riley. Beijing, China. 2001

**Rozak, Theodore** 1933–  
American social critic

If a problem does not have a technical solution, it must not be a real problem. It is but an illusion...a figment born of some regressive cultural tendency.

*The Making of a Counter Culture: Reflections on the Technocratic Society and Its Youthful Opposition*  
Chapter I (p. 10)  
Doubleday & Company, Inc. Garden City, New York, USA; 1969

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

I am sorry that I have had to leave so many problems unsolved. I always have to make this apology, but the world really is rather puzzling and I cannot help it.

In John G. Slater (ed.)  
*The Collected Papers of Bertrand Russell* (Volume 8)  
The Philosophy of Logical Atomism  
Lecture V (p. 211)  
George Allen & Unwin Ltd. London, England. 1986

**Russell, Henry Norris** 1877–1957  
American astronomer

The unsolved problems of Nature have a distinctive fascination, though they still far outnumber those which have even approximately been resolved.

*The Solar System and Its Origin*  
Chapter I (p. 1)  
The Macmillan Company. New York, New York, USA. 1935

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Religion is always right. Religion solves every problem and thereby abolishes problems from the Universe. Religion gives us certainty, stability, peace and the absolute. It protects us against progress which we all dread. Science is the very opposite. Science is always wrong. It never solves a problem without raising ten more problems.

In B. Patch  
*Thirty Years with G.B.S.*  
Chapter Twelve (p. 235)  
Dodd, Mead & Company. New York, New York, USA. 1951

My business tonight will be very largely to raise difficulties. That is all the use I am really in this world.

*The New York Times*  
Shaw Expounds Socialism as World Panacea  
December 12, 1926

...all problems are finally scientific problems.

*The Doctor's Dilemma*  
Preface on Doctors  
The Technical Problem (p. lxxxiii)  
Brentano's. New York, New York, USA. 1920

**Simon, H.**  
No biographical data available

Problem formulation in science is to be understood by looking at the continuity of the whole stream of scientific endeavor.

In Robert G. Colodny (ed.)  
*Mind and Cosmos*  
Scientific Discovery and the Psychology of Problem Solving (p. 37)  
University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1966

**Simon, Herbert Alexander** 1916–2001  
American social scientist

The capacity of the human mind for formulating and solving complex problems is very small compared with the size of problems whose solution is required for objectively rational behavior in the real world — or even for a reasonable approximation to such objective rationality.

*Models of Man: Social and Rational; Mathematical Essays on Rational Human Behavior in a Social Setting*  
Part IV (p. 198)  
John Wiley & Sons, Inc. New York, New York, USA. 1957

The more difficult and novel the problem, the greater is likely to be the amount of trial and error required to find a solution. At the same time, the trial and error is not completely random or blind; it is, in fact, rather highly selective. The new expressions that are obtained by transforming given ones are examined to see whether they represent progress toward the goal. Indications of progress spur further search in the same direction; lack of progress signals the abandonment of a line of search. Problem solving requires selective trial and error.

*The Sciences of the Artificial*  
Chapter 4 (pp. 95–96)  
The MIT Press. Cambridge, Massachusetts, USA. 1969

...human problem solving, from the most blundering to the most insightful, involves nothing more than varying mixtures of trial and error and selectivity.

*The Sciences of the Artificial*

Chapter 4 (p. 97)

The MIT Press. Cambridge, Massachusetts, USA. 1969

**Simpson, N. F.** 1919–

English playwright

And suppose we solve all the problems it presents? What happens? We end up with more problems than we started with. Because that's the way problems propagate their species. A problem left to itself dries up or goes rotten. But fertilize a problem with a solution — you'll hatch out dozens.

*New English Dramatists 2*

A Resounding Tinkle, Act I, Scene 1 (pp. 80–81)

Penguin Books. London, England. 1960

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

Somehow, problems get into my blood and they don't give me peace, they torture me. I have to get them out of my system, and there is but one way to get them out — by solving them. A problem solved is no problem at all, it just disappears.

On Scientific Creativity

*Perspectives in Biology and Medicine*, Volume 5, Number 2, Winter 1962 (p. 176)

**Tatum, Edward** 1909–75

American biochemist

As in any scientific research, a problem clearly seen is already half solved.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1958

A Case History in Biological Research (p. 610)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

**Thurstone, Louis Leon** 1887–1955

American pioneer of psychometrics and psychophysics

Every scientific problem can be stated most clearly if it is thought of as a search for the nature of the relation between two definitely stated variables. Very often a scientific problem is felt and stated in other terms, but it cannot be so clearly stated in any way as when it is thought of as a function by which one variable is shown to be dependent upon or related to some other variable.

*The Fundamentals of Statistics* (p. 187)

The Macmillan Company. New York, New York, USA. 1925

**Weil, Simone** 1909–43

French philosopher and mystic

Our science is like a store filled with the most subtle intellectual devices for solving the most complex

problems, and yet we are almost incapable of applying the elementary principles of rational thought.

In George A. Panichas (Ed(ed.)

*The Simone Weil Reader*

The Power of Words (p. 271)

McKay. New York, New York, USA. 1977

**Wiesner, Jerome Bert** 1915–94

Educational administrator

Some problems are just too complicated for rational logical solutions. They admit of insights, not answers.

In D. Lang

Profiles: A Scientist's Advice, II

*New Yorker*, 26 January 1963

**Wilson, Jr., E. Bright** 1908–92

American physical chemist

Many scientists owe their greatness not to their skill in solving problems but to their wisdom in choosing them. It is therefore worth considering the points on which this choice can be based.

*An Introduction to Scientific Research*

Chapter 1 (p. 1)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

**Yalow, Rosalyn** 1921–

American medical physicist

We bequeath to you, the next generation, our knowledge but also our problems. While we still live, let us join hands, hearts and minds to work together for their solution so that your world will be better than ours and the world of your children even better.

*Les Prix Nobel. The Nobel Prizes in 1977*

Nobel banquet speech for award received in 1977

Nobel Foundation. Stockholm, Sweden. 1978

## PROGRESS

**Abbey, Edward** 1927–89

American environmentalist and nature writer

[T]here is a cloud on my horizon. A small dark cloud no bigger than my hand.

Its name is progress.

*Desert Solitaire*

Industrial Tourism and the National Parks (p. 48)

Ballantine Books. New York, New York, USA. 1968

**Belinsky, Vissarion Grigorievich** 1811–48

Russian writer and literary critic

Without the striving for infinity there is no life, no development, and no progress.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

**Boorstin, Daniel J.** 1914–2004  
American historian

One of the great obstacles to progress is not ignorance, but the illusion of knowledge.

*The Discoverers*

Part One, Chapter II (p. 86)

Random House, Inc. New York, New York, USA. 1983

**Chernyshevsky, Nikolai Gavrilovich** 1828–89  
Russian socialist reformer

To renounce progress is as silly as to renounce the Earth's force of gravitation.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Clerke, Agnes Mary** 1842–1907  
Irish astronomer

Progress is the result, not so much of sudden flights of genius, as of sustained, patient, often commonplace endeavor; and the true lesson of scientific history lies in the close connection which it discloses between the most brilliant developments of knowledge and the faithful accomplishment of his daily task by each individual thinker and worker.

*A Popular History of Astronomy During the Nineteenth Century*

Part I, Chapter VI (p. 108)

A. & C. Black. London, England. 1908

**Curie, Marie Sklodowska** 1867–1934  
Polish-born French physical chemist

...I was taught that the way of progress is neither swift nor easy...

*Pierre Curie*

Autobiographical Notes

Chapter I (p. 167)

The Macmillan Company. New York, New York, USA. 1926

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The knowledge that progress will inevitably lead to a readjustment of ideas must instill a writer with caution; but I believe that excessive caution is not to be desired. There can be no harm in building hypotheses, and weaving explanations which seem best fitted to our present partial knowledge. These are not idle speculations if they help us, even temporarily, to grasp the relations of scattered facts, and to organise our knowledge.

*Stellar Movements and the Structure of the Universe*

Preface (p. v)

Macmillan & Company Ltd. London, England. 1914

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

The only principle that does not inhibit progress is: Anything goes.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter I (p. 23)

Verso. London, England. 1978

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer, and statistician

If we summon before our imagination in a single mighty host, the whole number of living things from the earliest date at which terrestrial life can be deemed to have probably existed, to the latest future at which we may think it can probably continue, and if we cease to dwell on the mis-carriages of individual lives or single generations, we shall plainly perceive that the actual tenantry of the world progresses in a direction that may in some sense be described as the greatest happiness of the greatest number.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (pp. 194–195)

AMS Press. New York, New York, USA. 1973

**Goddard, Robert H.** 1882–1945  
American physicist

How many more years I shall be able to work on the problem, I do not know; I hope, as long as I live. There can be no thought of finishing, for "aiming at the stars," both literally and figuratively, is a problem to occupy generations, so that no matter how much progress one makes, there is always the thrill of just beginning.

*The Papers of Robert H. Goddard* (Volume 2)

R.H. Goddard to H.G. Wells

April 20, 1932 (p. 823)

McGraw-Hill Book Company. New York, New York, USA. 1970

**Jastrow, Joseph** 1863–1944  
Polish-born psychologist

Mind in the making follows no straightforward progression; its many wanderings in the quest for truth compose a cyclopedia of error and vain solutions far more than orderly annals of successful advance.

In Joseph Jastrow (ed.)

*The Story of Human Error*

Introduction (p. 2)

D. Appleton-Century Company, Inc. New York, New York, USA. 1936

**Lavrov, Pyotr**  
No biographical data available

The physical, intellectual, and ethical development of the personality and the embodiment of truth and justice in social forms — this, it seems to me, is the brief formula that encompasses everything we can regard as progress.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Lawrence, Ernest** 1901–58  
American physicist

No individual is alone responsible for a single stepping stone along the path of progress, and where the path is smooth progress is most rapid.

*Les Prix Nobel. The Nobel Prizes in 1939*  
Nobel banquet speech for award received in 1939  
Nobel Foundation. Stockholm, Sweden. 1940

**Lodge, Sir Oliver** 1851–1940  
English physicist

The present is an epoch of astounding activity in physical science. Progress is a thing of months and weeks, almost days. The long line of isolated ripples of past discovery seen blending into a might wave, on the crest of which one begins to discern some oncoming magnificent generalization. The suspense is becoming feverish, at times almost painful. One feels like a boy who has been long strumming on the silent keyboard of a deserted organ, into the chest of which an unseen power begins to blow a vivifying breath.

*Modern View of Electricity*  
Lecture III  
The Discharge of a Leyden Jar (pp. 382–382)  
Macmillan & Company Ltd. London, England. 1889

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

To deride the hope of progress is the ultimate fatuity, the last word in poverty of spirit and meanness of mind.

*The Hope of Progress*  
Introduction (p. 1)  
Anchor Books. Garden City, New York, USA. 1973

**Nirenberg, Marshall W.** 1927–  
American biochemist and geneticist

One individual alone creates only a note or so that blends with those produced by others.

*Les Prix Nobel. The Nobel Prizes in 1968*  
Nobel banquet speech for award received in 1968  
Nobel Foundation. Stockholm, Sweden. 1969

**Poincaré, Lucien** 1862–1920  
French physicist

There are no limits to progress, and the field of our investigations has no boundaries. Evolution will continue with invincible force. What we today call the unknowable, will retreat further and further before science, which will never stay her onward march. Thus physics will give greater and increasing satisfaction to the mind by furnishing new interpretations of phenomena; but it will accomplish, for the whole of society, more valuable work still, by rendering, by the improvements it suggests, life every day more easy and more agreeable, and by providing mankind with weapons against the hostile forces of Nature.

*The New Physics and Its Evolution*  
Chapter XI (p. 328)  
Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1907

**Ramsay, Sir William** 1852–1916  
English chemist

Progress is made by trial and failure; the failures are generally a hundred times more numerous than the successes; yet they are usually left unchronicled.

*Essays Biographical and Chemical*  
Chemical Essays  
Radium and Its Products (p. 179)  
Archibald Constable & Company Ltd. London, England. 1908

**Sarton, George** 1884–1956  
Belgian-born American scholar and writer

The history of science is the only history which can illustrate the progress of mankind. In fact, progress has no definite and unquestionable meaning in fields other than the fields of science.

*The Study of The History of Science* (p. 5)  
Harvard University Press. Cambridge, Massachusetts, USA. 1936

The saints of today are not necessarily more saintly than those of a thousand years ago; our artists are not necessarily greater than those of early Greece; they are likely to be inferior; and, of course, our men of science are not necessarily more intelligent than those of old; yet one thing is certain, their knowledge is at once more extensive and more accurate. The acquisition and systemization of positive knowledge is the only human activity that is truly cumulative and progressive.

*Introduction to the History of Science* (Volume 1)  
Introductory Chapter (p. 3)  
The Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

**Schmidt, O. Y.**  
No biographical data available

There can be no progress in science and education in the absence of political progress.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneiererson  
Progress Publishers. Moscow, Russia. 1979

**Serres, Michel** 1930–  
French philosopher

But, irresistibly, I cannot help thinking that this idea is the equivalent of those ancient diagrams we laugh at today, which place the Earth at the center of everything, or our galaxy at the middle of the universe, to satisfy our narcissism. Just as in space we situate ourselves at the center, at the navel of things in the universe, so for time, through progress, we never cease to be at the summit, on the cutting edge, at the state-of-the-art of development. It follows that we are always right, for the simple, banal, and

naïve reason that we are living in the present moment. The curve traced by the idea of progress thus seems to me to sketch or project into time the vanity and fatuousness expressed spatially by that central position. Instead of inhabiting the heart or the middle of the world, we are sojourning at the summit, the height, the best of truth.

*Conversations on Science, Culture, and Time*

Second Conversation

Method (pp. 48–49)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1995

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Sir Patrick: Lord! Yes. Modern science is a wonderful thing. Look at your great discovery! Look at all the great discoveries! Where are they leading to? Why, right back to my poor dear old father's ideas and discoveries. He's been dead now over forth years. Oh, it's very interesting.

Ridgerton: Well, there's nothing like progress, is there?

*The Doctor's Dilemma*

Act I (p. 11)

Brentano's. New York, New York, USA. 1909

**Stoppard, Tom** 1937–

Czech-born English playwright

Don't confuse progress with perfectibility. A great poet is always timely. A great philosopher is an urgent need. There's no rush for Isaac Newton. We were quite happy with Aristotle's cosmos. Personally, I preferred it. Fifty-five crystal spheres geared to God's crankshaft is my idea of a satisfying universe.

*Arcadia*

Act II, Scene Five (p. 61)

Faber & Faber Ltd. London, England. 1993

**von Liebig, Justus** 1803–73

German organic chemist

To resolve an enigma, we must have a perfectly clear conception of the problem. there are many ways to the highest pinnacle of a mountain, but those only can hope to reach it who keep the summit constantly in view. All our labour and all our efforts, if we strive to attain it through a morass, only serve to cover it more completely with mud; our progress is impeded by difficulties of our own creation, and at last even the greatest strength must give way when so absolutely wasted.

*Animal Chemistry*

Part II

The Metamorphosis of Tissues (p. 125)

Johnson Reprint Corporation. New York, New York, USA. 1964

**Walker, Kenneth** 1882–1966

No biographical data available

We travel through life with so much mental luggage that it is advisable occasionally to pause and take stock of it

in order that we may get rid of those ideas which impede our progress.

*Meaning and Purpose*

Chapter I (p. 14)

Jonathan Cape. London, England. 1944

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Too many apples from the tree of systematized knowledge lead to the fall of progress.

*Modes of Thought*

Chapter I, Lecture Three (p. 79)

The Macmillan Company. New York, New York, USA. 1938

**PROOF**

**Auster, Paul** 1947–

American writer

I had made an empirical discovery and it carried all the weight of a mathematical proof.

*The Book of Illusions* (pp. 9–10)

Picador. New York, New York, USA. 2002

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

There is a sharp disagreement among competent men as to what can be proved and what cannot be proved, as well as an irreconcilable divergence of opinions as to what is sense and what is nonsense.

*Debunking Science* (p. 18)

University of Washington Book Store. Seattle, Washington, USA. 1930

**Bernal, John Desmond** 1901–71

Irish-born physicist and x-ray crystallographer

...the cardinal rule in science is that a statement must be provable — but that does not mean that it has to be proved now.

In S.W. Fox (ed.)

*The Origins of Prebiological Systems and of Their Molecular Matrices*

The Folly of Probability, Discussion (pp. 53–55)

Academic Press. New York, New York, USA. 1965

**Blake, William** 1757–1827

English poet, painter, and engraver

What is now proved was once only imagined.

*The Complete Poetry and Prose of William Blake*

The Marriage of Heaven and Hell

University of California Press. Berkeley, California, USA. 1982

**Buchanan, Scott** 1895–1968

American educator and philosopher

The best proofs in mathematics are short and crisp like epigrams, and the longest have swings and rhythms that are like music.

*Poetry and Mathematics*

Chapter 1 (p. 36)  
The University of Chicago Press. Chicago, Illinois, USA. 1975

**Cabell, James Branch** 1879–1958  
American essayist and novelist

“But I can prove it by mathematics, quite irrefutably. I can prove anything you require of me by whatever means you may prefer,” said Jurgen, modestly, “for the simple reason that I am a monstrous clever fellow.”

*Jurgen: A Comedy of Justice*  
Chapter 32 (p. 236)  
Robert M. McBride & Company. New York, New York, USA. 1925

**Davis, Philip J.** 1923–  
American mathematician

**Hersh, Reuben** 1927–  
American mathematician

Proof serves many purposes simultaneously.... Proof is respectability. Proof is the seal of authority. Proof, in its best instance, increases understanding by revealing the heart of the matter. Proof suggests new mathematics.... Proof is mathematical power, the electric voltage of the subject which vitalizes the static assertions of the theorems.

*The Mathematical Experience*  
Proof (p. 151)  
Birkhäuser. Boston, Massachusetts, USA. 1981

Proof is for cosmetic purposes and also to reduce somewhat the edge of insecurity on which one always lives.

*The Mathematical Experience*  
A Physical Look at Mathematics (p. 48)  
Birkhäuser. Boston, Massachusetts, USA. 1981

He rests his faith on rigorous proof; he believes that the difference between a correct proof and an incorrect one is an unmistakable and decisive difference. He can think of no condemnation more damning than to say of a student, “He doesn’t even know what a proof is.”

*The Mathematical Experience*  
The Ideal Mathematician (p. 34)  
Birkhäuser. Boston, Massachusetts, USA. 1981

**de Morgan, Augustus** 1806–71  
English mathematician and logician

Would Mathematics — forsooth —  
If true, have failed to prove truth?  
Would not they — if they could — submit  
Some overwhelming proofs of it?

*A Budget of Paradoxes*  
The Moon’s Rotation (p. 262)  
Longmans, Green. London, England. 1872

Proof requires a person who can give and a person who can receive....

*A Budget of Paradoxes*  
The Moon’s Rotation (p. 262)  
Longmans, Green. London, England. 1872

**Dedekind, Richard** 1831–1916  
German mathematician

In science nothing capable of proof ought to be accepted without proof.

Translated by Wooster Woodruff Beman  
*Essays on the Theory of Numbers*  
The Nature and Meaning of Numbers  
Preface to the First Edition (p. 31)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1901

**Euclid of Alexandria** 325 BCE–265 BCE  
Greek mathematician

*Quod erat demonstrandum* (Q.E.D.)

Which was to be proved.

*The Thirteen Books of Euclid’s Elements*  
Element I, Proposition 5  
At The University Press. Cambridge, England. 1906

**Evans, Bergen** 1904–78  
Author

“You can’t prove it isn’t so!” is as good as Q.E.D. in folk logic.

*The Natural History of Nonsense*  
Chapter 19 (p. 264)  
Alfred A. Knopf. New York, New York, USA. 1947

**Gleason, Andrew M.**  
Mathematician

...proofs really aren’t there to convince you that something is true — they’re there to show why it is true.

In D. Albers, G. Alexanderson and C. Reid (eds.)  
*More Mathematical People*  
Andrew M. Gleason (p. 86)  
Harcourt Brace Jovanovich. New York, New York, USA. 1990

**Hamming, Richard W.** 1915–98  
Mathematician

Some people believe that a theorem is proved when a logically correct proof is given; but some people believe a theorem is proved only when the student sees why it is inevitably true. The author tends to belong to this second school of thought.

*Coding and Information Theory*  
Chapter 9 (p. 155)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1980

**Hilbert, David** 1862–1943  
German mathematician

...it is an error to believe that rigor in the proof is the enemy of simplicity....

Hilbert: Mathematical Problems  
*Bulletin of the American Mathematical Society*, Volume 8, 2<sup>nd</sup> Series,  
October 1901–July 1902 (p. 441)

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

What constitutes proof in one generation is not the same thing as proof in another.

*Of Men and Galaxies*

Motives and Aims of the Scientist (pp. 16–17)

University of Washington Press. Seattle, Washington, USA. 1964

### Lenstra, Jr., H. W.

A math talk without a proof is like a movie without a love scene.

AMS-MAA 2002 annual meeting

San Diego, January 8, 2002

### Lowell, Percival 1855–1916

American astronomer

Now, between the truths we take for granted because of their age, and those we question because of their youth, we are apt to forget that in both, proof is nothing but preponderance of probability.

*Mars*

Chapter I, 1 (p. 6)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

### Manin, Yu I.

No biographical data available

... a good proof is one that makes us wiser.

*A Course in Mathematical Logic* (p. 51)

Springer-Verlag. New York, New York, USA. 1977

### Nicholas Bourbaki

Mathematical discussion group

Indeed every mathematician knows that a proof has not been “understood” if one has done nothing more than verify step by step the correctness of the deductions of which it is composed and has not tried to gain a clear insight into the ideas which have led to the construction of this particular chain of deductions in preference to every other one.

Quoted in Douglas M. Campbell and John C. Higgins

*Mathematics: People, Problems, Results* (Volume 3)

In Richard A. De Millo, Richard J. Lipton and Alan J. Perlos

*Social Processes and Proofs of Theorems and Programs* (p. 25)

Wadsworth, Inc. Belmont, California, USA. 1984

### Pearson, Karl 1857–1936

English mathematician

... we must remember that because a proposition has not yet been proved, we have no right to infer that its converse must be true.

*The Grammar of Science*

Chapter IV, Section 17 (p. 179)

Charles Scribner's Sons. London, England. 1892

### Platt, John R.

No biographical data available

There is no such thing as proof in science — because some later alternative explanation may be as good or

better — so that science advances only by disproofs. There is no point in making hypotheses that are not falsifiable, because such hypotheses do not say anything: it must be possible for an empirical scientific system to be refuted by experience.

Strong Inference

*Science*, Volume 146, Number 3641, 16 October 1964 (p. 350)

### Shakespeare, William 1564–1616

English poet, playwright, and actor

Be sure of it: give me the ocular proof...

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Othello, The Moor of Venice

Act III, Scene iii, l. 360

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

And this may help to thicken other proofs

That do demonstrate thinly.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Othello, The Moor of Venice

Act III, Scene iii, l. 429–431

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Stewart, Ian 1945–

English mathematician and science writer

Proofs knit the fabric of mathematics together, and if a single thread is weak, the entire fabric may unravel.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*

Chapter 3 (p. 45)

Basic Books, Inc. New York, New York, USA. 1995

An intuitive proof allows you to understand why the theorem must be true; the logic merely provides firm grounds to show that it is true.

*Concepts of Modern Mathematics*

Chapter 1 (p. 5)

Dover Publications, Inc. New York, New York, USA. 1995

### Sylvester, James Joseph 1814–97

English mathematician

*Divide et impera*: is as true in algebra as in statecraft; but no less true and even more fertile is the maxim *auge et impera*. The more to do or to prove, the easier the doing or the proof.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

Proof of the Fundamental Theorem of Invariants (1878) (p. 126)

At The University Press. Cambridge, England. 1904–1912

It always seems to me absurd to speak of a complete proof, or of a theorem being rigorously demonstrated. An incomplete proof is no proof, and a mathematical truth not rigorously demonstrated is not demonstrated at all.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2) (p. 200)

At The University Press. Cambridge, England. 1904–12



**Truzzi, Marcello** 1935–2003  
Danish-born American sociology professor

And when such claims are extraordinary, that is, revolutionary in their implications for established scientific generalizations already accumulated and verified, we must demand extraordinary proof.

Editorial  
*Zetetic Scholar*, Volume 1, Number 1, Fall/Winter 1976 (p. 4)

**Tymoczko, Thomas** 1943–86  
Logician

A proof is a construction that can be looked over, reviewed, verified by a rational agent. We often say that a proof must be perspicuous or capable of being checked by hand. It is an exhibition, a derivation of the conclusion, and it needs nothing outside itself to be convincing. The mathematician surveys the proof in its entirety and thereby comes to know the conclusion.

The Four Color Problems  
*Journal of Philosophy*, Volume 76, 1979

**Ward, Peter D.**  
American paleontologist

**Brownlee, Donald**  
No biographical data available

Proof is a rarity in science.

*Rare Earth: Why Complex Life Is Uncommon in the Universe*  
Preface (p. ix)  
Springer-Verlag New York, Inc. New York, New York, USA. 2000

**White, Arthur**  
No biographical data available

A teacher once, having some fun,  
In presenting that two equals one,  
Remained quite aloof

From his rigorous proof;  
But his class was convinced and undone.

*Mathematical Magazine*, Volume 64, Number 2, April 1991 (p. 91)

## PROPHECY

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

With monotonous regularity, apparently competent men have laid down the law about what is technically possible or impossible — and have been proved utterly wrong, sometimes while the ink was scarcely dry from their pens.

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 1 (p. 1)  
Harper & Row, Publishers. New York, New York, USA. 1973

Before one attempts to set up in business as a prophet, it is instructive to see what success others have made of this

dangerous occupation — and it is even more instructive to see where they have failed.

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 1 (p. 1)  
Harper & Row, Publishers. New York, New York, USA. 1973

## PROPOSITION

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

If he contend, as sometimes he will contend, that he has defined all his terms and proved all his propositions, then either he is a performer of logical miracles or he is an ass; and, as you know, logical miracles are impossible.

*Mathematical Philosophy: A Study of Fate and Freedom*

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

The belief or unconscious conviction that all propositions are of the subject-predicate form — in other words, that every fact consists in some thing having some quality — has rendered most philosophers incapable of giving any account of the world of science and daily life.

*Our Knowledge of the External World*  
Lecture II (p. 45)  
The Open Court Publishing Company. Chicago, Illinois. 1914

...I wish to propose for the reader's favourable consideration a doctrine which may, I fear, appear wildly paradoxical and subversive. The doctrine in question is this: that it is undesirable to believe a proposition when there is no ground whatever for supposing it true...

*Skeptical Essays*  
Chapter I (p. 11)  
W.W. Norton & Company, Inc. New York, New York, USA. 1928

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

My method for examining any proposition is to take its two extremes, both of them impracticable; make a scale between them; and try to determine at what point on the scale it can best be put into practice. A mother who has to determine the temperature of her baby's bath has two fixed limits to work between. The baby must not be boiled and must not be frozen.

*Everybody's Political What's What?*  
Chapter 20 (p. 162)  
Dodd, Mead & Company. New York, New York, USA. 1944

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

It is more important that a proposition be interesting than that it be true. This statement is almost a tautology. For the energy of operation of a proposition in an occasion of experience is its interest and is its importance. But of

course a true proposition is more apt to be interesting than a false one.

*Process and Reality: An Essay in Cosmology*

Part III, Chapter IV, Section II (pp. 395–396)

The Macmillan Company. New York, New York, USA. 1929

## PROTON

**Ball, Philip** 1962–

English science writer

As far as atoms are concerned, protons and electrons are like knives and forks at the dinner table; no matter how big the table, there are equal numbers of each.

*Life's Matrix: A Biography of Water*

Part One, Chapter 1 (p. 7)

Farrar, Straus & Giroux. New York, New York, USA. 2000

**Dyson, Freeman J.** 1923–

American physicist and educator

The most serious uncertainty affecting the ultimate fate of the universe is the question whether the proton is absolutely stable against decay into lighter particles. If the proton is unstable, all matter is transitory and must dissolve into radiation.

Time Without End: Physics and Biology in an Open Universe

*Reviews of Modern Physics*, Volume 51, Number 3, July 1979

## PROTOPLASM

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

Life carries on. Through all the tortures inflicted by a changing earth, through glacial cold and desert thirst, through flood and famine, the protoplasm has climbed with unabating vigor toward the future.

*Parade of the Living*

Part III, Chapter XVIII (p. 248)

Coward-McCann, Inc. New York, New York, USA. 1930

## PROVINCIAL REGION

**Forbes, Edward** 1815–54

English naturalist

Everyone knows that the same animals and plants are not found everywhere...but that they are distributed so as to be gathered together in distinct zoological and botanical provinces, of greater or less extent, according to their degree of limitation by physical conditions, whether features of the earth's outline or climate.

*The Natural History of the European Seas*

Chapter I (p. 1)

John Van Voorst. London, England. 1859

## PSEUDOSCIENCE

**Sagan, Carl** 1934–96

American astronomer and author

Pseudoscience is embraced, it might be argued, in exact proportion as real science is misunderstood.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 1 (p. 15)

Random House, Inc. New York, New York, USA. 1995

## PSYCHICAL CONSTITUTION

**Pavlov, Ivan Petrovich** 1849–1936

Russian physiologist

Essentially only one thing in life interests us: our psychical constitution, the mechanism of which was and is wrapped in darkness. All human resources, art, religion, literature, philosophy and historical sciences, all of them join in bringing light in this darkness.

*Nobel Lectures, Physiology or Medicine 1901–1921*

Nobel lecture for award received in 1904

*Physiology of Digestion* (pp. 154–155)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

## PUBLIC SPEAKING

**Sylvester, James Joseph** 1814–97

English mathematician

When called upon to speak in public [the mathematician] feels as a man might...who has passed all his life in peering through a microscope, and is suddenly called upon to take charge of an astronomical observatory. He has to get out of himself, as it were, and change the habitual focus of his vision.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 3)

An Inquiry into Newton's Rule for the Discovery of Imaginary Roots

(p. 73)

University Press. Cambridge, England. 1904–1912

## PURITY

**Nilson, Lars Fredrik**

No biographical data available

On the purity of substances depends the perfection of the whole.

In Mary Elvira Weeks

*The Discovery of the Elements* (p. 407)

Journal of Chemical Education. Easton Pennsylvania, USA. 1956

## PURPOSE

**Einstein, Albert** 1879–1955

German-born physicist

How strange is the lot of us mortals! Each of us is here for a brief sojourn; for what purpose he knows not, though he sometimes thinks he senses it. But without deeper reflection one knows from daily life that one exists for other people — first of all for those upon whose smiles and well-being our own happiness is wholly dependent, and then for the many, unknown to us, to whose destinies we are bound by the ties of sympathy. A hundred times every day I remind myself that my inner and outer life are based on the labors of other men, living and dead, and that I must exert myself in order to give in the same measure as I have received and am still receiving.

*Ideas and Opinions*

The World as I See It (p. 8)

Crown Publishers, Inc. New York, New York, USA. 1954

**Townson, Robert** 1763–1827

Australian scholar and scientist

Plan and design are in all Nature's works, though universal discord and confusion seem to prevail, and though certain ruin awaits her fairest productions.

*Philosophy of Mineralogy*

Chapter III (p. 32)

Printed for the author. London, England. 1798

## PYRAMID

**Bonaparte, Napoleon** 1765–1821

French general

From the top of those pyramids, forty centuries look down on you.

In Ralph Waldo Emerson

*English Traits and Representative Men*

Representative Men, Chapter VII (p. 324)

Oxford University Press, Inc. Oxford, England. 1934

**Kipling, Rudyard** 1865–1936

British writer and poet

Who shall doubt “the secret hid  
Under Cheops' pyramid”

Was that the contractor did  
Cheops out of several million?

*Rudyard Kipling's Verse*

A General Summary

Hodder & Stoughton. London, England. 1919

**Shelley, Percy Bysshe** 1792–1822

English poet

Nile shall pursue his changeless way:

Those Pyramids shall fall;

Yea! Not a stone shall stand to tell

The spot where on they stood.

Their very site shall be forgotten,

As is their builder's name.

*The Complete Poetical Works of Percy Bysshe Shelley*

Queen Mab

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

As for the pyramids, there is nothing to wonder in at them so much as the fact that so many men could be found degraded enough to spend their lives constructing a tomb for some ambitious booby, whom it would have been wiser and manlier to have drowned in the Nile, and then given the body to the dogs.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter I (p. 93)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

## PYTHAGORAS

**Browne, Sir Thomas** 1605–82

English author and physician

I have often admired the mystical way of Pythagoras, and the secret magic of numbers.

*Religio Medici*

12

Elliot Stock. London, England. 1883

## Q

### QUACK

**Aesop** ca. 620 BCE–560 BCE  
Greek fabulist and author

A frog once upon a time came forth from his home in the marsh and proclaimed to all the beasts that he was a learned physician, skilled in the use of drugs and able to heal all diseases. A Fox asked him, “How can you pretend to prescribe for others when you are unable to heal your own lame gait and wrinkled skin?”

*The Quack Frog*

SeaStar Books. New York, New York, USA. 2000

**Ames, Nathaniel** 1708–64  
American almanac maker

Where silly quacks are most respected, there honest doctors are neglected. Petty Attorneys and Quack Doctors are like Wolves and scabbed Sheep among the Flock. One devours and the other breeds the rot.

*An Astronomical Diary, or, an Almanack for...1734*

Printed for the Booksellers and sold at their shops. Boston, Massachusetts, USA. 1734

**Bernstein, Al**  
American writer and stage performer

You can usually tell a quack doctor by his bill.

*Quote, the Weekly Digest*, July 28, 1968 (p. 77)

**Bishop, Samuel**  
No biographical data available

When quacks, as quacks may by good luck, to be sure,  
Blunder out at haphazard a desperate cure,  
In the prints of the day, with due pomp and parade,  
Case, patient, and doctor are amply display’d.  
And this is quite just — and no mortal can blame it;  
If they save a man’s life, they’ve a right to proclaim it  
But there’s reason to think they might save more lives still,

Did they publish a list of the numbers they kill!

In William Davenport Adams

*English Epigrams*

Audi Alteram Partem, cclxxxv

G. Routledge. London, England. 1878

**Clowes, William** 1540–1604  
Surgeon and medical author

Yea, nowadays, it is too apparent to see how tinkers, tooth-drawers, peddlers, ostlers, carters, porters, horse-gelders, and horse-leeches, idiots, apple-squires, broom-men, bawds, witches, conjurers, soothsayers and sow-gelders, rogues, ratcatchers, runagates and proctors of Spittlehouses, with

such other like rotten and stinking weeds do in town and country, without order, honesty or skill, daily abuse both Physic and Surgery, having no more perseverance, reason or knowledge in this art than has a goose, but only a certain blind practice, without wisdom or judgment, and most commonly use one remedy for all diseases and one way of curing to all persons, both old and young, men, and women and children, which is as possible to perform or to be true as for a shoemaker with one last to make a shoe fit for every man’s foot, and this is one principal cause [why] so many perish.

*Selected Writings*

Of Blind Buzzards and Cracking Cumbatters (pp. 77–78)

Harvey & Blythe. London, England. 1948

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

It is better to have recourse to a quack, if he can cure the disorder, although he cannot explain it, than to a physician, if he can explain our disease, but cannot cure it.

*Lacon; or Many Things in a Few Words*

1:170

William Gowans. New York, New York, USA. 1849

**Crabbe, George** 1754–1832  
English poet

A potent quack, long versed in human ills,  
Who first insults the victim whom he kills...

*The Poetical Works of George Crabbe*

The Village L. 282–283 (p. 15)

Oxford University Press, Inc. London, England. 1908

**Graves, Richard**  
No biographical data available

A doctor, who, for want of skill,  
Did sometimes cure — and sometimes kill;  
Contriv’d at length, by many a puff,  
And many a bottle fill’d with stuff,  
To raise his fortune, and his pride;  
And in a coach, forsooth! must ride.  
His family coat long since worn out,  
What arms to take, was all the doubt.  
A friend, consulted on the case,  
Thus answer’d with a sly grimace:  
“Take some device in your own way,  
Neither too solemn nor too gay;  
Three ducks, suppose; white, grey, or black;  
And let your motto be, Quack! quack!”

In William Davenport Adams

*English Epigrams*

A Doctor’s Motto, cclxxxi

G. Routledge. London, England. 1878

**Hood, Thomas** 1799–1845  
English poet and editor

Not one of these self-constituted saints,  
Quacks — not physicians — in the cure of souls.

*The Complete Poetical Works of Thomas Hood*  
Ode to Rae Wilson ESQ.  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Jenner, Edward** 1749–1823  
English physician

I've dispatc'd, my dear madam, this scrap of a letter,  
To say that Miss —  
— is very much better.

A Regular Doctor no longer she lacks,  
And therefore I've sent her a couple of Quacks.

In William Davenport Adams

*English Epigrams*

Sent to a Patient, with the Present of a Couple of Ducks, cclxxiii  
G. Routledge. London, England. 1878

**Lydston, George Frank** 1858–1923  
American urologist

The quack doesn't find out what the matter is but, to the patient's cost, he does find a lot of things that do not exist, and all because the reputable physician flouted as imaginary conditions which, to the patient's sensitive and morbid mind, are always terribly real.

Sexual Neurasthenia and the Prostate

*Medical Record*, Volume 81, 1912

**Massinger, Philip** 1583–1640  
English dramatic poet

Out, you impostors!  
Quacksalving, cheating mountebanks! your skill  
Is to make sound men sick, and sick men kill.

*The Plays of Philip Massinger* (Volume 1)

The Virgin-Martyr, Act IV, Scene I (p. 78)

G. & W. Nicol. London, England. 1805

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Did I hear from the fireside armchair the bow-wow of the old school defending its drugs? Ah, believe me, Paddy, the world would be healthier if every chemist's shop in England were demolished. Look at the papers! full of scandalous advertisements of patent medicines! a huge commercial system of quackery and poison. Well, whose fault is it? Ours. I say, ours. We set the example. We spread the superstition. We taught the people to believe in bottles of doctor's stuff; and now they buy it at the stores instead of consulting a medical man.

*The Doctor's Dilemma*

Act I (p. 27)

Brentano's. New York, New York, USA. 1920

**Wycherley, William** 1640–1760  
English dramatist

A quack is as fit for a pimp as a midwife for a bawd: they are still but in their way, both helpers of nature.

*The Country Wife*

Act 1 (p. 5)  
Random House, Inc. New York, New York, USA. 19—

## QUALITIES

**Darwin, Charles Robert** 1809–82  
English naturalist

I am inclined to agree with Francis Galton in believing that education and environment produce only a small effect on the mind of any one, and that most of our qualities are innate.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter I (p. 21)

D. Appleton & Company. New York, New York, USA. 1896

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

The only qualifications required for the study of Nature's story-book are devotion to truth, and sincerity of spirit; all the other qualities will come to the possessor of these, and a habit of mind will be developed that tries to face all facts squarely and honestly, despises shams and false conventions, and exposes superstition whenever it is encountered.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 44)

Macmillan & Company Ltd. London, England. 1918

## QUANTIFICATION

**Platt, John R.**  
No biographical data available

Today we preach that science is not science unless it is quantitative. We substitute correlation for causal studies., and physical equations for organic reasoning. Measurements and equations are supposed to sharpen thinking, but...they more often tend to make the thinking non-causal and fuzzy.

Strong Inference

*Science*, Volume 146, Number 3641, 16 October 1964 (pp. 351–352)

**Sagan, Carl** 1934–96  
American astronomer and author

Quantify. If whatever it is you're explaining has some measure, some numerical quantity attached to it, you'll be much better able to discriminate among competing hypotheses. What is vague and qualitative is open to many explanations.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 12 (p. 211)

Random House, Inc. New York, New York, USA. 1995

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Elegant intellects which despise the theory of quantity are but half developed.

*The Aims of Education*

Presidential Address

Mathematical Association of England, 1916

## QUANTUM MECHANICS

**Abbey, Edward** 1927–89

American environmentalist and nature writer

Quantum mechanics provides us with an approximate, plausible, conjectural explanation of what actually is, or was, or may be taking place inside a cyclotron during a dark night in February.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 10 (p. 93)

St. Martin's Press. New York, New York, USA. 1989

**Barrow, John D.** 1952–

English theoretical physicist

We live in the in-between world...betwixt the "devil" of the quantum world and the "deep blue sea" of curved space.

*The World Within The World* (p. 161)

Clarendon Press. Oxford, England. 1988

**Belinfante, Frederik Jozef** 1913–1991

Dutch-born American physicist

If I get the impression that Nature itself makes the decisive choice what possibility to realize, where quantum theory says that more than one outcome is possible, then I am ascribing personality to Nature, that is to something that is always everywhere. Omnipresent eternal personality which is omnipotent in taking the decisions that are left undetermined by physical law is exactly what in the language of religion is called God.

In John D. Barrow

*The World Within the World* (p. 157)

Clarendon Press. Oxford, England. 1988

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

Anyone who is not shocked by quantum theory has not understood it.

In N.C. Panda

*Maya in Physics* (p. 73)

Motilal Banarsdass Publishers. Delhi, India. 1991

If anybody says he can think about quantum problems without getting giddy, that only shows he has not understood the first thing about them.

In Ruth Moore

*Niels Bohr* (p. 127)

MIT Press. Cambridge, Massachusetts, USA. 1985

There is no quantum world. There is only an abstract quantum physical description. It is wrong to think that

the task of physics is to find out how nature is. Physics concerns what we can say about nature.

The Philosophy of Niels Bohr

*Bulletin of the Atomic Scientists*, Volume 19, Number 7, September

1963 (p. 12)

...the fundamental postulate of the indivisibility of the quantum is itself from the classical point of view, an irrational element which inevitably requires us to forgo a causal mode of description and which, because of the coupling between phenomena and their observation, forces us to adopt a new mode of description designated as complementary in the sense that any given application of classical concepts precludes the simultaneous use of other classical concepts which in a different connection are equally necessary for the elucidation of the phenomena.

*Atomic Theory and the Description of Nature*

Introductory Survey (p. 10)

Cambridge University Press. Cambridge, England. 1934

**Born, Max** 1882–1970

German-born English physicist

[In quantum mechanics] we have the paradoxical situation that observable events obey laws of chance, but that the probability for these events itself spreads according to laws which are in all essential features causal laws.

*Natural Philosophy of Cause and Chance*

Chapter IX (p. 103)

At The Clarendon Press. Oxford, England. 1949

**Bridgman, Percy Williams** 1882–1961

American physicist

The explanatory crisis which now confronts us in relativity and quantum phenomena is but a repetition of what has occurred many times in the past.... Every kitten is confronted with such a crisis at the end of nine days.

*The Logic of Modern Physics*

Chapter II (p. 42)

The Macmillan Company. New York, New York, USA. 1927

**Calvin, William H.** 1939–

Theoretical neurophysiologist

Quantum mechanics is probably essential to consciousness in about the same way as crystals were once essential to radios, or spark plugs are still essential to traffic jams. Necessary, but not sufficient.

*How Brains Think: Evolving Intelligence, Then and Now*

Chapter 3 (p. 36)

Basic Books, Inc. New York, New York, USA. 1996

## Captain Janeway

Fictional character

Who wanted to muck around in the dirt when you could be studying quantum mechanics?

*STAR TREK: Voyager*

Resolutions

Television program  
Season 2, 1996

**Cole, K. C.** 1946–  
American science writer

The introduction of quantum theory in the early 1920s marked one of the greatest revolutions in all of physical science. It could not (cannot) adequately be described in metaphors borrowed from our previous view of reality, because many of those metaphors no longer apply. This inability to imagine quantum goings-on led to the popular perception that the realm of the inner atom is fuzzy, elusive, murky, and uncertain. On the contrary, most physicists would agree that what quantum theory has brought to science is exactly the opposite — concreteness and clarity.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Chapter Seven (p. 113)  
Harcourt Brace & Company, New York, New York, USA. 1999

**DeWitt, Bryce** 1923–2004  
American theoretical physicist

**Graham, Neill**

No biographical data available

No development of modern science has had a more profound impact on human thinking than the advent of quantum theory. Wrenched out of centuries-old thought patterns, physicists of generation ago found themselves compelled to embrace a new metaphysics. The distress which the reorientation caused continues to the present day. Basically physicists have suffered a severe loss: their hold on reality.

Resource IQM-1 on the Interpretation of Quantum Mechanics  
*American Journal of Physics*, Volume 39, 1971

**Dirac, Paul Adrian Maurice** 1902–84  
English theoretical physicist

...the main object of physical science is not the provision of pictures, but in the formulation of laws governing phenomena and the application of these laws to the discovery of new phenomena. If a picture exists, so much the better; but whether a picture exists or not is a matter of only secondary importance. In the case of atomic phenomena no picture can be expected to exist in the usual sense of the word “picture,” by which is meant to model functioning essentially on classical lines. One may extend the meaning of the word “picture” to include any way of looking at the fundamental laws which make their self-consistency obvious. With this extension, one may acquire a picture of atomic phenomena by becoming familiar with the laws of quantum theory.

*The Principles of Quantum Mechanics* (2<sup>nd</sup> edition)  
Chapter I, Section 4 (p. 10)  
At The Clarendon Press, Oxford, England. 1935

**Dyson, Freeman J.** 1923–  
American physicist and educator

...Dick Feynman told me about his “sum over histories” version of quantum mechanics. “The electron does anything it likes,” he said. “It goes in any direction at any speed, forward or backward in time, however it likes, and then you add up the amplitudes and it gives you the wave function.” I said to him, “You’re crazy.” But he wasn’t.

In Harry Woolf (ed.)  
*Some Strangeness In the Proportion*  
Chapter 23 (p. 376)  
Addison-Wesley Publishing Company, Inc. Reading, Massachusetts, USA. 1980

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Rather against my better judgment I will try to give a rough impression of the theory. It would probably be wiser to nail up over the door of the new quantum theory a notice, “Structural alterations in progress — No admittance except on business”, and particularly to warn the doorkeeper to keep out prying philosophers.

*The Nature of the Physical World*  
Chapter X (p. 211)  
The Macmillan Company, New York, New York, USA. 1930

A very useful kind of operator is the selective operator. In my schooldays a foolish riddle was current — “How do you catch lions in the desert?” Answer: “In the desert you have a lot of sand and a few lions; so you take a sieve and sieve out the sand and the lions remain.” I recall it because it describes one of the most usual methods used in quantum theory for obtaining anything that we wish to study.

*New Pathways in Science*  
Chapter XII, Section III (p. 263)  
The Macmillan Company, New York, New York, USA. 1935

**Einstein, Albert** 1879–1955  
German-born physicist

This theory [quantum theory] reminds me a little of the system of delusions of an exceedingly intelligent paranoiac, concocted of incoherent elements of thoughts.

In Arthur Fine  
*The Shaky Game: Einstein, Realism, and the Quantum Theory*  
Letter of July 5, 1952 to D. Lipkin (p. 1)  
University of Chicago Press, Chicago, Illinois, USA. 1986

Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not bring us any closer to the secret of the Old One. I, at any rate, am convinced that He does not throw dice.

In Ronald W. Clark  
*Einstein: The Life and Times*  
Letter to Max Born, 1926 (p. 340)  
The World Publishing Company, New York, New York, USA. 1971

The quantum theory gives me a feeling very much like yours. One really ought to be ashamed of its success, because it has been obtained with the Jesuit maxim: "Let not thy left hand know what thy right hand doeth."

*The Born–Einstein Letters: Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955*  
Letter to Max Born, June 4, 1919 (p. 11)  
Walker & Company. New York, New York, USA. 1971

I cannot seriously believe in [the quantum theory] because it cannot be reconciled with the idea that physics should represent a reality in time and space, free from spooky actions at a distance.

*The Born–Einstein Letters: Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955*  
Letter to Max Born, March 1948 (p. 158)  
Walker & Company. New York, New York, USA. 1971

[Quantum theory] If this is correct, it signifies the end of physics as a science.

In L.I. Ponomarev  
*The Quantum Dice* (p. 80)  
Institute of Physics Publishing. Bristol, England. 1993

The more one chases after quanta, the better they hide themselves.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side: New Glimpses from His Archives*  
Letter to Paul Ehrenfest, 12 July 1924 (p. 69)  
Princeton University Press. Princeton, New Jersey, USA. 1979

**Ekert, Artur** 1961  
Polish/British quantum physicist

Possibly the best way to agitate a group of jaded but philosophically inclined physicists is to buy them a bottle of wine and mention interpretations of quantum mechanics. It is like opening a Pandora's box. I have been amused to discover that the number of viewpoints often exceeds the number of participants.

*Physics World*  
Pet Theories of Quantum Mechanics, December 1995

**Ferris, Timothy** 1944–  
American science writer

Gertrude Stein said of modern art, "A picture may seem extraordinarily strange to you and after some time not only does it not seem strange but it is impossible to find what there was in it that was strange." Quantum physics isn't like that. The longer you look at it, the stranger it gets.

*The Whole Shebang: A State-of-the Universe's Report*  
Quantum Weirdness (p. 265)  
Simon & Schuster. New York, New York, USA. 1996

**Feynman, Richard P.** 1918–88  
American theoretical physicist

The theory of quantum electrodynamics describes Nature as absurd from the point of view of common sense. And it

agrees with experiment. So I hope you can accept Nature as She is — absurd.

*QED: The Strange Theory of Light and Matter*  
Chapter 1 (p. 10)  
Princeton University Press. Princeton, New Jersey, USA. 1985

There was a time when the newspapers said that only twelve men understood the theory of relativity. I do not believe that there ever was such a time. There might have been a time when only one man did, because he was the only guy who caught on, before he wrote his paper. But after people read the paper a lot of people understood the theory of relativity in some way or other, certainly more than twelve. On the other hand I think I can safely say that nobody understands quantum mechanics.... Do not keep saying to yourself, if you can possibly avoid it, "But how can it be like that?" because you will get "down the drain", into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that.

*The Character of Physical Law*  
Chapter 6 (p. 129)  
BBC. London, England. 1965

**Feynman, Richard P.** 1918–88  
American theoretical physicist

**Leighton, Robert B.** 1919–97  
American physicist

**Sands, Matthew L.** 1919–  
American physicist

It is possible in quantum mechanics to sneak quickly across a region which is illegal energetically.

*The Feynman Lectures on Physics* (Volume 3)  
Chapter 8–6 (p. 8–12)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

...there are certain situations in which the peculiarities of quantum mechanics can come out in a special way on a large scale.

*The Feynman Lectures on Physics* (Volume 3)  
Chapter 21–1 (p. 21–1)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

**Gell-Mann, Murray** 1929–  
American physicist

All of modern physics is governed by that magnificent and thoroughly confusing discipline called quantum mechanics, invented more than fifty years ago. It has survived all tests and there is no reason to believe that there is any flaw in it. We suppose that it is exactly correct. Nobody understands it, but we all know how to use it and how to apply it to problems; and so we have learned to live with the fact that nobody can understand it.

In Frank Durham and Robert D. Purrington (eds.)  
*Some Truer Method: Reflections on the Heritage of Newton*



Chapter 2 (p. 51)  
Columbia University Press. New York, New York, USA. 1990

**Harrison, Edward Robert** 1919–2007  
English-born American cosmologist

...in the impalpable and seemingly inconsequential entities of the quantum world, one finds the true music and magic of nature.

*Masks of the Universe*  
Chapter 8 (p. 123)  
Macmillan Publishing Company. New York, New York, USA. 1985

**Hawking, Stephen William** 1942–  
English theoretical physicist

You would have to fly around the world four hundred million times to add one second to your life; but your life would be reduced by more than that by all those airline meals.

*Black Holes and Baby Universes and Other Essays*  
Chapter Eight (p. 72)  
Bantam Books. New York, New York, USA. 1987

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Quantum theory reminds us of the old wisdom that when searching for harmony in life we must forget that in the drama of existence we are ourselves both players and spectators.

In Denis Alexander  
*Beyond Science*  
Chapter Two (p. 48)  
Lion Publishing. Berkhamsted, Hertz, England. 1972

Quantum theory thus provides us with a striking illustration of the fact that we can fully understand a connection though we can only speak of it in images and parables.

*Physics and Beyond: Encounters and Conversations*  
Chapter 17 (p. 210)  
Harper & Row, Publishers. New York, New York, USA. 1971

The problem of quantum theory centers on the fact that the particle picture and the wave picture are merely two different aspects of one and the same physical reality.

*The Physical Principles of the Quantum Theory*  
Translated by Carl Eckhart and Frank C. Hoyt (p. 177)  
The University of Chicago Press. Chicago, Illinois, USA. 1930

If anything like mechanics were true then one would never understand the existence of atoms. Evidently there exists another [type of mechanics — ] “quantum mechanics.”

In Keith Hannabuss  
*An Introduction to Quantum Theory*  
Letter to Wolfgang Pauli, June 21, 1925 (p. 21)  
Oxford University Press, Inc. Oxford, England. 1997

**Joyce, James** 1882–1941  
Irish-born author

I am working out a quantum theory about it for it is really most tantalizing state of affairs.

*Finnegans Wake*  
Book I (p. 149)  
The Viking Press. New York, New York, USA. 1939

**Kaku, Michio**  
Theoretical physicist

...it is often stated that of all the theories proposed in this century, the silliest is quantum theory. In fact, some say that the only thing that quantum theory has going for it is that it is unquestionably correct.

*Hyperspace : A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10<sup>th</sup> Dimension*  
Chapter 12 (p. 262)  
Oxford University Press, Inc. New York, New York, USA. 1995

**Kramers, Hendrick Anthony** 1894–1952  
Physicist

The theory of quanta is similar to other victories in science; for some months you smile at it, and then for years you weep.

In L.I. Ponomarev  
*The Quantum Dice* (p. 80)  
Institute of Physics Publishing. Bristol, England. 1993

The theory of quanta can be likened to a medicine that cures the disease but kills the patient.

In L.I. Ponomarev  
*The Quantum Dice* (p. 81)  
Institute of Physics Publishing. Bristol, England. 1993

**Krauss, Lawrence M.** 1954–  
American theoretical physicist

...what we really should be discussing is “the interpretation of classical mechanics” — that is, how can the classical world we see — which is only an approximation of the underlying reality, which in turn is quantum mechanical in nature — be understood in terms of the proper quantum mechanical variables? If we insist on interpreting quantum mechanical phenomena in terms of classical concepts, we will inevitably encounter phenomena that seem paradoxical, or impossible.

*The Physics of Star Trek*  
Chapter Nine (pp. 150–151)  
Harp Perennial Publishers. New York, New York, USA. 1995

**Lawrence, D. H. (David Herbert)** 1885–1930  
English writer

I like relativity and quantum theories because I don't understand them and they make me feel as if space shifted about like a swan that can't settle, refusing to sit still and be measured; and as if the atom were an impulsive thing Always changing its mind.

In Vivian de Sola Pinto and Warren Roberts (eds.)

*The Complete Poems of D.H. Lawrence*  
Relativity (p. 524)  
Viking Press. New York, New York, USA. 1973

**Lindley, David** 1956–  
English astrophysicist and author

[I]t is misleading to say that “measurement affects the thing measured” because that can seem to imply that a quantum object was in some definite but unknown state, but was then disturbed by an act of measurement and is now in some other state. Rather, measurement gives definition to quantities that were previously indefinite; there is no meaning that can be given to a quantity until it is measured.

*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*  
Which Way Did the Photon Go? (p. 60)  
Basic Books, Inc. New York, New York, USA. 1996

Although quantum mechanics provides explanations of the results of experiments, those explanations tend not, in our minds, to add up to an understanding. But why should they? It’s the job of science to provide theories and models that give us an accurate picture of the way the world works, but we are not free also to demand that these theories should conform to our prior expectations of the way we would like the world to work, or think it ought to work. If science sometimes provides explanations without giving us what we would regard as an understanding, the deficiency belongs to us, not to science.

*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*  
You Can Push It Around, But You Can’t Get Rid of It (p. 125)  
Basic Books, Inc. New York, New York, USA. 1996

The Moon really is there, after all, when no one’s looking. In a general sense, Einstein’s comment was correct: quantum mechanics demands that a measurement be made in order for the Moon really to exist at a particular spot. But the new insight afforded by the decoherence argument is that the rain of solar photons onto the Moon’s surface is enough of a physical process to constitute a “measurement” — it’s enough to get rid of superposed states, which is what we want a measurement to accomplish. No actual observation is required, and the whole process carries on efficiently and relentlessly without any intervention of human action, let alone human consciousness. The world works in its own way, and doesn’t need us to look at it.

*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*  
In Which Einstein’s Moon Is Restored (p. 204)  
Basic Books. New York, New York, USA. 1996

The microworld is not a simple place, and physicists have therefore not been able to keep their theories of it simple.

*The End of Physics: The Myth of a Unified Theory*

Part I (p. 24)  
Basic Books, Inc. New York, New York, USA. 1993

**Moser, David**  
No biographical data available

Quantum Particles: the dreams that stuff is made of.  
In Douglas Hofstadter  
*Metamagical Themas: Questing for the Essence of Mind and Pattern*  
Section IV, Chapter 20 (p. 473)  
Basic Books, Inc. New York, New York, USA. 1985

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

Another way the old physics differs from the quantum physics is the way the determinism of a clock differs from the contingency of a pinball machine.  
*The Cosmic Code: Quantum Physics as the Language of Nature*  
Foreword (p. 13)  
Simon & Schuster. New York, New York, USA. 1982

**Pauli, Wolfgang** 1900–58  
Austrian-born physicist

Physics is a blind alley again. In any case, it has become too difficult for me, and I would prefer to be a comedian in the cinema, or something like that, and hear no more about physics.  
In L.I. Ponomarev  
*The Quantum Dice* (p. 81)  
Institute of Physics Publishing. Bristol, England. 1993

I know a great deal. I know too much. I am a quantum ancient.  
In Jeremy Bernstein  
*Experiencing Science*  
Part 1. Two Faces of Physics. Chapter 2. Rabi: The Modern Age (p. 102)  
Basic Books, Inc. New York, New York, USA. 1978

**Peat, F. David**  
Theoretical physicist

The choice before us is either to abandon any hope of knowing the nature of quantum reality or to accept a nonlocal universe.  
*Einstein’s Moon* (p. 124)  
Contemporary Books. Chicago, Illinois, USA. 1990

**Planck, Max** 1858–1947  
German physicist

My futile attempts to fit the elementary quantum of action somehow into the classical theory continued for a number of years and they cost me a great deal of effort. Many of my colleagues saw in this something bordering on a tragedy. But I feel differently about it, for the thorough enlightenment I thus received was all the more valuable. I now knew for a fact that the elementary quantum of action played a far more significant part in physics than I had originally been inclined to suspect, and this recogni-

tion made me see clearly the need for the introduction of totally new methods of analysis and reasoning in the treatment of atomic problems.

*Scientific Autobiography and Other Papers*

A Scientific Autobiography (pp. 44–45)

Philosophical Library. New York, New York, USA. 1949

**Polkinghorne, John** 1930–

British physicist, Episcopal priest, and writer

Quantum theory is both stupendously successful as an account of the small-scale structure of the world and it is also the subject of unresolved debate and dispute about its interpretation. That sounds rather like being shown an impressively beautiful palace and being told that no one is quite sure whether its foundations rest on bedrock or shifting sand.

*The Quantum World*

Chapter 1 (p. 1)

Princeton University Press. Princeton, New Jersey, USA. 1984

**Robinson, Arthur L.**

No biographical data available

In short, quantum mechanics, special relativity, and realism cannot all be true.

Quantum Mechanics Passes Another Test

*Science*, Volume 217, Number 4558, July 30, 1982 (p. 435)

**Rothman, Tony** 1953–

American cosmologist

Quantum mechanics — the theory that explains phenomena on the size of atoms — is right. It is also so conceptually weird that physicists to this day feel uncomfortable with it.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 7 (p. 159)

Ballentine Books. New York, New York, USA. 1995

**Sagan, Carl** 1934–96

American astronomer and author

How can light simultaneously be a wave and a particle? It might be better to think of it as something else, neither a wave nor a particle, something with no ready counterpart in the everyday world of the palpable, that under some circumstances partakes of the properties of a wave, and, under others, of a particle. This wave-particle dualism is another reminder of a central humbling fact: Nature does not always conform to our predispositions and preferences, to what we deem comfortable and easy to understand.

*Billions & Billions: Thoughts on Life and Death at the Brink of the Millennium*

Chapter 4 (p. 37)

Random House, Inc. New York, New York, USA. 1997

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

I don't like it, and I'm sorry I ever had anything to do with it.

In John Gribbin

*In Search of Schrödinger's Cat: Quantum Physics and Reality* (p. v)

Bantam Books. New York, New York, USA. 1984

If all this damned quantum jumping were really here to stay, I should be sorry I ever got involved with quantum theory.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 75)

Harper & Row, Publishers. New York, New York, USA. 1971

**Stapledon, Olaf** 1886–1950

English author

...whenever a creature was faced with several possible courses of action, it took them all, thereby creating many distinct temporal dimensions and distinct histories of the cosmos. Since in every evolutionary sequence of the cosmos there were very many creatures, and each was constantly faced with many possible courses, and the combinations of all their courses were innumerable, an infinity of distinct universes exfoliated from every moment of every temporal sequence in this cosmos.

*Last and First Man and Star Maker*

Chapter XV, 2 (p. 426)

Dover Publications, Inc. New York, New York, USA. 1968

**Stenger, Victor J.** 1935–

American physicist

This type of schizophrenic behavior is not confined to photons alone. Electrons, neutrons, and other entities that normally appear as localized particles also can't seem to decide whether they are waves or particles. It all depends on what you try to measure. If you look for localized electrons, neutrons, or photons, you find them. If, on the other hand, you set up an experiment designed to measure wave properties, you find these too. We look at the world through colored glasses, and so it should not surprise us that the world appears a different color when we change to another pair.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 10 (p. 215)

Prometheus Books. Buffalo, New York, USA. 1990

**Trefil, James** 1938–

American physicist

But...we recognize that the wave-particle duality does not arise because of anything paradoxical about the behavior of elementary particles, but simply from the fact that we have asked the wrong question. If we had asked "How does an elementary particle behave?" instead of asking "Does it behave like a particle or a wave?", we would have been able to give a perfectly sensible answer. An elementary particle is not a particle in the sense that

a bullet is, and it is not a wave like the surf. It exhibits some properties that we normally associate with each of these kinds of things, but it is an entirely new kind of phenomenon.

*From Atoms to Quarks: An Introduction to the Strange World of Particle Physics* (Revised edition), 1994  
Charles Scribner's Sons. New York, New York, USA. 1980

### **Wheeler, John Archibald** 1911–

American theoretical physicist and educator

There may be no such thing as the “glittering central mechanism of the universe” to be seen behind a glass wall at the end of the trail. Not machinery but magic may be the better description of the treasure that is waiting.

In Nick Herbert

*Quantum Reality: Beyond the New Physics*

Chapter 2 (p. 29)

Anchor Press. Garden City, New York, USA. 1985

Nothing is more important about quantum physics than this: it has destroyed the concept of the world as “sitting out there.” The universe afterwards will never be the same.

Quoted by Jefferson Hane Weaver

*The World of Physics* (Volume 2)

N.10 (p. 427)

Simon & Schuster. New York, New York, USA. 1987

So the quantum, fiery creative force of modern physics, has burst forth in eruption after eruption and for all we know the next may be the greatest of all.

In Franco Selleri

*Quantum Mechanics Versus Local Realism: The Einstein–Podolsky–Rosen Paradox*

Chapter 1, Section 3 (p. 47)

Plenum Press. New York, New York, USA. 1988

...if one really understood the central point and its necessity in the construction of the world, one ought to be able to state it in one clear, simple sentence. Until we see the quantum principle with this simplicity we can well believe that we do not know the first thing about the universe, about ourselves, and about our place in the universe.

In Francesco de Finis (ed.)

*Relativity, Quanta and Cosmology in the Development of the Scientific Thought of Albert Einstein* (Volume 2)

The Quantum and the Universe

### **Yang, Chen Ning** 1922–

Chinese-born American theoretical physicist

To those of us who were educated after light and reason had struck in the final formulation of quantum mechanics, the subtle problems and the adventurous atmosphere of these pre-quantum mechanics days, at once full of promise and despair, seem to take on an almost eerie quality. We could only wonder what it was like when to reach correct conclusions through reasonings that were manifestly inconsistent constituted the art of the profession.

*Elementary Particles: A Short History of Some Discoveries in Atomic Physics*

Chapter 1 (p. 9)

Princeton University Press. Princeton, New Jersey, USA. 1962

### **von Baeyer, Hans Christian** 1938–

German-born physicist and author

That, in a nutshell, is the mystery of the quantum: When an electron is observed, it is a particle, but between observations its map of potentiality spreads out like a wave. Compared to the electron, even a platypus is banal.

*Taming the Atom*

Chapter 3 (p. 51)

Random House, Inc. New York, New York, USA. 1992

### **Wolf, Fred Alan** 1934–

American theoretical physicist, writer, and lecturer

The quantum is that embarrassing little piece of thread that always hangs from the sweater of space-time. Pull it and the whole thing unravels.

*Star Wave: Mind Consciousness of Quantum Physics*

The Macmillan Company. New York, New York, USA. 1984

### **Zee, Anthony**

American physicist

Welcome to the strange world of the quantum, where one cannot determine how a particle gets from here to there. Physicists are reduced to bookies, posting odds on the various possibilities.

*Fearful Symmetry*

Chapter 10 (p. 141)

Macmillan Publishing Company. New York, New York, USA. 1986

## **QUARK**

### **Author undetermined**

O! O! you eight colourful guys

You won't let quarks materialize

You're tricky, but now we realize

You hold together our nucleus.

In Frank Wilczek and Betsy Devine

*Longing for the Harmonies*

Chapter 18 (p. 200)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Even if quarks should be found (and I do not believe that they will be), they will not be more elementary than other particles, since a quark could be considered as consisting of two quarks and one anti-quark, and so on. I think we have learned from experiments that by getting to smaller and smaller units, we do not come to fundamental units, or indivisible units, but we do come to a point where division has no meaning. This is a result of the experiments

of the last twenty years, and I am afraid that some physicists simply ignore this experimental fact.

In Paul Buckley and F. David Peat

*Glimpsing Reality: Ideas in Physics and the Link to Biology*

Werner Heisenberg (p. 15)

University of Toronto Press. Toronto, Ontario, Canada. 1996

**Joyce, James** 1882–1941

Irish-born author

Three quarks for Muster Mark!

Sure he hasn't got much of a bark

And sure any he has it's all beside the mark.

*Finnegans Wake*

Book II (p. 383)

The Viking Press. New York, New York, USA. 1939

**Melnechuk, Theodore**

Neuroscientist

Poor Gell-Man seeks

But fails to find

The fractioned freaks

He bore in mind.

And yet a Quark,

Yea, better, three,

Exist in stark

Reality.

The Hunting of the Quark

*The Physics Teacher*, Volume 7, Number 7, October 1969 (p. 415)

**Stenger, Victor J.** 1935–

American physicist

Today's quarks and leptons can be viewed as metaphors of the underlying reality of nature, though metaphors that are objectively and rationally defined and are components of theories that have great predictive power. And that's the difference between the metaphors of science and those of myth: scientific metaphors work.... In the pragmatic view of truth of William James, science is true because it works. Science may not be the only path to the truth, but it is the best one we have yet been able to discover.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 4 (p. 79)

Prometheus Books. Buffalo, New York, USA. 1990

**Taylor, Richard E.** 1929–

Canadian-born American physicist

The quarks and the stars were here when you came, and they will be here when you go. They have no sense of humor so, if you want a world where more people smile, you will have to fix things yourselves.

*Les Prix Nobel. The Nobel Prizes in 1990*

Nobel banquet speech for award received in 1990

Nobel Foundation. Stockholm, Sweden. 1991

## QUASAR

**Mundell, Carole**

English astronomer

...observing quasars is like observing the exhaust fumes of a car from a great distance and then trying to figure out what is going on under the hood.

A New Look at Quasars

*Scientific American*, Volume 278, Number 6, June 1998 (p. 57)

## QUATERNION

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

...Frenchmen, Germans, and Italians, urging their respective substitutes for quaternions, added to the din. By the second decade of the twentieth century there was a babble of conflicting vector algebras, each fluently spoken only by its inventor and his few chosen disciples. If, at any time in the brawling half-century after 1862, the bickering sects had stopped quarreling for half an hour to listen attentively to what Grassmann was doing his philosophical best to tell them, the noisy battle would have ended as abruptly as a thunderclap. Such, at any rate, seems to have been the opinion of Gibbs. In retrospect, the fifty-year war between quaternions and its rivals for scientific favor, appears as an interminable sequence of duels fought with stuffed clubs in a vacuum over nothing.

*The Development of Mathematics* (p. 208)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

## QUESTION

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

"I checked it very thoroughly," said the computer, "and that quite definitely is the answer. I think the problem, to be quite honest with you, is that you've never actually known what the question is."

*The Ultimate Hitchhiker's Guide to the Galaxy*

The Hitchhiker's Guide to the Galaxy

Chapter 28 (p. 121)

The Ballantine Book Company. New York, New York, USA. 2002

**Alvarez, Luis Walter** 1911–88

American experimental physicist

Much of the work we do as scientists involves filling in the details about matters that are basically understood already, or applying standard techniques to new specific cases. But occasionally there is a question that offers an opportunity for a really major discovery.

*T. Rex and the Crater of Doom*

Chapter 2 (p. 42)

Princeton University Press. Princeton, New Jersey, USA. 1997

**Beecher, Henry Ward** 1813–87

American Congregational preacher and orator

Never ask a question if you can help it; and never let a thing go unknown for the lack of asking a question if you can't help it.

In James Orton

*Comparative Zoology, Structural and Systematic*

Preceding Chapter XXI (p. 222)

Harper & Brothers. New York, New York, USA. 1877

### **Bloor, David**

English sociologist and philosopher of science

To ask questions of the sort which philosophers address to themselves is usually to paralyze the mind...

*Knowledge and Social Imagery*

Chapter Three (p. 52)

The University of Chicago Press. Chicago, Illinois, USA. 1991

### **Bohm, David** 1917–92

American physicist

...it is frequently realised that half the battle is over when we know what are the right questions to ask.

On the Relationship Between Methodology in Scientific Research and the Content of Scientific

*British Journal for the Philosophy of Science*, Volume 12, Number 46, 12, August 1961 (p. 105)

### **Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

If a general intends to conquer a hostile city, he will not consult his map for the shortest road leading there; rather he will be found to make the most various detours, and every hamlet, even if quite off the path, will become a valuable point of leverage for him, if only he can take it; impregnable places will be isolated. Likewise, the scientist asks not what are the currently most important questions, but, "Which are at present solvable?", or sometimes simply, "In which can we make some small but genuine advance?"

In Brian McGuinness (ed.)

*Theoretical Physics and Philosophical Problems. Selected Writings*

The Second Law of Thermodynamics (p. 13–14)

Reidel Publishing Company. Boston, Massachusetts, USA. 1974

...but all the more splendid is the success when, groping in the thicket of special questions, we suddenly find a small opening that allows a hitherto undreamt of outlook on the whole.

In Brian McGuinness (ed.)

*Theoretical Physics and Philosophical Problems. Selected Writings*

The Second Law of Thermodynamics (p. 14)

Reidel Publishing Company. Boston, Massachusetts, USA. 1974

### **Bombieri, Enrico** 1940–

Italian mathematician

When things get too complicated, it sometimes makes sense to stop and wonder: Have I asked the right question?

Prime Territory: Exploring the Infinite Landscape at the Base of the Number System

*The Sciences*, Volume 32, Number 5, 1992

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

Science is wonderfully equipped to answer the question "How?" But it gets terribly confused when you ask it the question "Why?"

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 1 (p. 8)

The Seabury Press. New York, New York, USA. 1977

### **Colby, Frank Moore** 1865–1925

American educator and writer

Every man ought to be inquisitive through every hour of his great adventure down to the day when he shall no longer cast a shadow in the sun. For if he dies without a question in his heart, what excuse is there for his continuance?

In Hans Selye

*From Dream to Discovery: On Being a Scientist*

Why Should You Do Research (p. 10)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

### **Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

There may be some deep questions about the cosmos that are forever beyond science. The mistake is to think that they are therefore not beyond religion too.

*A Devil's Chaplain: Reflections on Hope, Lies, Science, and Love* (p. 149)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2003

### **Feynman, Richard P.** 1918–88

American theoretical physicist

There are all kinds of interesting questions that come from a knowledge of science, which only adds to the excitement and mystery and awe of a flower. It only adds. I don't understand how it subtracts.

*What Do You Care What Other People Think?*

Further Adventures of a Curious Character, The Making of a Scientist (p. 11)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

So right away I found out something about biology: it was very easy to find a question that was very interesting, and that nobody knew the answer to. In physics you had to go a little deeper before you could find an interesting question that people didn't know.

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character* A Map of a Cat? (p. 71)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

### **Fischer, D. H.**

No biographical data available

Questions are the engines of intellect, the cerebral machines which convert energy to motion, and curiosity to controlled inquiry.

*Historian's Fallacies: Toward a Logic of Historical Thought*  
Chapter I (p. 3)  
Harper & Row, Publishers. New York, New York, USA. 1970

**Gore, George** 1826–1909  
English electrochemist

The area of scientific discovery enlarges rapidly as we advance; every scientific truth now known yields many questions yet to be answered. To some of these questions it is possible to obtain answers at the present time, others may only be decided when other parts of science are more developed.

*The Art of Scientific Discovery*  
Part I, Chapter III (p. 27)  
Longmans, Green & Company. London, England. 1878

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Questions are not neutral; they presuppose a list of assumptions that may be long and complex.

*Dinosaur in a Haystack: Reflections in Natural History*  
Part Three, Chapter 11 (p. 136)  
Random House, Inc. New York, New York, USA. 1995

Supporters assume that the greatness and importance of a work correlates directly with its stated breadth of achievement: minor papers solve local issues, while great works claim to fathom the general and universal nature of things. But all practicing scientists know in their bones that successful studies require strict limitations. One must specify a particular problem with an accessible solution, and then find a sufficiently simple situation where attainable facts might point to a clear conclusion. Potential greatness then arises from cascading implications toward testable generalities. You don't reach the generality by direct assault without proper tools. One might as well dream about climbing Mount Everest wearing a T-shirt and tennis shoes and carrying a backpack containing only an apple and a bottle of water.

Writing in the Margins  
*Natural History*, Volume 7, Number 9, 1998 (p. 19)

**Greene, Brian** 1963–  
American physicist

Sometimes attaining the deepest familiarity with a question is our best substitute for actually having the answer.

*The Elegant Universe*  
Chapter 14 (p. 365)  
W.W. Norton & Company, Inc. New York, New York, USA. 2003

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

We ask, "What does a proton consist of? Can an electron be divided or is it indivisible? Is a photon simple or compound?" But all these questions are wrongly put, because words such as "divide" or "consists of" have to a large extent lost their meaning. It must be our task to adapt our thinking and speaking — indeed our scientific philosophy — to the new situation created by the experimental evidence. Unfortunately this is very difficult. Wrong questions and wrong pictures creep automatically into particle physics and lead to developments that do not fit the real situation in nature.

The Nature of Elementary Particles  
*Physics Today*, Volume 29, Number 3, March 1976 (p. 37)

Our scientific work in physics consists in asking questions about nature in the language that we possess and trying to get an answer from experiment by the means that are at our disposal. In this way quantum theory reminds us, as Bohr has put it, of the old wisdom that when searching for harmony in life one must never forget that in the drama of existence we are ourselves both players and spectators. It is understandable that in our scientific relation to nature our own activity becomes very important when we have to deal with parts of nature into which we can penetrate only by using the most elaborate tools.

*Physics and Philosophy: The Revolution in Modern Science*  
Chapter III (p. 58)  
Harper & Row, Publishers. New York, New York, USA. 1958

**Hoffer, Eric** 1902–83  
American longshoreman and philosopher

To spell out the obvious is often to call it in question.

*The Passionate State of Mind, and Other Aphorisms*  
No. 220  
Harper & Brothers. New York, New York, USA. 1955

**Horrobin, David F.** 1939–2003  
Medical researcher

One needs to be neither particularly observant nor particularly arrogant to realise that the majority of the human race is capable of understanding the nature of the universe in only the simplest and crudest terms. The truth about the universe is clearly beyond the comprehension of most men. Most human brains are incapable of framing appropriate questions, let alone of providing adequate answers.

*Science Is God*  
Chapter 2 (p. 16)  
Medical and Technical Publishing Company Ltd. Aylesbury, England. 1969

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

...in science answers are not important, it is the questions that are important.

In Philip Morrison

*Nothing Is Too Wonderful to Be True*

Less May Be More (p. 219)

The American Institute of Physics. Woodbury, New York, USA. 1995

**Huxley, Elspeth** 1907–97

English writer

The best way to find things out... is not to ask questions at all. If you fire off a question, it is like firing of a gun; bang it goes, and everything takes flight and runs for shelter. But if you sit quite still and pretend not to be looking, all the little facts will come and peck round your feet, situations will venture forth from thickets, and intentions will creep out and sun themselves on a stone; and if you are very patient you will see and understand a great deal more than a man with a gun.

*The Flame Trees of Thika*

Chapter Twenty-Eight (p. 272)

William Morrow & Company. New York, New York, USA. 1959

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Questions of personal priority... however interesting they may be to the persons concerned, sink into insignificance in the prospect of any gain of deeper insight into the secrets of nature.

In Silvanus P. Thompson

*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*

The Kelvin Lecture: The Life and Work of Lord Kelvin (p. 752)

Government Printing Office. Washington, D.C. 1909

**Kundera, Milan** 1929–

Czech-born writer

...the only truly serious questions are the ones that even a child can formulate. Only the most naive of questions are truly serious. They are questions with no answers. A question with no answer is a barrier that cannot be breached. In other words, it is questions with no answers that set the limits of human possibilities, describe the boundaries of human existence.

Translated by Michael Henry Heim

*The Unbearable Lightness of Being*

Part Four, Section 6 (p. 139)

Harper & Row, Publishers. New York, New York, USA. 1984

**Landau, Lev** 1908–68

Russian physicist

Physicists have learned that certain questions cannot be asked, not because the level of our knowledge does not yet permit us to find the answer, but because such an answer simply isn't stored in nature.

In Alexandre Dorozynski

*The Man They Wouldn't Let Die*

Chapter 7 (p. 108)

Secker & Warburg. London, England. 1966

**Leggett, A. J.**

No biographical data available

In those exciting but frustrating fields of knowledge, or perhaps one should say ignorance, where physics tangles with philosophy, the difficulties usually lie less in finding answers to well-posed questions than in formulating the fruitful questions in the first place.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*

The "Arrow of Time" and Quantum Mechanics (p. 102)

Pergamon Press. Oxford, England. 1977

**Little, T. M.**

No biographical data available

The purpose of an experiment is to answer questions. The truth of this seems so obvious, that it would not be worth emphasizing were it not for the fact that the results of many experiments are interpreted and presented with little or no reference to the questions that were asked in the first place.

Interpretation and Presentation of Results

*Hortscience*, Volume 16, 1981 (pp. 637–640)

**MacRobert, Alan**

Editor

Valid physical questions face us for which our physics is utterly inadequate. This can only be a sign that we stand at a great frontier of science, one that will form a cutting edge of inquiry for generations to come, with results we cannot guess.

Beyond the Big Bang

*Sky & Telescope*, Volumes 65–66, March 1983 (p. 213)

**Maxwell, James Clerk** 1831–79

Scottish physicist

There are some questions in Astronomy, to which we are attracted rather on account of their peculiarity, as the possible illustration of some unknown principle, than from any direct advantage which their solution would afford to mankind.

*On the Stability of the Motion of Saturn's Rings*

Macmillan & Company Ltd. London, England. 1859

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

I do not believe that there is any intrinsic limitation upon our ability to answer the questions that belong to the domain of natural knowledge and fall therefore within the agenda of scientific enquiry.

*The Strange Case of the Spotted Mice and Other Classic Essays on Science*

On "The Effecting of All Things Possible"

Oxford University Press, Inc. New York, New York, USA. 1996

**Midgley, Mary** 1919–

English moral philosopher



The astonishing successes of western science have not been gained by answering every kind of question, but precisely by refusing to. Science has deliberately set narrow limits to the kinds of questions that belong to it, and further limits to the questions peculiar to each branch. It has practiced an austere modesty, a rejection of claims to universal authority.

Can Science Save Its Soul?  
*New Scientist*, 1 August 1992 (p. 25)

**Morris, Desmond** 1928–  
Zoologist and ethnologist

We never stop investigating. We are never satisfied that we know enough to get by. Every question we answer leads on to another question. This has become the greatest survival trick of our species.

*The Naked Ape*  
Chapter Four (p. 130)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1967

**Payne-Gaposchkin, Celia** 1900–79  
British-American astronomer

Whenever we look in nature we can see spiral forms in the uncurling fern, the snail, the nautilus shell, the hurricane, the stirred cup of coffee, the water that swirls out of a wash bowl. Perhaps we shouldn't be surprised to see spirals in the great star systems whirling in space. Yet they remain a great, intriguing question.

Why Do Galaxies Have a Spiral Form?  
*Scientific American*, Volume 189, Number 3, September 1953 (p. 89)

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

Who would have said, a few years ago, that we could ever know of what substances stars are made of whose light may have been longer in reaching us than the human race existed? Who can be sure of what we shall now know in a few hundred years? Who can guess what would be the result of continuing the pursuit of science for ten thousand years, with the activity of the last hundred? And if it were to go on for a million, or a billion, or any number of years you please, how is it possible to say that there is any question which might not ultimately be solved.

*Values in a Universe of Chance*  
How to Make Ideas Clear (p. 134)  
Stanford University Press. Stanford, California, USA. 1958

...all the followers of science are fully persuaded that the processes of investigation, if only pushed far enough, will give one certain solution to each question to which they can be applied.... This great law is embodied in the conception of truth and reality. The opinion which is fated to be ultimately agreed to by all who investigate is what we mean by the truth, and the object represented in this opinion is the real.

In H.S. Thayer (ed.)

*Pragmatism: The Classic Writings*  
How to Make Ideas Clear (p. 97)  
New American Library. New York, New York, USA. 1970

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

...a young scientist who hopes to make discoveries is badly advised if his teacher tells him, "Go round and observe," and he is well advised if his teacher tells him: "Try to learn what people are discussing nowadays in science. Find out where difficulties arise, and take an interest in disagreements. These are the questions which you should take up."

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 4 (p. 129)  
Harper & Row, Publishers. New York, New York, USA. 1963

**Ramsay, Sir William** 1852–1916  
English chemist

Whosoever asks shall receive, but he must ask sensible questions in definite order, so that the answer to the first suggests a second, and the reply to the second suggests a third, and so on.

*Essays Biographical and Chemical*  
Chemical Essays  
How Discoveries Are Made (p. 128)  
Archibald Constable & Company Ltd. London, England. 1908

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Clearly our first problem must be to define the issue, since nothing is more prolific of fruitless controversy than an ambiguous question.

Determinism and Physics  
*Proceeding of the University of Durham Philosophical Society*, 1936

**Sagan, Carl** 1934–96  
American astronomer and author

There are no forbidden questions in science, no matters too sensitive or delicate to be probed, no sacred truths.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 2 (p. 31)  
Random House, Inc. New York, New York, USA. 1995

**Seignobos, Charles** 1854–1942  
French historian

It is useful to ask oneself questions, *but very dangerous to answer them.*

In Marc Bloch  
*The Historian's Craft*  
Introduction (p. 14)  
Manchester University Press. Manchester, England. 2004

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

No question is so difficult to answer as that to which the answer is obvious.

*Saturday Review*, January 26, 1895

**Silver, Brian L.**

Israeli professor of physical chemistry

The Big Questions may be beyond the capabilities of the human computer, just as dogs will never understand jokes. We understand a very great deal about what forces do but are far from finalizing the discussion about what forces are. Maybe we never will. Newton very specifically refused to commit himself as to what gravitational force was, but he nevertheless accounted for the movements of Earth and Moon and deduced the masses of the Earth and the Sun by knowing only what gravity does. We have discovered forces that Newton never knew, but basically we still only define force by what it does.

*The Ascent of Science*

Part II, Chapter 3 (p. 30)

Solomon Press Book. New York, New York, USA. 1998

**Steinbeck, John** 1902–68

American novelist

The literature of science is filled with answers found when the question propounded had an entirely different direction and end.

*Sea of Cortez*

Chapter 17 (pp. 179–180)

Paul P. Appel, Publisher. Mount Vernon, New York, USA. 1982

**Stewart, Ian** 1945–

English mathematician and science writer

**Cohen, Jack**

Reproductive biologist

The history of science, broadly speaking, is the tale of a lengthy battle to dig out the secret simplicities of a complicated world. It is an astonishing story of insignificant humanity's triumph over huge mysteries.

*The Collapse of Chaos: Discovering Simplicity in a Complex World*

Chapter 1 (p. 28)

Viking Press. New York, New York, USA. 1994

**Trefil, James** 1938–

American physicist

Great questions in science — questions like the ones Herschel raised about the structure of the universe — are seldom answered by ivory-tower types engaging in pure thought. They are answered by people who are willing to get down into the trenches and grapple with nature. If that means casting your own telescope mirrors, as Herschel did, so be it.

*Reading the Mind of God: In Search of the Principle of Universality*

Charles Scribner's Sons. New York, New York, USA. 1989

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

If only people would finally stop finding points of disagreement in the personal characteristics and external

circumstances of investigators! It does not matter at all whether someone is a professor of clinical medicine or of theoretical pathology, whether he is a practitioner or a hospital physician, if only he possesses material for observation. In addition, it is not of decisive significance whether he confronts an overwhelming or a modest amount of material, if only he understands how to exploit it. And to do this he must know what he wants: in other words, he must be in a position to put the right questions and to find the right methods for answering them.

Translated by Lelland J. Rather

*Disease, Life, and Man*

Cellular Pathology (p. 77)

Stanford University Press. Stanford, California, USA. 1958

**Walker, Kenneth** 1882–1966

Physician

We must accept the fact that the scientist can answer only a few of the questions we ask him and never the question of “why?.”

*Meaning and Purpose*

Chapter VIII (p. 80)

Jonathan Cape. London, England. 1944

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

It was absolutely marvelous working for Pauli. You could ask him anything. There was no worry that he would think a particular question was stupid, since he thought all questions were stupid.

Working for Pauli

*American Journal of Physics*, Volume 45, Number 5, May 1977 (p. 422)

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Questions are never indiscreet. Answers sometimes are.

*The Plays of Oscar Wilde*

An Ideal Husband

Act I (p. 10)

The Modern Library. New York, New York, USA. No date

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

As long as I continue to come across questions in more remote regions which I can't answer, it is understandable that I should still not be able to find my way around regions that are less remote. For how do I know that what stands in the way of an answer here is not precisely what is preventing me from clearing away the fog over there?

Translated by Peter Winch

*Culture and Value* (p. 66e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

I may find scientific questions interesting, but they never really grip me. Only conceptual and aesthetic questions

do that. At bottom I am indifferent to the solution of scientific problems; but not the other sort.

Translated by Peter Winch

*Culture and Value* (p. 79e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Zinkernagel, Rolf M.** 1944–

Swiss immunologist and pathologist

To ask questions, to search for answers, to do research — I mean re-search in nature what is already there, but has not been revealed, so far is the most fascinating and the most exciting thing we can dream of doing and what we would like to continue doing.

*Les Prix Nobel. The Nobel Prizes in 1996*

Nobel banquet speech for award received in 1996

Nobel Foundation. Stockholm, Sweden. 1997

## QUESTIONNAIRE

**Hauge, Bernt K.**

No biographical data available

[One] feature of questionnaires is that they give [an] excellent opportunity to gather useless information in such a way that it can be handled by data machines, a handling that can give a mysterious authority of exactness to the most incredible nonsense.

Etcetera

*The Physics Teacher*, Volume 15, Number 9, December 1977 (p. 575)

## QUOTATION

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

History is replete with anecdotes and *bons mots* relating to statesmen, soldiers, artists, philosophers, and most other types of notables; but even a well-informed man finds it difficult to enliven talk with quotations from scientists.

*The Dreams of Reason*

Chapter 3 (p. 40)

Columbia University Press. New York, New York, USA. 1961

## R

### RACISM

**Huntington, Ellsworth** 1876–1947  
American geographer

The climate of many countries seems to be one of the great reasons why idleness, dishonesty, immorality, stupidity, and weakness of will prevail. If we can conquer climate, the whole world will become stronger and nobler.

*Civilization and Climate* (p. 294)  
University Press of the Pacific. Honolulu, Hawaii, USA. 2001

**Lewin, Roger Amos**  
Anthropologist

Racism, as we would characterize it today, was explicit in the writings of virtually all the major anthropologists of the first decades of this century, simply because it was the generally accepted world view. The language of the epic tale so often employed by Arthur Keith, Grafton Elliot Smith, Henry Fairfield Osborn, and their contemporaries fitted perfectly an imperialistic view of the world, in which Caucasians were the most revered product of a grand evolutionary march to nobility.

*Bones of Contention*  
Chapter 13, Man's Place in Nature (p. 307)  
Simon & Schuster Inc. New York, New York, USA. 1987

**Mandela, Nelson** 1918–  
First president of South Africa

The doctors and nurses treated me in a natural way as though they had been dealing with blacks on a basis of equality all their lives. It reaffirmed my long-held belief that education was the enemy of prejudice. These were men and women of science, and science had no room for racism.

*The Long Walk to Freedom: The Autobiography of Nelson Mandela*  
(p. 492)  
Little, Brown, Boston & Company. Boston, Massachusetts, USA. 1994

### RADIATION

**Bryson, Bill** 1951–  
American-born travel author

Incidentally, disturbance from cosmic background radiation is something we have all experienced. Tune your television to any channel it doesn't receive, and about 1 percent of the dancing static you see is accounted for by this ancient remnant of the Big Bang. The next time you complain that there is nothing on, remember that you can always watch the birth of the universe.

*A Short History of Nearly Everything*  
Chapter 1 (p. 12)  
Broadway Books. New York, New York, USA. 2003

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

It has been widely supposed that the ultimate fate of protons and electrons is to annihilate one another, and release the energy of their constitution in the form of radiation. If so it would seem that the universe will finally become a ball of radiation, becoming more and more rarefied and passing into longer and longer wave-lengths. The longest waves of radiation are Hertzian waves of the kind used in broadcasting. About every 1500 million years this ball of radio waves will double its diameter; and it will go on expanding in geometrical progression for ever. Perhaps then I may describe the end of the physical world as — one stupendous broadcast.

*New Pathways in Science*  
Chapter III, Section VI (p. 71)  
The Macmillan Company. New York, New York, USA. 1935

**Gamow, George** 1904–68  
Russian-born American physicist

Radiation is like butter, which can be bought or returned to the grocery store only in quarter-pound packages, although the butter as such can exist in any desired amount (not less, though, than one molecule!).

*Thirty Years That Shook Physics*  
Chapter 1 (pp. 22–23)  
Doubleday & Company, Inc. Garden City, New York, USA. 1966

**Planck, Max** 1858–1947  
German physicist

Either the quantum of action was a fictional quantity, then the whole deduction of the radiation law was in the main illusionary and represented nothing more than an empty nonsignificant play on formulae, or the derivation of the radiation law was based on sound physical conception.

In Jefferson Hane Weaver  
*The World of Physics* (Volume 2)  
N.1 (p. 284)  
Simon & Schuster. New York, New York, USA. 1987

### RADICAL

**von Liebig, Justus** 1803–73  
German organic chemist

**Dumas, Jean Baptiste-Andre** 1800–84  
French biochemist

...in inorganic chemistry the radicals are simple; in organic chemistry they are compounds — that is the sole difference.

In William H. Brock

*Justus von Liebig*

Chapter 3 (p. 81)

Cambridge University Press, Cambridge, England. 1997

**Mark, Herman F.** 1898–1992

Polymer chemist

The concept of “free radicals” was not known in 1920 — well perhaps in politics, but not in chemistry.

*From Small Organic Molecules to Large: A Century of Progress*

Chemistry Study in Vienna (p. 15)

American Chemical Society, Washington, D.C. 1993

## RADIO ASTRONOMY

**Christiansen, Chris**

No biographical data available

Radio astronomy was not born with a silver spoon in its mouth. Its parents were workers. One parent was the radio-telescope, the other was radar.

*Daily Telegraph (Sydney)*, August 25, 1952

### Commentary

It has been demonstrated that a receiving set of great delicacy in New Jersey will get a new kind of static from the Milky Way. This is believed to be the longest distance anybody ever went to look for trouble.

*The New Yorker Magazine*, 17 June 1933

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

It is a striking thought that ten years of radio astronomy have taught humanity more about the creation and organization of the universe than thousands of years of religion and philosophy.

*Space and Time in the Modern Universe* (p. 211)

Cambridge University Press, Cambridge, England. 1977

**Gingerich, Owen** 1930–

American astronomer

But even if radio astronomy has not so much destroyed our older astronomical viewpoint, it has enormously enlarged and enriched it. It is like that magical moment in the old Cinerama, when the curtains suddenly opened still further, unveiling the grandeur of the wide screen. Optical astronomy in the 1950s, on that narrow, central screen, offered a quiescent view of a slowly burning universe, the visible radiations from thermal disorder. But then the curtains abruptly parted, adding a grand and breathtaking vista, a panorama of swift and orderly motions that revealed themselves through the synchrotron radiation they generated — the so-called violent universe.

In W.T. Sullivan III

*The Early Years of Radio Astronomy: Reflections Fifty Years After Jansky's Discovery*

Radio Astronomy and the Nature of Science (p. 404)

Cambridge University Press, Cambridge, England. 1984

**Kraus, John** 1910–2004

Radio astronomer

The radio sky is no carbon copy of the visible sky; it is a new and different firmament, one where the edge of the universe stands in full view and one which bears the tell-tale marks of a violent past.

*Big Ear*

Chapter 21 (p. 166)

Cygnus-Quasar Books, Powell, Ohio, USA. 1976

**Mitton, Simon**

No biographical data available

During the last 20 years radio astronomers have led a revolution in our knowledge of the Universe that is paralleled only by the historic contributions of Galileo and Copernicus. In particular, the poetic picture of a serene Cosmos populated by beautiful wheeling galaxies has been replaced by a catalogue of events of astonishing violence: a primeval fireball, black holes, neutron stars, variable quasars and exploding galaxies.

Newest Probe of the Radio Universe

*New Scientist*, Volume 56, Number 816, 19 October 1972 (p. 138)

**Unsold, Albrecht** 1905–95

Astrophysicist

The old dream of wireless communication through space has now been realized in an entirely different manner than many had expected. The cosmos' short waves bring us neither the stock market nor jazz from distant worlds. With soft noises they rather tell the physicist of the endless love play between electrons and protons.

In W.T. Sullivan, III

*Classics in Radio Astronomy*

Preface (p. xiii)

R. Reidel Publishing Company, Dordrecht, Netherlands. 1982

## RAIN FOREST

**Fuertes, Louis Agassiz** 1874–1920

American ornithologist

The principal sensation one gets in the tropical forests is the mystery of the unknown voices. Many of these remain forever mysteries unless one stays long and seeks diligently.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1915*

Impressions of the Voices of Tropical Birds (p. 313)

Government Printing Office, Washington, D.C. 1916

## RAINBOW

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

We have not the reverent feeling for the rainbow that the savage has, because we know how it is made. We have lost as much as we gained by prying into that matter.

*A Tramp Abroad*

Chapter XLIII (p. 318)

Penguin Books. New York, New York, USA. 1997

One can enjoy a rainbow without necessarily forgetting the forces that made it.

*Europe and Elsewhere*

Queen Victoria's Jubilee (p. 210)

Harper & Brothers. New York, New York, USA. 1923

## RAMIFICATION

**Sylvester, James Joseph** 1814–97

English mathematician

The theory of ramification is one of pure colligation, for it takes no account of magnitude or position; geometrical lines are used, but these have no more real bearing on the matter than those employed in genealogical tables have in explaining the laws of procreation.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 3)

On Recent Discoveries in Mechanical Conversion of Motion (p. 23)

University Press. Cambridge, England. 1904–1912

## RANDOMNESS

**Cohen, John**

No biographical data available

...nothing is so alien to the human mind as the idea of randomness.

*Chance, Skill, and Luck*

Chapter 2, Part IV (p. 42)

Penguin Books. Baltimore, Maryland, USA. 1960

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The postulate of randomness thus resolves itself into the question, “of what population is this a random sample?” which must frequently be asked by every practical statistician.

On the Mathematical Foundation of Theoretical Statistics

*Philosophical Transactions of the Royal Society of London*, Volume

A222, 1922 (p. 313)

**James, William** 1842–1910

American philosopher and psychologist

If I should throw down a thousand beans at random upon a table, I could doubtless, by eliminating a sufficient number of them, leave the rest in almost any geometrical pattern you might propose to me, and you might then say that that pattern was the thing prefigured beforehand, and that the other beans were mere irrelevance and packing material. Our dealings with Nature are just like this.

*The Varieties of Religious Experience*

Lecture XVIII (p. 429)

The Modern Library. New York, New York, USA. 1967

**Leucippus** 5<sup>th</sup> century BCE

Greek philosopher of Atomism

Nothing occurs at random, but everything for a reason and by necessity.

In G.S. Kirk, J.E. Raven and M. Schofield (eds.)

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Aetius I.25.4 (p. 420)

At The University Press. Cambridge, England. 1963

**Peterson, Ivars**

Mathematics and physics writer

We are surrounded by jungles of randomness. With our mathematical and statistical machetes, we can hack out extensive networks of trails and clearings that provide for most of our day-to-day needs and make sense of some fraction of human experience. The vast jungle, however, remains close at hand, never to be taken for granted, never to reveal all its secrets — and always teasing the inquiring mind.

*The Jungle of Randomness: A Mathematical Safari*

Chapter 10 (p. 203)

John Wiley & Sons, Inc. New York, New York, USA. 1998

**Sophocles** 496 BCE–406 BCE

Greek playwright

IOCLASTA: Nay, what should mortal[s] fear, for whom the degree of fortune are supreme, and who hath clear foresight of nothing? ‘Tis best to live at random, as one may.

In *Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

Oedipus the King, I. 997

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

The usual answer to this question is that there was plenty of time to try everything. I could never accept this answer. Random shuttling of bricks will never build a castle or a Greek temple, however long the available time. A random process can build meaningful structures only if there is some kind of selection between meaningful and nonsense mutations.

*Molecular Evolution: Prebiological and Biological*

The Evolutionary Paradox and Biological Stability (p. 111)

Plenum Press. New York, New York, USA. 1972

## RANDOM DIGITS

**Dickens, Charles** 1812–70

English novelist

Anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin.

*Oliver Twist*

Chapter LI

P.F. Collier & Son, Company. New York, New York, USA. 1912

## RANDOM NUMBER

### Coveyou, R. R.

No biographical data available

The generation of random numbers is too important to be left to chance.

Random Number Generation Is Too Important to Be Left to Chance

*Studies in Applied Mathematics*, Volume 3, 1970

## RATIOCINATION

### Keyser, Cassius Jackson 1862–1947

American mathematician

When the greatest of American logicians, speaking of the powers that constitute the born geometrician, had named Conception, Imagination, and Generalization, he paused. Thereupon from one of the audience there came the challenge, “What of reason?” The instant response, not less just than brilliant, was: “Ratiocination — that is but the smooth pavement on which the chariot rolls.”

In Columbia University

*Lectures on Science, Philosophy and Art 1907–1908* (p. 31)

New York, New York, USA. 1908

## REACTION

### Baudrimont, A. E.

No biographical data available

A chemical reaction cannot take place without a movement of the atoms. Consequently a reaction...cannot and will never be able to indicate the arrangement of the atoms in a combination.... For a reaction, by establishing a molecular movement, destroys the preceding arrangements of the atoms. Therefore, being able to extract a compound substance from a combination does not mean that this compound already existed in this combination.

In S.C. Kapoor

The Origins of Laurent’s Organic Classification

*Isis*, Volume 60, 1960 (p. 493)

### Hoffmann, Roald 1937–

Polish-born American chemist

there was no question that the reaction but transient colors were seen in the slurry of sodium methoxide in dichloromethane and we got a whole lot of products for which we can’t sort out the kinetics the next slide will show

the most important part very rapidly within two minutes and I forgot to say on further warming we get in fact the keynote...

*The Metamict State*

Next Slide Please (p. 51)

University of Central Florida Press. Orlando, Florida, USA. 1987

### Lippmann, Walter 1889–1974

American journalist and author

The reaction of one chemical element to another chemical element is always correct, is never misled by misinformation, by untruth, and by illusion.

*Essays in the Public Philosophy*

Chapter VIII (p. 92)

Little, Brown & Company. Boston, Massachusetts, USA. 1955

## READING

### Bacon, Sir Francis 1561–1626

English lawyer, statesman, and essayist

Read not to contradict and confute, nor to believe and take for granted, nor to find talk and discourse, but to weigh and consider.

*Bacon’s Essays*

Of Studies (p. 210)

Donohue, Henneberry & Company. Chicago, Illinois, USA. 1883

### Fisher, Sir Ronald Aylmer 1890–1962

English statistician and geneticist

Fairly large print is a real antidote to stiff reading.

In J.H. Bennett (ed.)

*Natural Selection, Heredity, and Eugenics*

Letter to K. Sisam, 31 May 1929 (p. 20)

Clarendon Press. Oxford, England. 1983

### Huxley, Thomas Henry 1825–95

English biologist

I MUST adopt a fixed plan of studies, for unless this is done I find time slips away without knowing it — and let me remember this — that it is better to read a little and thoroughly, than cram a crude undigested mass into my head, though it be great in quantity.

*The Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter 1.1

Macmillan & Company Ltd. London, England. 1903

## REAL (BEING)

### Bianco, Margery Williams 1880–1944

Author

“What is REAL?” asked the Rabbit one day, when they were lying side by side near the nursery fender, before Nana came to tidy up the room. “Does it mean having

things that buzz inside you and a stick-out handle?"

*The Velveteen Rabbit: Or How Toys Become Real*  
Athenaeum Books for Young Readers. New York, New York, USA.  
2002

You become. It takes a long time. That's why it doesn't often happen to people who break easily, or have sharp edges, or who have to be carefully kept. Generally, by the time you are Real, most of your hair has been loved off, and your eyes drop out, and you get loose in the joints and very shabby. But these things don't matter at all, because once you are Real you can't be ugly, except to people who don't understand.

*The Velveteen Rabbit: Or How Toys Become Real*  
Athenaeum Books for Young Readers. New York, New York, USA.  
2002

**Einstein, Albert** 1879–1955

German-born physicist

The important point for us to observe is that all these constructions and the laws connecting them can be arrived at by the principle of looking for the mathematically simplest concepts and the link between them. In the limited number of mathematically existent simple field types, and the simple equations possible between them, lies the theorist's hope of grasping the real in all its depth.

*Ideas and Opinions*  
On the Methods of Theoretical Physics (p. 275)  
Crown Publishers, Inc. New York, New York, USA. 1954

## REALITY

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

The conception of the objective reality of the elementary particles has evaporated in a curious way, not into the fog of some new, obscure reality concept, but into the transparent clarity of a mathematics that represents no longer the behavior of the elementary particles but rather our knowledge of this behavior.

The Representation of Reality in Contemporary Physics  
*Daedalus*, 87(3), 1958

...an independent reality in the ordinary physical sense can neither be ascribed to the phenomena nor to the agencies of observation.

*Atomic Theory and the Description of Nature*  
Chapter II (p. 54)  
Cambridge University Press. Cambridge, England. 1934

**Born, Max** 1882–1970

German-born English physicist

The simple and unscientific man's belief in reality is fundamentally the same as that of the scientist.

*Physics in My Generation*  
On the Meaning of Physical Theories (p. 16)  
Springer-Verlag New York, Inc. New York, New York, USA. 1969

**Bronowski, Jacob** 1908–74

Polish-born English mathematician and polymath

Reality is not an exhibit for man's inspection, labeled "Do not touch." There are no appearances to be photographed, no experiences to be copied, in which we do not take part. Science, like art, is not a copy of nature but a re-creation of her.

*Science and Human Values*  
The Creative Mind (p. 20)  
Harper & Row, Publishers. New York, New York, USA. 1965

**Brooks, Harvey**

No biographical data available

A more problematic example is the parallel between the increasingly abstract and insubstantial picture of the physical universe which modern physics has given us and the popularity of abstract and non-representational forms of art and poetry. In each case the representation of reality is increasingly removed from the picture which is immediately presented to us by our senses.

Scientific Concepts and Cultural Change  
*Daedalus*, Winter 1965

**Burt, E. A.**

No biographical data available

Man begins to appear for the first time in the history of thought as an irrelevant spectator and insignificant effect of the great mathematical system which is the substance of reality.

*The Metaphysical Foundations of Modern Physical Science* (p. 80)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1954

**Cerf, Bennett** 1898–1971

American publisher and editor

The best of them was the conversation between Ginsberg, who demanded to know what reality was, and Garfinkle, who brazenly attempted to explain it to him.

*Try and Stop Me: A Collection of Anecdotes and Stories, Mostly Humorous*  
Jokes About Relativity (p. 163)  
Simon & Schuster. New York, New York, USA. 1944

**Cromer, Alan** 1935–

American physicist and educator

Reality has far more wonders than all the tales of Arabia, giving us in return for our lost feeling of omnipotence some knowledge of the external world, some control over and responsibility for our lives, and even a touch of humility.

*Uncommon Sense: The Heretical Nature of Science*  
Chapter 10 (p. 207)  
Oxford University Press, Inc. New York, New York, USA. 1993

**Dampier-Whetham, William** 1867–1952

English scientific writer



The physicist analyzes matter into particles, and finds that their forces and motions can be described in mathematical terms. The materialist pushes this scientific result into philosophy, and says that there is no other reality.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 14 (p. 181)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

### Drees, Willem B.

Dutch philosopher of science and religion

That natural reality is assumed rather than explained is not proof for the existence of a creator. Introducing god as an explanatory notion only shifts the locus of the question: why would such a god exist? And, it is possible that the universe just happens to exist, without explanation.

In Victor J. Stenger

*Has Science Found God?: The Latest Results in the Search for Purpose in the Universe*

Chapter Seven (p. 163)

Prometheus Books. Amherst, New York, USA. 2003

### Dürrenmatt, Friedrich 1921–90

Swiss playwright and novelist

Our researches are perilous, our discoveries are lethal. For us physicists there is nothing left but to surrender to reality.

Translated by James Kirkup

*The Physicists*

Act Two (p. 81)

Grove Press, Inc. New York, New York, USA. 1964

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

It is by looking into our own nature that we first discover the failure of the physical universe to be co-extensive with our experience of reality. The “something to which truth matters” must surely have a place in reality whatever definition of reality we may adopt.

*New Pathways in Science*

Chapter XIV, Section II (p. 317)

The Macmillan Company. New York, New York, USA. 1935

### Egler, Frank E. 1911–96

American botanist and ecologist

Reality is not what is; it is what the layman wishes it to be.

*The Way of Science*

Science Concepts (p. 22)

Hafner Publishing Company. New York, New York, USA. 1970

### Einstein, Albert 1879–1955

German-born physicist

Pure logical thinking cannot yield us any knowledge of the empirical world; all knowledge of reality starts from experience and ends in it. Propositions arrived at by purely logical means are completely empty of reality.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Einstein's Conception of Science (p. 391)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

Physics is an attempt conceptually to grasp reality as it is thought independently of its being observed. In this sense one speaks of “physical reality.”

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Autobiographical Notes (p. 81)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

Space has devoured ether and time; it seems to be on the point of swallowing up also the field and the corpuscles, so that it alone remains as the vehicle of reality.

In R. Thiel

*And There Was Light* (p. 345)

New American Library. New York, New York, USA. 1960

All our science, measured against reality, is primitive and childlike — good yet it is the most precious thing we have.

*The Physics Teacher*, April 1970 (p. 200)

### Einstein, Albert 1879–1955

German-born physicist

### Infeld, Leopold 1898–1968

Polish physicist

In our endeavor to understand reality we are somewhat like a man trying to understand the mechanism of a closed watch. He sees the face and moving hands, and even hears the ticking, but he has no way of opening the case. If he is ingenious enough he may form some picture of a mechanism which could be responsible for all the things he observes, but he may never be quite sure his picture is the only one which could explain his observations.

*The Evolution of Physics*

On Clew Remains (p. 31)

Simon & Schuster. New York, New York, USA. 1961

### Frankel, Felice 1945–

Science photographer

### Whitesides, George M.

American chemist

Our reality is illusion: We don't know for sure what's out there.

*On the Surface of Things: Images of the Extraordinary in Science*

Illusion (p. 121)

Chronicle Books. San Francisco, California, USA. 1997

### Frost, Robert 1874–1963

American poet

You're searching, Joe

For things that don't exist.

I mean beginnings

Ends and beginnings

Ends and beginnings — there are no such things  
There are only middles.

*Complete Poems of Robert Frost*

Mountain Interval

Henry Holt & Company. New York, New York, USA. 1949

### Gribbin, John

English science writer and astronomer

Don't look here for any "eastern mysticism", spoon bending or ESP. Do look here for the true story of quantum mechanics, a truth far stranger than any fiction.... The question this book addresses is "What is reality?" The answer(s) may surprise you; you may not believe them.

*In Search of Schrödinger's Cat: Quantum Physics and Reality*

Introduction (p. xvi)

Bantam Books. New York, New York, USA. 1984

### Heisenberg, Werner Karl 1901–76

German physicist and philosopher

[The probability wave] meant a tendency for something. It was a quantitative version of the old concept of "Potentialia" in Aristotelian philosophy. It introduced something standing in the middle between the idea of an event and the actual event, a strange kind of physical reality just in the middle between possibility and reality.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter II (p. 41)

Harper & Row, Publishers. New York, New York, USA. 1958

### Hilbert, David 1862–1943

German mathematician

It has become perfectly clear that physics does not deal with the material world or with the contents of reality, but rather, what it perceives is merely the formal constitutions of reality.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 10, Section 10.1 (p. 240)

The Macmillan Company. New York, New York, USA. 1967

### Hubble, Edwin Powell 1889–1953

American astronomer

...sometimes, through the strangely compelling experience of mystical insight, a man knows beyond the shadow of a doubt, that he has been in touch with a reality that lies behind mere phenomena. He himself is completely convinced, but he cannot communicate the certainty. It is a private revelation. He may be right, but unless we share his ecstasy we cannot know.

*The Nature of Science and Other Lectures*

Part I, The Nature of Science (p. 19)

The Huntington Library, San Marino, California, USA. 1954

### Jacobi, Abraham 1830–1919

Pioneer of pediatrics

It is one thing to build an educational tower in the air at your library table, and another to face its actual appearance under the existing circumstances.

In R. Kagan (ed.)

*Leaders of Medicine*

Chapter IV (p. 41)

The Medico-Historical Press. Boston, Massachusetts, USA. 1941

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

...the most outstanding achievement of twentieth-century physics is not the theory of relativity with its welding together of space and time, or the theory of quanta with its present apparent negation of the laws of causation, or the dissection of the atom with the resultant discovery that things are not what they seem; it is the general recognition that we are not yet in contact with ultimate reality.

*The Mysterious Universe*

Chapter V (pp. 150–151)

The Macmillan Company. New York, New York, USA. 1932

### Kaufmann, William J., III 1942–94

American astronomer

From the moment of birth, our daily experiences strongly enforce the notion that reality is comprehensible. The fact that a rock released from your hand always falls down or that the moon goes through its phases every 29 1/2 days implies order rather than chaos to the rational human mind. To discover this order, to understand the basic and underlying qualities of all physical objects, to comprehend the fundamental principles that dictate the behavior of reality: this is the business of science.

*Introduction to Particles and Fields* (p. 1)

Scientific American, Inc., 1953

### Mead, George H. 1863–1931

American philosopher, sociologist and psychologist

...the ultimate touchstone of reality is a piece of experience found in an unanalyzed world. The approach to the crucial experiment may be a piece of torturing analysis, in which things are physically and mentally torn to shreds, so that we seem to be viewing the dissected tissues of objects in ghostly dance before us, but the actual objects in the experimental experience are the common things of which we say that seeing is believing, and of whose reality we convince ourselves by handling. We extravagantly advertise the photograph of the path of an electron, but in fact we could never have given as much reality to the electrical particle as does now inhabit it if the photograph had been of naught else than glistening water vapour.

*The Philosophy of the Act*

Chapter II (p. 32)

The University of Chicago, Chicago, Illinois, USA; 1938

### Olson, Sigurd F. 1899–1982

American conservationist

Flashes of insight or reality are sunbursts of the mind.

*Reflections from the North Country*

Flashes of Insight (p. 131)

Alfred A. Knopf. New York, New York, USA. 1976

**Pagels, Heinz R.** 1939–88

American physicist and science writer

We may begin to see reality differently simply because the computer...provides a different angle on reality.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1988

**Palmieri, M.**

No biographical data available

Since the dawn of human intelligence man has tried to form for himself a conception of the outside world which would correspond to the truest reality. But to determine what this reality is has proved to be a task of no mean import, and we still stand bewildered and wondering at the door of what has been and remains for mankind the greatest of all mysteries: the nature of ultimate reality.

*Relativity: An Interpretation of Einstein's Theory*

Introduction

Forbush Publishing Company. Los Angeles. 1931

**Raymo, Chet** 1936–

American physicist and science writer

Science is a map of reality.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 16 (p. 147)

The Viking Press. New York, New York, USA. 1991

**Reeve, F. D.**

No biographical data available

Because all things balance — as on a wheel — and we cannot see nine-tenths of what is real, our claims of self-reliance are pieced together by unpanned gold. The whole system is a game: the planets are the shells; our earth, the pea. May there be no moaning of the bar. Like ships at sunset in a reverie, We are shadows of what we are.

Coasting

*The American Poetry Review*, Volume 24, Number 4, July–August 1995 (p. 38)

**Riordan, Michael**

Physicist

Subatomic reality is a lot like that of a rainbow, whose position is defined only relative to an observer. This is not an objective property of the rainbow-in-itself but involves such subjective elements as the observer's own position. Like the rainbow, a subatomic particle becomes fully "real" only through the process of measurement.

*The Hunting of the Quark*

Chapter 1 (p. 39)

Touchstone Books/Simon & Schuster. New York, New York, USA. 1987

**Smith, David**

No biographical data available

Everything imagined is reality. The mind cannot conceive unreal things.

The Private Thoughts of David Smith

*Vogue*, November 15, 1968 (p. 198)

**Trilling, Lionel** 1905–75

American critic, author, and teacher

In the American metaphysic, reality is always material reality, hard, resistant, unformed, impenetrable, and unpleasant.

*The Liberal Imagination*

Reality in America, ii (p. 13)

Charles Scribner's Sons. New York, New York, USA. 1950

**Wald, George** 1906–97

American biologist and biochemist

A scientist lives with all reality. There is nothing better.

To know reality is to accept it, and eventually to love it.

*Lex Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

**Walgate, Robert**

No biographical data available

...what the scientist must now admit is that in many problems of great consequence to people reality may not be accessible, in practice, through entirely manipulative and analytical methods.

Breaking Through the Disenchantment

*New Scientist*, September 18, 1975 (p. 667)

**Weinberg, Steven** 1933–

American nuclear physicist

When we say that a thing is real we are simply expressing a sort of respect.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Chapter II (p. 46)

Pantheon Books. New York, New York, USA. 1992

Physical reality remains so mysterious even to physicists because of the extreme improbability that it was constructed to be understood by the human mind.

The Form of Nature

*Bulletin of the American Academy of Arts and Sciences*, Volume 29, Number 4, 1976

**Weyl, Hermann** 1885–1955

German mathematician

A picture of reality drawn in a few sharp lines cannot be expected to be adequate to the variety of all its shades. Yet even so the draftsman must have the courage to draw the lines firm.

*Philosophy of Mathematics and Natural Science*

Appendix D (p. 274)  
Princeton University Press. Princeton, New Jersey, USA. 1949

**Wheeler, John Archibald** 1911–  
American physicist and educator

What we call reality consists...of a few iron posts of observation between which we fill an elaborate papier-mâché of imagination and theory.

In Harry Woolf (ed.)  
*Some Strangeness in the Proportion*  
Chapter 22  
Fig. 22.10 (p. 358)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1980

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Progress in truth — truth of science and truth of religion — is mainly a progress in the framing of concepts, in discarding artificial abstractions or partial metaphors, and in evolving notions which strike more deeply into the root of reality.

*Religion in the Making*  
Truth and Criticism (p. 127)  
New American Library. New York, New York, USA. 1960

**Yeats, William Butler** 1865–1939  
Irish poet and playwright

ILLE: The rhetorician would deceive his neighbors,  
The sentimentalist himself; while art  
Is but a vision of reality.

*The Collected Poems of W.B. Yeats*  
Ego Dominus Tuus (p. 159)  
The Macmillan Company. New York, New York, USA. 1956

## REASONING

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

Reason is the newest and rarest thing in human life, the most delicate child of human history.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
Chapter 10 (p. 91)  
St. Martin's Press. New York, New York, USA. 1989

**Arnauld, Antoine** 1612–94  
French philosopher, lawyer, and mathematician

We use Reason for improving the Sciences; whereas we ought to use the Sciences for improving our Reason.

*The Port-Royal Logic*  
Preface  
Printed for T.B. and J. Taylor. London, England. 1696

**Barnett, P. A.**  
No biographical data available

...the reasoning of mathematics is a type of perfect reasoning.

*Common Sense in Education and Teaching*  
Chapter IX (p. 222)  
Longmans, Green & Company. London, England. 1899

**Beaumarchais, Pierre-Augustin Caron de** 1732–99  
French dramatist

It is not necessary to believe things in order to reason about them.

*The Barber of Seville*  
Act V, Scene 4  
Pioneer Classics. Long Beach, California, USA. 1994

**Beck, Lewis White** 1913–97  
American scholar in German philosophy

In the logic of science there is a principle as important as that of parsimony: it is that of sufficient reason.

The "Natural Science Ideal" in the Social Sciences  
*The Scientific Monthly*, Volume LXVIII, June 1949 (p. 393)

**Bernard, Claude** 1813–78  
French physiologist

Pile up facts or observations as we may, we shall be none the wiser. To learn, we must necessarily reason about what we have observed, compare the facts and judge them by other facts used as controls.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I, Section iv (p. 16)  
Henry Schuman, Inc. New York, New York, USA. 1927

Reasoning will always be correct when applied to accurate notions and precise facts; but it can lead only to error when the notions or facts on which it rests were originally tainted with error or inaccuracy.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Introduction (p. 2)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

Every experience and history teach us that in the biological and medical sciences reason seldom can progress far from the facts without going astray.

*The Art of Scientific Investigation*  
Chapter Seven (p. 81)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

The role of reason in research is not so much in exploring the frontiers of knowledge as in developing the findings of the explorers.

*The Art of Scientific Investigation*  
Chapter Seven (p. 91)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

A useful habit for scientists to develop is that of not trusting ideas based on reason only.... Practically all reasoning is influenced by feelings, prejudice and past experience, albeit often subconsciously.

*The Art of Scientific Investigation*

Chapter Seven (p. 87)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Brophy, Brigid** 1929–95

English novelist

Reason is necessarily the language of moral, political, and scientific argument: not because reason is holy or on some elevated plane, but because it isn't; because it is accessible to all humans; because, as well as working, it can be seen to work.

In Stanley and Rosiland Godlovitch and John Harris (eds.)

*Animals, Men and Morals: An Enquiry into the Maltreatment of Non-Humans*

In Pursuit of Fantasy (p. 126)

Taplinger Publishing Company. New York, New York, USA. 1972

**Browne, Sir Thomas** 1605–82

English author and physician

Every man's own reason is his best Oedipus.

*Religio Medici*

Part I, Section 6

Elliot Stock. London, England. 1883

**Bryant, William Cullen** 1794–1878

American poet

I would make

Reason my guide.

*Poems*

Conjunction of Jupiter and Venus

D. Appleton & Company. New York, New York, USA. 1874

**Burton, Sir Richard Francis** 1821–90

English explorer

Reason is Life's sole arbiter, the magic Laby'rinth's single clue...

*The Kasidah of Haji Abdu El-Yezdi*

Part vii, Stanza xxi

Citadel Press. New York, New York, USA. 1965

**Chrysostom, John** 349–c.407

Archbishop of Constantinople and preacher

...there is nothing that has been created without some reason, even if human nature is incapable of knowing precisely the reason for them all.

*Homilies on Genesis*

7.14

Catholic University of American Press. Washington, D.C. 1986

**Congreve, William** 1670–1729

English dramatist

...error lives

Ere reason can be born.

*The Mourning Bride*

Act III, Scene I

J. Dicks. London, England. 1883

**Darwin, Charles Robert** 1809–82

English naturalist

It is a fatal fault to reason whilst observing, though so necessary beforehand and so useful afterwards.

*The Autobiography of Charles Darwin, 1809–1882: With Original*

*Omissions Restored*

Appendix, Quotations (p. 159)

Harcourt, Brace. New York, New York, USA. 1959

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Those long chains of reasoning, simple and easy as they are, of which geometers make use in order to arrive at the most difficult demonstrations, had caused me to imagine that all those things which fall under the cognizance of man might very likely be mutually related in the same fashion...

In *Great Books of the Western World* (Volume 31)

*Discourse on the Method of Rightly Conducting the Reason*

Part II (p. 47)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

I believe that all those to whom God has given the use of reason are bound to use it mainly to know Him and to know themselves. This is where I endeavored to begin my own research, and I can say that I would have been unable to find the foundation of physics had I not sought after them in this way

In William R. Shea

*The Magic of Numbers and Motion: The Scientific Career of René*

*Descartes*

Chapter Eight (p. 166)

Science History Publications Canton, Massachusetts, USA. 1991

**Dewey, John** 1859–1952

American philosopher and educator

Reason is experimental intelligence, conceived after the pattern of science, and used in the creation of social arts; it has something to do. It liberates man from the bondage of the past, due to ignorance and accident hardened into custom. It projects a better future and assists man in its realization. And its operation is always subject to test in experience...The principles which man projects as guides...are not dogmas. They are hypotheses to be worked out in practice, and to be rejected, corrected and expanded as they fail or succeed in giving our present experience the guidance it requires. We may call them programmes of action, but since they are to be used in making our future acts less blind, more directed, they are flexible. Intelligence is not something possessed once for all. It is in constant process of forming, and its retention requires constant alertness in observing consequences, an open-minded will to learn and courage in re-adjustment.

*Reconstruction in Philosophy*

Chapter IV (p. 96)

Beacon Press. Boston, Massachusetts, USA. 1920

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

You reasoned it out beautifully, I exclaimed in unfeigned admiration. It is so long a chain, and yet every link rings true.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

The Red Headed League (p. 438)

Wings Books. New York, New York, USA. 1967

Like all Holmes's reasoning the thing seemed simplicity itself when it was once explained.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

Stockbroker's Clerk (p. 154)

Wings Books. New York, New York, USA. 1967

I can see nothing, said I, handing it back to my friend.

On the contrary, Watson, you can see everything. You fail, however, to reason from what you see. You are too timid in drawing your inferences.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of the Blue Carbuncle (p. 453)

Wings Books. New York, New York, USA. 1967

I feel that there is reason lurking in you somewhere, so we will patiently grope round for it.

*The Lost World*

Chapter IV (p. 52).

The Colonial Press. Clinton, Massachusetts, USA. 1959

Ah! my dear Watson, there we come into those realms of conjecture where the most logical mind may be at fault.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of the Empty House (p. 348)

Wings Books. New York, New York, USA. 1967

**Drummond, William, Sir**

No biographical data available

...he who will not reason is a bigot; he who cannot is a fool; and he who dares not is a slave.

*Academical Questions*

Preface (p. xv)

Scholar's Facsimiles & Reprints. Delmar, New York, USA. 1984

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Reason dreams of an empire of knowledge, a mansion of the mind. Yet sometimes we end up living in a hotel by its side.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 14 (p. 333)

Simon & Schuster. New York, New York, USA. 1988

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

...our reasoning appears to become more accurate as our ignorance becomes more complete; that when we have embarked upon chaos we seem to drop down into a cosmos.

The Philosophy of Chance

*Mind*, Volume 9, 1884 (p. 229)

**Einstein, Albert** 1879–1955

German-born physicist

We have thus assigned to pure reason and experience their places in a theoretical system of physics. The structure of the system is the work of reason: the empirical contents and their mutual relations must find their representation in the conclusions of the theory. In the possibility of such a representation lie the sole value and justification of the whole system, and especially of the concepts and fundamental principles which underlie it. Apart from that, these latter are free inventions of human intellect, which cannot be justified either by the nature of that intellect or in any other fashion a priori.

*Ideas and Opinions*

On the Methods of Theoretical Physics (p. 272)

Crown Publishers, Inc. New York, New York, USA. 1954

**Eldridge, Paul** 1888–1982

American educator

Reason is the shepherd trying to corral life's vast flock of wild irrationalities.

*Maxims for a Modern Man*

2194

T. Yoseloff. New York, New York, USA. 1965

**Epictetus** ca. 55–135

Greek philosopher

Since it is Reason which shapes and regulates all other things, it not ought itself to be left in disorder.

*Discourses*

Chapter XVII

G. Bell & Sons. London, England. 1908

**Fersman, A. E.** 1883–1945

Geochemist and mineralogist

There are no bounds to fantasy, no limits to the penetration of reason, and none to the technical powers that conquer nature.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Copernicanism and other essential ingredients of modern science survived only because reason was frequently overruled in their past.

*Against Method: Outline of an Anarchistic Theory of Knowledge*  
Analytical Index (p. 13)  
Verso. London, England. 1978

**Galilei, Galileo** 1564–1642

Italian physicist and astronomer

SALVIATI: Now, since I wish to convince you by demonstrative reasoning rather than to persuade you by mere probabilities, I shall suppose that you are familiar with present-day mechanics...

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

First Day (p. 133)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In science the authority embodied in the opinion of thousands is not worth a spark of reason in one man.

In Pedro Redondi

*Galileo: Heretic*

Chapter 2 (p. 37)

Princeton University Press. Princeton, New Jersey, USA. 1987

**Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

The scientific glory of a country may be considered in some measure, as an indication of its innate strength. The exaltation of Reason must necessarily be connected with the exaltation of the other faculties of the mind; and there is one spirit of enterprise, vigor and conquest in science, arts, and arms.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 4 (p. 80)

Cambridge University Press. Cambridge, England. 1978

**Gore, George** 1826–1909

English electrochemist

That which is beyond reason at present may not be so in the future; but it has now no place in science for want of a basis of verified truth.

*The Art of Scientific Discovery*

Chapter III (p. 25)

Longmans, Green & Company. London, England. 1878

**Grew, Nehemiah** 1641–1712

Scientific writer and journalist

He that speaketh Reason may be rather satisfied in being understood, than believed.

*The Anatomy of Vegetables Begun*

Preface

Printed for Spencer Hickman. London, England. 1672

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

REASON: The arithmetic of the emotions.

*The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 126)

The Roycrofters. East Aurora, New York, USA. 1914

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

...to reason without data is nothing but delusion.

*The Theory of the Earth* (Volume 1)

Part I, Chapter III (p. 281)

Messrs. Cadwell, Junior & Davies. London, England. 1795

**John of Salisbury** ca. 1115–80

English author and diplomatist

Reason, therefore, is a mirror in which all things are seen...

In John van Laarhoven (ed.)

*Entheticus Maior and Minor* (Volume 1)

Part II, Section I, Notes from Epicurus, I. 657

E.J. Brill. Leiden, Netherlands. 1987

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

We may take fancy for a companion, but must follow Reason as our guide.

*The Life of Samuel Johnson* (Volume 1)

Letter to Boswell 1774 (p. 474)

Sir Isaac Pitman & Sons, Ltd. London, England. 1907

Memory is the purveyor of reason, the power which places those images before the mind upon which the judgment is to be exercised, and which treasures up the determinations that are once passed, as the rules of future action, or grounds of subsequent conclusions.

*The Rambler* (Volume 1)

No. 41, August 7, 1750 (p. 296)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Joos, Georg** 1894–1959

German physicist

As soon as we inquire into the reasons for the phenomena, we enter the domain of theory, which connects the observed phenomena and traces them back to a single “pure” phenomena, thus bringing about a logical arrangement of an enormous amount of observational material.

*Theoretical Physics*

Introduction (p. 1)

Blackie & Son Ltd. London, England. 1968

**Kant, Immanuel** 1724–1804

German philosopher

Mathematics and physics are the two theoretical sciences of reason, which have to determine their objects a priori.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

Preface to the Second Edition (p. 5)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Human reason has this peculiar fate that in one species of its knowledge it is burdened by questions which, as prescribed by the very nature of reason itself, it is not able to ignore, but which, as transcending all its powers, it is also not able to answer.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

Preface to First Edition (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Kasner, Edward** 1878–1955

American mathematician

**Newman, James Roy** 1911–66

Mathematician and mathematical historian

One of the difficulties arising out of the subjective view of probability results from the principle of insufficient reasons. This principle...holds that if we are wholly ignorant of the different ways an event can occur and therefore have no reasonable ground for preference, it is as likely to occur one way as another.

*Mathematics and the Imagination*

Chance and Chanceability (p. 229)

Simon & Schuster. New York, New York, USA. 1940

**Lamarck, Jean-Baptiste Pierre Antoine**

1744–1829

French biologist

Reason is not a faculty; still less is it a torch or entity of any kind; but it is a special condition of the individual's intellectual faculties; a condition that is altered by experience, gradually improves and controls the judgments, according as the individual exercises his intellect.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VIII (p. 401)

The University of Chicago Press. Chicago, Illinois, USA. 1984

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

Reason hates the false décor by which advocates of error try to make her more impressive. She recognizes that one should doubt where reasons are not sufficient, that one should present each reason stripped of all that makes it apparent, and then she will assist if proper tools are on hand, and reserve for herself to pronounce the sentence, or if she suspends it, to indicate what is required to proceed to the conclusion.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Twentieth Letter (p. 186)

Science History Publications. New York, New York, USA. 1976

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

...scientific reasoning is a kind of dialogue between the possible and the actual, what might be and what is in fact the case...

*Induction and Intuition in Scientific Thought*

Chapter III, Section 1 (p. 48)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

**Miller, Hugh** 1802–56

Scottish geologist and theologian

In the geologic, as in other departments,

What can we reason but from what we know?

*The Old Red Sandstone*

Geological Evidences in Favour of Revealed Religion (p. 280)

J.M. Dent & Sons Ltd. London, England. 1922

**Minnick, Wayne C.** 1915–2006

Professor of communications

This kind of reasoning has weaknesses, of course, as do all forms of reasoning. If the correspondence between two things compared is not complete, that is, if significant differences can be shown to exist, then the argument collapses.

*The Art of Persuasion* (p. 16)

Houghton Mifflin Company. New York, New York, USA. 1968

**Moulton, Forest Ray** 1872–1952

American astronomer

...reason and the laws of nature...have become a sort of intellectual telescope, as it were, with which modern science looks back across the geological ages and discerns, at least in outline, the chief steps of the evolution of the inanimate and of the organic world; and, similarly, penetrates the future to a time when this earth will cease to be suited for the abode of life.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 2)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

A Vulgar Mechanick can practice what he has been taught or seen done, but if he is an error he knows not how to find it out and correct it, and if you put him out of his road, he is at a stand; Whereas he that is able to reason nimbly and judiciously about figure, force and motion is never at rest till he gets over every rub.

In Richard S. Westfall

*Never at Rest: A Biography of Isaac Newton*

Letter to Nathaniel Hawes, 25 May 1694 (p. ii)

Cambridge University Press. Cambridge, England. 1980

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

With reason, science never parts company, but with feeling, emotion, passion, what has she to do? They are



not of her; they owe her no allegiance. She may study, analyze, and define, she can never control them, and by no possibility can their ways be justified to her.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (p. 93)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

### **Parkington, J. E.**

No biographical data available

The ability to sort out stone implements into “types” as one would playing-cards into suits is of minor importance compared to the reasons underlying the tendency for implements to cluster into “ideal forms.” It is not the group “handaxes” which is important but, as Plato might have said, “handaxeness.”

Stone Implements as Information

*The Interpretation of Archaeological Evidence*, Goodwin Series,

Number 1, June 1972 (p. 12)

### **Pascal, Blaise** 1623–62

French mathematician and physicist

The last proceeding of reason is to recognise that there is an infinity of things which are beyond it.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section IV, 267

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

Every work of science great enough to be remembered for a few generations affords some exemplification of the defective state of the art of reasoning of the time when it was written; and each chief step in science has been a lesson in logic.

Inquiry and Belief

*The Popular Science Monthly*, Volume 12, 1877–1878

### **Pope, Alexander** 1688–1744

English poet

What can we reason but from what we know?

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle I, l. 18

Houghton Mifflin Company. New York, New York, USA. 1903

### **Price, Bartholomew** 1818–98

English mathematician and educator

...the reasoning process [employed in mathematics] is not different from that of any other branch of knowledge...but there is required, and in a great degree, that attention of mind which is in some part necessary for the acquisition of all knowledge, and in this branch [it] is indispensably necessary. This must be given in its fullest intensity.... [T]he other elements especially characteristic

of a mathematical mind are quickness in perceiving logical sequence, love of order, methodical arrangement and harmony, distinctness of conception.

*Treatise on Infinitesimal Calculus* (Volume 3) (p. 6)

At The Clarendon Press. Oxford, England. 1868

### **Recorde, Robert** 1510?–58

English mathematician and writer

You are to farre deceived, and therefore I interrupt your woordes, for all things are to bee governed by reason.

*The Castle of Knowledge*

The Fourth Treatise (p. 243)

Imprinted by R. Wolfe. London, England. 1556

If reasons reache transcende the skye,

Why shoulde it then to earthe be bounde?

The witte is wronged and leadde awrye,

If mynde be maried to the grounde.

*The Castle of Knowledge*

The Preface

Imprinted by R. Wolfe. London, England. 1556

...who so ever will travail in the sciences with profit, must lean rather to reason, than to authority, else he may be deceived.

*The Castle of Knowledge*

The Fourth Treatise (p. 182)

Imprinted by R. Wolfe. London, England. 1556

### **Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

Reasoning goes beyond the analysis of facts.

*Encyclopedia of Thoughts*

Aphorisms 1973

Ithaca Heritage Books. Ithaca, New York, USA. 1975

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Reason is a harmonizing, controlling force rather than a creative one.

*Our Knowledge of the External World*

Lecture I (p. 21)

The Open Court Publishing Company. Chicago, Illinois. 1914

Supposing you got a crate of oranges that you opened, and you found all the top layer of oranges bad, you would not argue, “The underneath ones must be good, so as to redress the balance”; You would say, “Probably the whole lot is a bad consignment”; and that is really what a scientific person would say about the universe.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Why I Am Not A Christian (p. 13)

Watts. London, England. 1927

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

FOOL: “The reason why the seven stars are no more than seven is a pretty reason.”

LEAR: "Because they are not eight?"

FOOL: "Yes, indeed. Thou wouldst make a good fool."

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

King Lear

Act I, Scene v, l. 38–40

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Good reason must, of force, give place to better.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Julius Caesar

Act IV, Scene iii, l. s03

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

His reasons are as two grains of wheat hid in two bushels of chaff: you shall seek all day ere you find them, and when you have them, they are not worth the search.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Merchant of Venice

Act I, Scene i, l. 115

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Spencer-Brown, George** 1923–

English mathematician and polymath

The concept of randomness arises partly from games of chance. The word "chance" derives from the Latin *cadentia* signifying the fall of a die. The word "random" itself comes from the French *randir* meaning to run fast or gallop.

*Probability and Scientific Inference*

Chapter VII (p. 35)

Longmans, Green & Company. London, England. 1957

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

Reason is applied to what is developing, practical understanding to what is developed. The former does not ask, What is the Purpose? and the latter does not ask, What is the source? Reason takes pleasure in development; practical understanding tries to hold things fast so that it can use them.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 308)

Suhrkamp. New York, New York, USA. 1988

The texture of this world is made up of necessity and chance. Human reason holds the balance between them, treating necessity as the basis of existence, but manipulating and directing chance, and using it.

In Eric A. Blackall (ed.)

*Wilhelm Meister's Apprenticeship*

Book One, Chapter Seventeen (p. 38)

Princeton University Press. Princeton, New Jersey, USA. 1995

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

The iron labor of conscious logical reasoning demands great perseverance and great caution; it moves on but

slowly, and is rarely illuminated by brilliant flashes of genius. It knows little of that facility with which the most varied instances come thronging into the memory of the philologist or historian. Rather is it an essential condition of the methodical progress of mathematical reasoning that the mind should remain concentrated on a single point, undisturbed alike by collateral ideas on the one hand, and by wishes and hopes on the other, and moving on steadily in the direction it has deliberately chosen.

*Vorträge and Reden*

Ueber das Verhältniss der Naturwissenschaften zur Gesamtheit der Wissenschaft, Bd. 1, 1896 (p. 178)

English novelist, historian, and sociologist

Friedrich Viewig & Sohn. Brunswick, Germany. 1896

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

"It's against reason?" said Filby.

"What reason?" said the Time Traveler.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine

Chapter One (p. 451)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The art of reasoning consists in getting hold of the subject at the right end, of seizing on the few general ideas that illuminate the whole, and of persistently organizing all subsidiary facts round them. Nobody can be a good reasoner unless by constant practice he has realized the importance of getting hold of the big ideas and hanging on to them like grim death.

In W.W. Sawyer

*Prelude to Mathematics*

Presidential Address to the London Branch of the Mathematical Association, 1914 (p. 183)

Penguin Books Limited. London, England. 1960

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

The great mathematician fully, almost ruthlessly, exploits the domain of permissible reasoning and skirts the impermissible. That his recklessness does not lead him into a morass of contradiction is a miracle in itself. Certainly it is hard to believe that our reasoning power was brought, by Darwin's process of natural selection, to the perfection which it seems to possess.

The Unreasonable Effectiveness of Mathematics in Natural Science

*Communications on Pure and Applied Mathematics*, Volume 13, Number 1, 1960 (p. 3)

**Wright, Frances** 1795–1852

Scottish-born American reformer

The best road to correct reasoning is by physical science; the way to trace effects to causes is through physical science; the only corrective, therefore, of superstition is physical science.

*Course of Popular Lectures*

Lecture 3

Published by the author. Philadelphia, Pennsylvania, USA. 1836

## RECOGNITION

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Whatever the individual motivation and belief of the scientist, without the recognition from his fellow men of the value of his work, in the long term science will perish.

Atomic Weapons

*Proceeding of the American Philosophical Society*, Volume 90, Number 1, 1946

## RECORD

**Coues, E.**

No biographical data available

Don't trust your memory; it will trip you up; what is clear now will grow obscure; what is found will be lost. Write down everything while it is fresh in your mind; write it out in full. Time so spent will be time saved in the end, when you offer your researches to the discriminating public.

*Field Ornithology* (pp. 44–45)

Naturalist's Agency. Salem, Massachusetts, USA. 1874

**Dickens, Charles** 1812–70

English novelist

When found, make a note of.

*The Works of Charles Dickens*

*Dombey and Son* (Part I)

Chapter XV (p. 217)

P.F. Collier & Son. New York, New York, USA. 1911

**Grove, Sir William** 1811–96

English chemist

It would be vain to attempt specifically to predict what may be the effect of Photography on future generations. A Process by which the most transient actions are rendered permanent, by which facts write their own annals in a language that can never be obsolete, forming documents which prove themselves, — must interweave itself not only with science but with history and legislature.

Lecture

Progress of Physical Science since the opening of the London Institution, (19 January 1842)

## RECOVERY

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

Despair of all recovery spoils longevity,  
And makes men's miseries of alarming brevity.

*The Complete Poetical Works of Byron*

Don Juan

Canto II, Stanza LXIV

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Massinger, Philip** 1583–1640

English dramatic poet

O my Doctor,  
I never shall recover.

*The Bondman*

Act I, Scene I

Printed for A. Bettesworth. London, England. 1719

**Petrarch (Francesco Petrarca)** 1304–74

Italian poet and humanist

I once heard a physician of high standing in his profession say: ...If a hundred men, or a thousand of the same age and general constitution and accustomed to the same diet, should all fall victim to a disease at the same time, and if half of them should follow the prescriptions of our contemporary doctors, and if the other half should be guided by their natural instinct and common sense, with no doctors at all, I have no doubt that the latter group would do better.

In M. Bishop

*Letters from Petrarch*

Book V, 3 (p. 250)

Indiana University Press. Bloomington, Indiana, USA. 1966

## RECTANGLE

**Frere, John Hookham** 1769–1846

British diplomat and man of letters

Alas! that partial Science should approve  
The sly RECTANGLE'S too licentious love!

In Charles Edmonds

*Poetry of the Anti-Jacobin*

The Loves of the Triangle, Canto II, l. 75–76

Printed for J. Wright, by W. Bulmer & Company. London, England. 1801

## RECURSION

**Papert, Seymour** 1928–

South African mathematician

Of all ideas I have introduced to children, recursion stands out as the one idea that is particularly able to evoke an excited response.

*Mindstorms: Children, Computers and Powerful Ideas*

Chapter 3 (p. 71)  
Basic Books, Inc. New York, New York, USA. 1980

### Young, Louise B.

Science writer

Whatever can be done once can always be repeated.

*The Mystery of Matter*

Introduction (p. 15)

Oxford University Press, Inc. New York, New York, USA. 1965

## RED SHIFT

### Boas, Jr., Ralph P. 1912–92

Consider the Pitiful Plight

Of a runner who wasn't too bright,

But sprinted so fast

He vanished at last

By red-shifting himself out of sight.

Reprinted in Ralph P. Boas, Jr.

*Lion Hunting & Other Mathematical Pursuits* (p. 103)

Mathematical Association of America. Washington, D.C. 1995

### Gamow, George 1904–68

Russian-born American physicist

The discovery of the red shift in the spectra of distant stellar galaxies revealed the important fact that our universe is in the state of uniform expansion, and raised an interesting question as to whether the present features of the universe could be understood as the result of its evolutionary development... We conclude first of all that the relative abundance of various atomic species (which were found to be essentially the same all over the observed region of the universe) must represent the most ancient archaeological document pertaining to the history of the universe.

The Evolution of the Universe

*Nature*, Volume 162, Number 4122, October 1948 (p. 680)

### Gray, George W.

Free lance science writer

...just as the shifting of bookkeeping accounts into the red measures disintegrating, scattering, dissipating financial resources, so the shifting of starlight into the red indicates disintegrating, scattering, dissipating physical resources. It says that the universe is running down.... To entertain this preposterous idea of all these massive star systems racing outward was to accept a radically new picture of the cosmos — a universe in expansion, a vast bubble blowing, distending, scattering, thinning out into gossamer, losing itself. The snug, tight, stable world of Einstein had room for no such flights.

Universe in the Red

*The Atlantic Monthly*, Volume 1151, Number 2, February 1933

(p. 233, 236)

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

Another possibility...is that the universe retains its size, while we and all material bodies shrink uniformly. The red shift we observe in the spectra of the nebulae is then due to the fact that the atoms which emitted the light millions of years ago were larger than the present-day atoms with which we measured the light — the shift is, of course, proportional to distance.

Contributions to a British Association Discussion on the Evolution of the Universe

*Supplement to Nature*, Volume 128, Number 3234 November 1931 (pp. 703–704)

### Stapledon, Olaf 1886–1950

English author

I noticed that the sun and all the stars in his neighborhood were ruddy. Those at the opposite pole of the heaven were of an icy blue. The explanation of this strange phenomenon flashed upon me. I was still traveling, and traveling so fast that light itself was not wholly indifferent to my passage. The overtaking undulations took long to catch me. They therefore affected me as slower pulsations than they normally were, and I saw them therefore as red. Those that met me on my headlong flight were congested and shortened, and were seen as blue.

*Last and First Men and Star Maker*

Star Maker, Chapter III (p. 262)

Dover Publications, Inc. New York, New York, USA. 1968

## REDUCTIONISM

### Commoner, Barry 1917–

American biologist, ecologist, and educator

There is, indeed, a specific fault in our system of science, and in the resultant understanding of the natural world.... This fault is reductionism, the view that effective understanding of a complex system can be achieved by investigating the properties of its isolated parts. The reductionist methodology, which is so characteristic of much of modern research, is not an effective means of analyzing the vast natural systems that are threatened by degradation.

*The Closing Circle: Nature, Man and Technology*

Chapter 10 (p. 189)

Alfred A. Knopf. New York, New York, USA. 1971

### d'Abro, Abraham

No biographical data available

...in spite of its achievements, thermodynamics suffers from the limitations common to all phenomenological theories. Because it restricts its attention to the macroscopic properties of bodies, it fails to anticipate many phenomena which find their interpretation in the interplay

of underlying microscopic processes, and which have since been clarified by the more speculative theories of the hidden-occurrence type.

*The Rise of the New Physics* (Volume 1)  
Chapter XXI (pp. 371–372)

Dover Publications, Inc. New York, New York, USA. 1951

**Dyson, Freeman J.** 1923–

American physicist and educator

My message is that science is a human activity, and the best way to understand it is to understand the individual human beings who practice it. Science is an art form and not a philosophical method. The great advances in science usually result from new tools rather than from new doctrines. If we try to squeeze science into a single philosophical viewpoint such as reductionism, we are like Procrustes chopping off the feet of his guests when they do not fit onto his bed.

The Scientist as Rebel

*New York Times Book Review*, May 25, 1995

**Eiseley, Loren C.** 1907–77 American anthropologist, educator, and author

In the end, science as we know it has two basic types of practitioners. One is the educated man who still has a controlled sense of wonder before the universal mystery, whether it hides in a snail's eye or within the light that impinges on that delicate organ. The second kind of observer is the extreme reductionist who is so busy stripping things apart that the tremendous mystery has been reduced to a trifle, to intangibles not worth troubling one's head about.

*The Star Thrower*

Science and the Sense of the Holy (p. 190)

Times Books. New York, New York, USA. 1978

## REFEREE

**Broad, William** 1951–

Science writer

**Wade, Nicholas**

British-born scientific writer

The ultimate gatekeeper of science is neither peer reviews, nor referees, nor replication, nor the universalism implicit in all three mechanisms. It is time. In the end, bad theories don't work, fraudulent ideas don't explain the world so well as true ideas do. The ideal mechanisms by which science should work are applied to a large extent in retrospect .... Time and the invisible boot that kicks out all useless science are the true gatekeepers of science. But these inexorable mechanisms take years, sometimes more than a millennium, to operate. During the interval, fraud may flourish, particularly if it can find shelter under the mantle of immunity that scientific elitism confers.

*Betrayers of the Truth* (p. 106)

Simon & Schuster. New York, New York, USA. 1982

**Magueijo, Joao** 1967–

Theoretical physicist and cosmologist

Peer review is an unpaid and usually anonymous activity. Perhaps for this reason the average referee report is sloppy and sleazy. Reports usually reveal that the referee has not read the paper. Acceptance or rejection often reflects the personal relationship between authors and referee. Publishers have always been reluctant to open their files to historians of science and sociologists. Clearly they are embarrassed to reveal how little science, and how much sociology, there is in their files.

*Electronic Archives and the Death of Journals*

<http://theory.ic.ac.uk/Dmagueijo/com.pdf>

**Zoman, John M.**

No biographical data available

The referee is the lynchpin about which the whole business of Science is pivoted.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 6 (p. 111)

At The University Press. Cambridge, England. 1968

## REFORM

**Hilbert, David** 1862–1943

German mathematician

We have reformed mathematics, the next thing is to reform physics, and then we'll go on to chemistry.

*Hilbert — Courant*

Hilbert

Chapter XVI (p. 129)

Springer-Verlag. New York, New York, USA. 1986

## REGRESSION

**Cardozo, Benjamin N.** 1870–1938

American jurist

Where the line is to be drawn the important and the trivial cannot be settled by a formula.

Jacob & Youngs v. Kent, 230

*New York Reports* 239, 243, 1921

**Fiedler, Edgar R.** 1916–2003

American economist

Most economists think of God as working great multiple regressions in the sky.

The Three R's of Economic Forecasting — Irrational, Irrelevant and Irreverent

*Across the Board*, June 1977

**Juster, Norton** 1929–

American architect and author

Once upon a time, there was a sensible straight line who was hopelessly in love with a dot.

*The Dot and the Line: A Romance in Lower Mathematics*  
The Film (1965)

## RELATION

**Buchanan, Scott** 1895–1968

American educator and philosopher

Science is an allegory that asserts that the relations between the parts of reality are similar to the relations between terms of discourse.

*Poetry and Mathematics*

Chapter 5 (pp. 96–97)

The University of Chicago Press. Chicago, Illinois, USA. 1975

**Dingle, Herbert** 1890–1978

English astrophysicist

...if, as we must surely do, we wish to characterize science by the elements in it that persist and grow, and not by that which continually changes, we must recognize...the progressive discovery of relations between the various constituents of our experience... Amid all the changes of theories and pictures and conceptions, the relations remain and steadily accumulate. Franklin found that lightning was a manifestation of the electric ether revealed in laboratory experiments. The electric ether has disappeared, and other theories of electricity have in turn succeeded it and disappeared also, but the relation between lightning and laboratory sparks remains. Maxwell established a relation between light and electromagnetic oscillations. His ether also has gone, but the relation stays. All permanent advances in science are discoveries of relations between phenomena, and the factor in science that shows a steady uninterrupted growth is the extent of the field of related observations.

*The Scientific Adventure: Essays in the History and Philosophy of Science*

Chapter One (p. 40)

Pitman. London, England. 1952

**Durant, William James** 1885–1981

American historian and essayist

Science tells us how to heal and how to kill; it reduces the death rate in retail and then kills us wholesale in war; but only wisdom — desire coordinated in the light of all experience — can tell us when to heal and when to kill. For a fact is nothing except in relation to a purpose and a whole.

*The Story of Philosophy*

Introduction (p. 2)

Simon & Schuster. New York, New York, USA. 1953

**Fiske, John** 1842–1901

American philosopher and historian

The ability to imagine relations is one of the most indispensable conditions of all precise thinking. No subject can be named in the investigation of which it is not imperatively needed; but it can be nowhere else so thoroughly acquired as in the study of mathematics.

*Darwinism and Other Essays* (p. 296)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Keyser, Cassius Jackson** 1862–1947

American mathematician

To be is to be related.

*Mole Philosophy and Other Essays*

Chapter XVII (p. 94)

E.P. Dutton & Company, Inc. New York, New York, USA. 1927

**Schukarev, A. N.**

No biographical data available

At present one can consider it universally acknowledged that among the phenomena of inanimate nature there is no arbitrary will; here the unshakable connection between phenomena rule with complete authority — relations which we call laws. In the invariance of these relations we are even inclined to see the characteristic sign which differentiates the inanimate from the living.

In Michael D. Gordin

*A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the Periodic Table*

Chapter 2 (p. 15)

Basic Books, Inc. New York, New York, USA. 2004

## RELATIVITY

**Asimov, Isaac** 1920–92

American author and biochemist

No physicist who is even marginally sane doubts the validity of special relativity.

In Timothy Ferris (ed.)

*The World Treasury of Physics, Astronomy and Mathematics*

The Two Masses (p. 186)

Little Brown & Company. Boston, Massachusetts, USA. 1991

Special relativity is so much a part not only of physics but of everyday life, that it is no longer appropriate to view it as the special “theory” of relativity. It is a fact...

*Was Einstein Right?* (p. 246)

Basic Books, Inc. New York, New York, USA.

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

**Gribbin, John** 1946–

English science writer and astronomer

All the implications of special relativity... have been confirmed by direct experiments. There are still people who believe it is “just a theory.” But they are wrong.

*The Matter Myth: Dramatic Discoveries That Challenge Our*

*Understanding of Physical Reality* (p. 85)  
Simon & Shuster. New York, New York, USA. 1992

**Durell, Clement V.** 1882–1968  
English mathematician

Relativity without mathematics may be compared with “Painless Dentistry,” or “Skiing without Falling,” or “Reading without Tears.”

*Readable Relativity*  
Preface (p. ix)  
Harper & Brothers. New York, New York, USA. 1960

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

Results of measurements are the subject-matter of physics; and the moral of the theory of relativity is that we can only comprehend what the physical quantities stand for if we first comprehend what they are.

*The Mathematical Theory of Relativity*  
Conclusion (p. 240)  
At The University Press. Cambridge, England. 1930

We walk the stage of life, performers of a drama for the benefit of the cosmic spectator. As the scene proceeds, he notices that the actors are growing smaller and the action quicker. When the last act opens the curtain rises on midgets rushing through their parts at frantic speed.

*The Expanding Universe*  
Chapter III, Section VI (p. 91–92)  
The University Press. Cambridge. 1933

**Einstein, Albert** 1879–1955  
German-born physicist

There is something attractive in presenting the evolution of a sequence of ideas in as brief a form as possible, and yet with a completeness sufficient to preserve throughout the continuity of development. We shall endeavor to do this for the Theory of Relativity, and to show that the whole ascent is composed of small, almost self-evident steps of thought.

A Brief Outline of the Development of the Theory of Relativity  
*Nature*, Volume 106, Number 2677, 17 February 1921 (p. 782)

When you are courting a nice girl an hour seems like a second. When you sit on a red-hot cinder a second seems like an hour. That’s relativity.

*News Chronicle*, 14 March 1949

Ought we to smile at the man and say that he errs in his conclusion? I do not believe we ought to if we wish to remain consistent; we must rather admit that his mode of grasping the situation violates neither reason nor known mechanical laws. Even though it is being accelerated with respect to the “Galilean space” first considered, we can nevertheless regard the chest as being at rest. We have thus good grounds for extending the principle of relativity to include bodies of reference which are accelerated

with respect to each other, and as a result we have gained a powerful argument for a generalised postulate of relativity.

Translated by Robert W. Lawson  
*Relativity: The Special and General Theory*  
Part II, Chapter 20 (p. 88)  
Pi Press. New York, New York, USA. 2005

I sometimes ask myself how it came about that I was the one to develop the theory of relativity. The reason, I think, is that a normal adult never stops to think about problems of space and time. These are things which he has thought of as a child. But my intellectual development was retarded, as a result of which I began to wonder about space and time only when I had already grown up.

In John D. Barrow  
*Theories of Everything: The Quest for Ultimate Explanation*  
Chapter Three (p. 68)  
The Clarendon Press. Oxford. London. 1991

The meaning of relativity...has been widely misunderstood. Philosophers play with the word, like a child with a doll. Relativity, as I see it, merely denotes that certain physical and mechanical facts, which have been regarded as positive and permanent, are relative with regard to certain other facts in the sphere of physics and mechanics. It does not mean that everything in life is mischievously topsy-turvy.

What Life Means to Einstein: An Interview by George Sylvester Viereck  
*The Saturday Evening Post*, October 26, 1929 (p. 17)

**Greene, Brian** 1963–  
American physicist

...general relativity and quantum mechanics, when combined, begin to shake, rattle, and gush with steam like a red-lined automobile.

*The Elegant Universe*  
Chapter 1 (p. 4)  
W.W. Norton & Company, Inc. New York, New York, USA.2003

**Haldane, R. B.** 1856–1928  
British liberal and labor politician

It is only a world embodying the principle of relativity, in the form which the doctrine entails, that can be said to exhibit the character of mind, with its exclusion of disconnected fragments and relations.

*The Reign of Relativity* (p. 138)  
Yale University Press. New Haven, Connecticut, USA. 1921

**Harrison, B.**  
No biographical data available

**Thorne, Kip S.** 1940–  
American theoretical physicist

If one intends to abandon Relativity, here is the place [black holes] to do so. Otherwise one is on the way to a new world of physics, both classical and quantum. Here we go!

In Jean-Pierre Luminet  
*Black Holes* (p. 117)  
 Cambridge University Press. New York, New York, USA. 1992

**Holton, Gerald** 1922–  
 Research professor of physics and science history

The cliché became, erroneously, “everything is relative”; whereas the point is that out of the vast flux one can distill the very opposite: “some things are invariant.”

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*  
 Part 1, Chapter 6 (p. 131)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

Relativity theory, of course, does not find that truth depends on the point of view of the observer but, on the contrary, reformulates the laws of physics so that they hold good for all observers, no matter how they move or where they stand. Its central meaning is that the most valued truths in science are independent of the point of view.... Einstein did not prove the work of Newton wrong; he provided a larger setting within which some limitations, contradictions, and asymmetries in the earlier physics disappeared.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*  
 Part 1, Chapter 2 (p. 48)  
 Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Krauss, Lawrence M.** 1954–  
 American theoretical physicist

Einstein was thus faced with the following apparent problem. Either give up the principle of relativity, which appears to make physics possible by saying that the laws of physics are independent of where you measure them, as long as you are in a state of uniform motion; or give up Maxwell’s beautiful theory of electromagnetism and electromagnetic waves. In a truly revolutionary move, he chose to give up neither.... It is a testimony to his boldness and creativity not that he chose to throw out existing laws that clearly worked, but rather that he found a creative way to live within their framework. So creative, in fact, that it sounds nuts.

*Fear of Physics: A Guide for the Perplexed*  
 Chapter 3 (p. 78)  
 Basic Books, Inc. New York, New York, USA. 1993

Indeed, long before the Star Trek writers conjured up warp fields, Einstein warped spacetime, and, like the Star Trek writers, he was armed with nothing other than his imagination. Instead of imagining twenty-second-century starship technology, however, Einstein imagined an elevator. He was undoubtedly a great physicist, but he probably never would have sold a screenplay.

*The Physics of Star Trek*

Chapter Three (p. 31)  
 Harp Perennial Publishers. New York, New York, USA. 1995

**L. L. Cool J.** 1968–  
 American hip hop artist and actor

Grab hold of a hot pan and a second can seem like an hour. Put your hands on a hot woman and an hour can seem like a second.

*Deep Blue Sea*  
 Film (1999)

**Lindley, David** 1956–  
 English astrophysicist and author

Relativity removes from physics the authoritarian rule of classical physics, with its absolute space and time, and replaces it not with anarchy, in which all participants have their own rules, but with perfect democracy, in which the same rules govern all.... It may seem unsatisfactory to respond that there can be only one correct theory of space and time, and that Einstein’s happens to be it, but for the physicist such an answer has to suffice. Relativity, like other physical theories, is a set of rules based on a number of crucial assumptions, and experiment and observation bear it out. That is all we ever ask of physical theories, and to ask for some further statement of why the special theory of relativity supplanted absolute Newtonian spacetime is to search for a truth beyond the domain of science.

*The End of Physics: The Myth of a Unified Theory*  
 Part I, Chapter 2 (p. 60, 61)  
 Basic Books, Inc. New York, New York, USA. 1993

**Lindon, J. A.**  
 English writer of comic verse

When they questioned her, answered Miss Bright,  
 “I was there when I got home that night;  
 So I slept with myself,  
 Like two shoes on a shelf,  
 Put-up relatives shouldn’t be tight!”

In Martin Gardner  
*Time Travel and Other Mathematical Bewilderments*  
 Chapter One (p. 9)  
 W.H. Freeman & Company. New York, New York, USA. 1988

**Mach, Ernst** 1838–1916  
 Austrian physicist and philosopher

I can accept the theory of relativity as little as I can accept the existence of atoms and other such dogmas.

In Stephen Pile  
*The Book of Heroic Failures*  
 Routledge & Kegan Paul. London, England. 1979

**Nabokov, Vladimir** 1899–1977  
 Russian-American writer

At this point, I suspect, I should say something about my attitude to “Relativity.” It is not sympathetic. What many



cosmogonists tend to accept as an objective truth is really the flaw inherent in mathematics which parades as truth.

*Ada or Ardor: A Family Chronicle*

Part Four (p. 543)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

General relativity has very few connections with any other part of physics and, as I said, is something that we might just now be beginning to discover...

*The Flying Trapeze: Three Crises for Physics*

Space and Time (p. 23)

Oxford University Press, Inc. London, England. 1964

**Page, Leigh** 1884–1952

American physicist

The rotating armatures of every generator and motor in this age of electricity are steadily proclaiming the truth of the relativity theory to all who have ears to hear.

Filler material

*American Journal of Physics*, Volume 43, Number 4, April 1975 (p. 330)

**Rindler, Wolfgang** 1952–

German writer

Relativity has taught us to be wary of time.

*Essential Relativity* (p. 203)

Van Nostrand Company, Inc. New York, New York, USA. 1969

**Rogers, Eric**

No biographical data available

Since Relativity is a piece of mathematics, popular accounts that try to explain it without mathematics are almost certain to fail.

*Physics for the Inquiring Mind*

Chapter 31 (p. 472)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Rothman, Tony** 1953–

American cosmologist

Relativity does not mean everything is relative. And the brilliance of Einstein's discoveries is so great that no amount of journalistic overkill has managed to dim it. Einstein and Bach are the only two people who deserve their reputations.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Chapter 5 (p. 115)

Ballantine Books. New York, New York, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Einstein's theory of relativity is probably the greatest synthetic achievement of the human intellect up to the present time.

*N.Y. Times*, April 19, 1955

**Sciama, Dennis** 1926–99

English physicist

General relativity contains within itself the seeds of its own destruction.

In John D. Barrow

*The World Within the World* (p. 306)

Clarendon Press. Oxford, England. 1988

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

The orbit of the electron observes no law: it chooses one path and rejects another: it is as capricious as the planet Mercury, who wanders from his road to warm his hands at the sun. All is caprice: the calculable world has become incalculable.

*Bernard Shaw's Plays*

Too True to Be Good: A Political Extravaganza

Act III

W.W. Norton & Company, Inc. New York, New York, USA. 1970

**Thomson, Sir Joseph John** 1856–1940

English physicist

It [relativity] was not a discovery of an outlying island, but of a whole continent of new scientific ideas of the greatest importance to some of the most fundamental questions connected with physics.

Eclipse Showed Gravity Variation: Hailed as Epochmaking

*The New York Times*, November 9, 1919 (p. 6)

**Weyl, Hermann** 1885–1955

German mathematician

It is as if a wall which separated us from Truth has collapsed. Wider expanses and greater depths are now exposed to the searching eye of knowledge, regions of which we had not even a presentiment. It has brought us much nearer to grasping the plan that underlies all physical happening.

Translated by Henry L. Brose

*Space — Time — Matter*

Preface to the First Edition (p. ix)

Dover Publications, Inc. New York, New York, USA. 1922

**Williams, W.**

No biographical data available

You hold that time is badly warped,

That even light is bent;

I think I get the idea there,

If this is what you meant;

The mail the postman brings me today,

Tomorrow will be sent.

In Ronald W. Clark

*Einstein: The Life and Times*

Part Four, Chapter 12 (p. 330)

The World Publishing Company. New York, New York, USA. 1971

**RELIABILITY**

**Adams, George** 1750–95  
English instrument maker

The mind of man admits with reluctance the truth of every testimony concerning matters of fact, which happen to be repugnant to the uniform experience of his senses; hence the general backwardness to believe the miracles in the Bible: and hence the Dutchman, who informed the king of Siam that water in his country would sometimes in cold weather be found so hard, that men walked upon it, and that it would bear an elephant, was esteemed a person unworthy of credit. Hitherto, says the king, I have believed the strange things you told me, because I looked upon you as a sober man, but now I am sure you lie.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture VI (pp. 279–280)  
Printed by R. Hindmarsh. London, England. 1794

**RELIGION**

**Barrow, John D.** 1952–  
English theoretical physicist

If a “religion” is defined to be a system of ideas that contains unprovable statements, then Gödel has taught us that, not only is mathematics a religion, it is the only religion that can prove itself to be one.

*Between Inner Space and Outer Space* (p. 88)  
Oxford University Press, Inc. New York, New York, USA. 1999

**Einstein, Albert** 1879–1955  
German-born physicist

It is quite clear to me that the religious paradise of youth, which [I] lost, was a first attempt to free myself from the chains of the “merely personal,” from an existence which is dominated by wishes, hopes, and primitive feelings.

In Gerald Holton  
*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*  
Part Two, Chapter 8 (p. 172)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

[My] deep religiosity...found an abrupt ending at the age of twelve, through the reading of popular scientific books.

In Gerald Holton  
*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*  
Part Two, Chapter 8 (p. 172)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Ferrer, Francisco** 1849–1909  
Spanish anarchist

When the masses become better informed about science, they will feel less need for help from supernatural Higher Powers. The need for religion will end when man becomes sensible enough to govern himself.

In James A. Haught (ed.)  
*2000 Years of Disbelief: Famous People with the Courage to Doubt*  
Part Six: The Early Twentieth Century Chapter 52 (p. 224)  
Prometheus Books. Amherst, New York, USA. 1996

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

I do get discouraged when some of my colleagues tout their private atheism (their right, of course, and in many ways my own suspicion as well) as a panacea for human progress against a caricature of “religion,” erected as a straw man for rhetorical purposes... If these colleagues wish to fight superstition, irrationalism, philistinism, ignorance, dogma, and a host of other insults to the human intellect, then God bless them — but don’t call this enemy “religion.”

*Rocks of Ages*  
The Two False Paths of Irenics (pp. 209–210)  
The Ballantine Publishing Group. New York, New York, USA. 1999

**RENORMALIZATION**

**Berry, Sir Michael**  
No biographical data available

In The Renormalization Group method you take a structure you don’t understand and convert it to another structure you don’t understand. You keep doing it until you finally understand.

2002 Gibbs Lecture, San Diego, California, January 6, 2002

**REPAIR**

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

The major difference between a thing that might go wrong and a thing that cannot possibly go wrong is that when a thing that cannot possibly go wrong goes wrong, it usually turns out to be impossible to get at and repair.

*The Ultimate Hitchhiker’s Guide to the Galaxy*  
Mostly Harmless  
Chapter 12 (p. 720)  
Ballantine Books. New York, New York, USA. 2002

**REPLICA**

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

For, whereas you can make a replica of an ancient statue, there is no possible replica of an ancient state of mind. There can be no nearer approximation [of one] than that which a masquerade bears to real life.

*Science and the Modern World*  
Chapter IX (p. 200)  
The Macmillan Company, New York, New York, USA. 1929

## REPORT

**Kettering, Charles Franklin** 1876–1958  
American engineer and inventor

Some technical reports are so dry and dusty...that if you put a pile of them in a hydraulic press and apply millions of pounds of pressure to it, not a drop of juice will run out.

*Professional Amateur*  
Part III, Chapter XXI (p. 215)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1957

## REPRODUCTION

**Bateson, William** 1861–1926  
English biologist and geneticist

I know nothing which to a man well trained in scientific knowledge and method brings so vivid a realisation of our ignorance of the nature of life as the mystery of cell-division.... It is this power of spontaneous division which most sharply distinguishes the living from the non-living.... The greatest advance I can conceive in biology would be the discovery of the instability which leads to the continued division of the cell. When I look at a dividing cell I feel as an astronomer might do if he beheld the formation of a double star: that an original act of creation is taking place before me.

In Louise B. Young (ed.)  
*The Mystery of Matter*  
Aspects of Immortality, Death, and Reproduction (p. 403)  
Oxford University Press, Inc. New York, New York, USA. 1965

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

We can set no limit to human potentialities; all that is best in man can be bettered...The ordinary social reformer sets out with a belief that no environment can be too good for humanity; it is without contradicting this that the eugenist may add that man can never be too good for his environment.

Some Hopes of a Eugenist  
*Eugenics Review*, 5:309, 1914

**Fletcher, Joseph** 1905–91  
Anglican theologian and founder of the theory of situational ethics

Our basic ethical choice as we consider man's new control over himself, over his body and his mind as well as over his society and environment, is still what it was when primitive men holed up in caves and made fires. Chance versus control. Should we leave the fruits of

human reproduction to take shape at random, keeping our children dependent on accidents of romance and genetic endowment, of sexual lottery or what one physician calls "the meiotic roulette of his parents' chromosomes?" Or should we be responsible about it, that is, exercise our rational and human choice, no longer submissively trusting to the blind worship of raw nature?

*The Ethics of Genetic Control: Ending Reproductive Roulette*  
Chapter I. Trying to be Natural (p. 36)  
Prometheus Books, Buffalo, New York, USA. 1988

**Huxley, Julian** 1887–1975  
English biologist, philosopher, and author

The pioneers of Eugenic Insemination by Donor...will be accused of mortal sin, of theological impropriety, of immoral and unnatural practices. But they can take heart from what has happened in the field of birth control, and can be confident that the rational control of reproduction aimed at the prevention of human suffering and frustration and the promotion of human well-being and fulfillment will in the not too distant future come to be recognized as a moral imperative.

*Eugenics Review*, Volume 54, 1963 (p. 123)

**Pearson, Karl** 1857–1936  
English mathematician

A majority of the community would probably also admit today that the physical characters of man are inherited with practically the same intensity as the like characters in cattle and horses. But few, however..., apply the results which flow from such acceptance to their own conduct in life.

On the Laws of Inheritance in Man  
*Biometrika*, Volume 3, 1904 (p. 131)

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...impregnation will be regarded in an entirely different manner, more in the light of a surgical operation, so that it will be thought not ladylike to have it performed in the natural manner.

*The Scientific Outlook*  
Chapter XVI (p. 262)  
George Allen & Unwin Ltd. London, England. 1931

## The Bible

Generations come and generations go...

*The Revised English Bible*  
Ecclesiastes 1:2  
Oxford University Press, Inc. Oxford, England. 1989

**Zihlman, Adrienne**  
American paleoanthropologist

As with most things in life, the debate centers on two themes: food and sex; or to give it a proper academic tone: diet and reproduction.

Sex, Sexes and Sexism in Human Origins  
*Yearbook of Physical Anthropology*, Volume 30, 12 April 1985 (p. 11)

## RESEARCH

**Abbe, Cleveland** 1838–1916  
 American meteorologist

The ultimate goal of scientific research is not the collection of facts furnished by explorations and surveys, not even the exact data furnished by the most laborious measurements as in astronomy, geodesy, chemistry, and physics. Neither is it the framing of a few generalizations and inductions, such as the general idea of evolution; nor is it the establishment of some isolated fundamental laws, such as the attraction of gravitation, the conservation of energy, the mechanical equivalent of heat, the atomic weights and their periodic law. Research aims to go deeper than all this and show how these laws and phenomena result necessarily from a few simple premises — not premises in the sense of assumption, but axioms that are just as truly the basis of the physical universe as Euclid's axioms are the basis of geometry.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1907

The Progress of Science as Illustrated by the Development of Meteorology (p. 287)  
 Government Printing Office. Washington, D.C. 1908

**Adams, George** 1750–95  
 English instrument maker

The best directed and most successful researches only inform us how little is known, and give us no cause to be satisfied with the discoveries they have made.

*Lectures on Natural and Experimental Philosophy* (Volume 3)  
 Chapter XXXV (p. 512)  
 Printed by R. Hindmarsh. London, England. 1794

The more diligent our search, the more accurate our scrutiny, the more we are convinced that our labours can never finish, and that subjects inexhaustible remain behind still unexplored.

*Lectures on Natural and Experimental Philosophy* (Volume 1)  
 Lecture X (p. 421)  
 Printed by R. Hindmarsh. London, England. 1794

**Agnew, Neil McK.**  
 No biographical data available

**Pyke, Sandra W.**  
 No biographical data available

Research is like a love affair. The ingredients include: (1) your image of the girl; (2) the real girl as she would appear to you if you...had access to all information about her; and (3) the bits, pieces, or samples of information you have, some of it clear, some of it vague, some of it twisted by memory or biased senses.... Changing a

once-loved picture is a very painful process, and we know the degrees to which a lover will go to ignore, twist, and blink away negative data...

*The Science Game*  
 Leaping to Conclusions (p. 128)  
 Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1969

**Asimov, Isaac** 1920–92  
 American author and biochemist

...One can appreciate and take pleasure in the achievements of science even though he does not himself have a bent for creative work in science.... Initiation into the magnificent world of science brings great aesthetic satisfaction, inspiration to youth, fulfillment of the desire to know, and a deeper appreciation of the wonderful potentialities and achievements of the human mind.

*Asimov's New Guide to Science*  
 What Is Science? (p. 15)  
 Basic Books, Inc. New York, New York, USA. 1984

### Author undetermined

Great cabinets may be unlocked by little keys.  
 Astronomical Observations  
*Nature*, Volume 4, May 11, 1871 (p. 31)

**Bachrach, Arthur J.**  
 No biographical data available

...people don't usually do research the way people who write books about research say that people do research.

*Psychological Research: An Introduction*  
 Introduction (pp. 19–20)  
 Random House, Inc. New York, New York, USA. 1965

**Ball, Sir Robert S.** 1840–1913  
 Astronomer

Just as the astronomer staggers our powers of conception by the description of appalling distances and stupendous periods of time, and relies with confidence on the evidence which convinces him of the reality of his statements, so the physicist avails himself of a like potent method of research to study distances so minute and time so brief that the imagination utterly fails to realize them.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1893  
 Atoms and Sunbeams (p. 127)  
 Government Printing Office. Washington, D.C. 1894

**Barrie, Sir James M.** 1860–1937  
 Scottish journalist, writer, and dramatist

...those hateful persons...Original Researchers...

*My Lady Nicotine*  
 Chapter XIII (p. 85)  
 Charles Scribner's Son's. New York, New York, USA. 1921

**Bates, Marston** 1906–74  
 American zoologist

Research is the process of going up alleys to see if they are blind.

In Jefferson Hane Weaver  
*The World of Physics* (Volume 2)  
K.6 (p. 63)

Simon & Schuster. New York, New York, USA. 1987

**Baum, L. Frank** 1856–1919

American author

“But, dear me, in that case you will never find your lost brother!” exclaimed the girl.

“Maybe not; but it’s my duty to try,” answered Shaggy. “I’ve wandered so far without finding him, but that only proves he is not where I’ve been looking.”

*Tik-Tok of Oz*

Chapter Six

The Reilly & Lee Company. Chicago, Illinois, USA. 1914

**Belloc, Hilaire** 1870–1953

French-born poet and historian

...anyone of common mental and physical health can practice scientific research.... Anyone can try by patient experiment what happens if this or that substance be mixed in this or that proportion with some other under this or that condition. Anyone can vary the experiment in any number of ways. He that hits in this fashion on something novel and of use will have fame.... The fame will be the product of luck, and industry. It will not be the product of special talent.

*Essays of a Catholic*

Science as the Enemy of Truth (pp. 226–227)

The Macmillan Company. New York, New York, USA. 1931

**Beveridge, William Ian Beardmore** 1908–

Australian zoologist

People in most other walks of life can allow themselves the indulgence of fixed ideas and prejudices which make thinking so much easier...but the research worker must try to keep his mind malleable and avoid holding set ideas in science. We have to strive to keep our mind receptive and to examine suggestions made by others fairly and on their own merits, seeking arguments for as well as against them. We must be critical, certainly, but beware lest ideas be rejected because an automatic reaction causes us to see only the arguments against them. We tend especially to resist ideas competing with our own.

*The Art of Scientific Investigation*

Chapter Seven (p. 86)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

Research is one of those highly complex and subtle activities that usually remain quite unformulated in the minds of those who practice them. This is probably why most scientists think that it is not possible to give any formal instruction in how to do research.

*The Art of Scientific Investigation*

Preface (pp. ix–x)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

The research worker remains a student all his life.

*The Art of Scientific Investigation*

Chapter One (p. 1)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

Anyone with an alertness of mind will encounter in the course of an investigation numerous interesting side issues that might be pursued. It is a physical impossibility to follow up all of these. The majority are not worth following, a few will reward investigation and the occasional one provides the opportunity of a lifetime. How to distinguish the promising clues is the very essence of the art of research.

*The Art of Scientific Investigation*

Chapter Three (p. 35)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Birch, Arthur J.** 1915–1995

Australian chemist

The details of a research career are dictated partly by accident, but largely by inclinations and temperament.

*To See the Obvious*

Prelude, and Evolution of a Chemist (p. 7)

American Chemical Society. Washington, D.C. 1995

**Bradley, A. C.** 1851–1935

English literary scholar

Research, though toilsome, is easy; imaginative vision, though delightful, is difficult.

*Oxford Lectures on Poetry*

Shakespeare’s Theatre and Audience (p. 362)

Macmillan & Company Ltd. London, England. 1909

**Brown, J. Howard**

No biographical data available

A man may do research for the fun of doing it but he can not expect to be supported for the fun of doing it.

*The Biological Approach to Bacteriology*

*Journal of Bacteriology*, Volume 18, Number 1, January 1932 (p. 9)

**Browning, Robert** 1812–89

English poet

...as is your sort of mind,

So is your sort of search: you’ll find

What you desire.

*The Poems and Plays of Robert Browning*

Easter Day, Part vii, l. 3 (p. 501)

The Modern Library. New York, New York, USA. 1934

**Bunge, Mario** 1919–

Argentine philosopher and physicist

Most scientists are prepared to grant that the chief theoretical (that is, nonpragmatic) aim of scientific research is to answer, in an intelligible, exact, and testable way,

five kinds of questions, namely those beginning with what (or how), where, when, whence, and why.... [T]he Five W's of Science. (Only radical empiricists deny that science has an explanatory function, and restrict the task of scientific research to the description and prediction of observable phenomena.) Also, most scientists would agree that all five W's are gradually (and painfully) being answered through the establishment of scientific laws, that is, general hypotheses about the patterns of being and becoming.

*Causality: The Place of the Causal Principle in Modern Science*  
Chapter 10 (p. 248)  
Harvard University Press. Cambridge, Massachusetts, USA. 1959

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

Basic research leads to new knowledge. It provides scientific capital. It creates the fund from which the practical applications of knowledge must be drawn. New products and new processes do not appear full-grown. They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science.

*Endless Horizons*  
Chapter 5 (pp. 52–53)  
Public Affairs Press. Washington, D.C. 1946

In these circumstances it is not at all strange that the workers sometimes proceed in erratic ways. There are those who are quite content, given a few tools, to dig away, unearthing odd blocks, piling them up in the view of fellow workers and apparently not caring whether they fit anywhere or not.... Some groups do not dig at all, but spend all their time arguing as to the exact arrangement of a cornice or an abutment. Some spend all their days trying to pull down a block or two that a rival has put in place. Some, indeed, neither dig nor argue, but go along with the crowd, scratch here and there, and enjoy the scenery. Some sit by and give advice, and some just sit.

*Endless Horizons*  
Chapter 17 (p. 180)  
Public Affairs Press. Washington, D.C. 1946

**Capra, Fritjof** 1939–  
Austrian-born American physicist

Scientists, therefore, are responsible for their research not only intellectually but also morally...the results of quantum mechanics and relativity theory have opened up two very different paths for physics to pursue. They may lead us — to put it in extreme terms — to the Buddha or to the bomb, and it is up to each of us to decide which path to take.

*The Turning Point*  
Chapter II (p. 87)  
A Bantam Book. New York, New York, USA. 1983

**Carrel, Alexis** 1873–1944  
French surgeon and biologist

In researches dealing with physics and chemistry, and also with physiology, one always attempts to isolate relatively simple systems, and to determine their exact conditions.

*Man the Unknown*  
Chapter 2, Section 5 (pp. 50–51)  
Harper & Brothers. New York, New York, USA. 1939

**Caullery, Maurice** 1868–1958  
French biologist

The double danger of research into this type of phenomenon lies, on the one hand, in bringing...pre-conceived ideas of too subjective a nature, bordering on an illusory anthropomorphism, and on the other hand, trying to reduce complex facts to simple elementary reactions.

Translated by Averil M. Lysaght  
*Parasitism and Symbiosis*  
Chapter I (p. 2)  
Sidgwick & Jackson Limited. London, England. 1952

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Research is the search of people who don't know what they want.

*The G.K. Chesterton Calendar*  
May 25  
Cecil Palmer & Hayward. London, England. 1916

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

In research the front line is almost always in a fog.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 3 (p. 35)  
Basic Books, Inc. New York, New York, USA. 1988

**Cussler, Clive**  
American author

**Dirgo, Craig**  
No biographical data available

Research is the key. You can never do enough research. This is so vital I'll repeat it. You can never to enough research.... Research can either lower the odds or tell you it's hopeless.

*The Sea Hunters*  
Introduction (p. 28)  
Simon & Schuster. New York, New York, USA. 1996

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Nothing is written as the result of new researches.

*Leonardo da Vinci's Note Books* (p. 53)  
Duckworth & Company. London, England. 1906

**Dawkins, Richard** 1941–

English ethologist, evolutionary biologist, and popular science writer

Existing science must be overthrown not by casual anecdotes but by the most rigorous research, repeated, dissected, and repeated again.

Putting Away Childish Things

*Skeptical Inquirer*, Jan/Feb 1995 (p. 31)

**Day, R. A.**

No biographical data available

The goal of scientific research is publication. Scientists, starting as graduate students, are measured primarily not by their innate knowledge of either broad or narrow scientific subjects, and certainly not by their wit or charm; they are measured, and become known (or remain unknown), by their publications.

*How to Write and Publish a Scientific Paper* (3<sup>rd</sup> edition) (p. vii)

Oryx Press. Phoenix, Arizona, USA. 1988

**Dessauer John** 1792–1871

English astronomer and chemist

All the efforts of the researcher to find other models, conceptions, different mathematical forms, better linguistic modes of expression, to do justice to newly discovered layers of being mean self-transformation. The researcher in his place is the human being in self-transformation to more profound insight into what is given.

*Universitas: A Quarterly German Review of the Arts and Sciences*,

Volume 26, Number 4, April 6, 1984 (p. 316)

**Dr. Gil**

No biographical data available

There! Little Research, don't you cry —

You'll be a paper by and by.

Three observations — half a page of notes,

Will bring prostration to seven other blokes.

The Professor Sings to His Brain Child

*Industrial and Engineering Chemistry: News Edition*, Volume 11, Number 9, 19 May 1933 (p. 149)

**Einstein, Albert** 1879–1955

German-born physicist

When a man after long years of searching chances upon a thought which discloses something of the beauty of this mysterious universe, he should not therefore be personally celebrated. He is already sufficiently paid by his experience of seeking and finding.

*New York Times*, 128:18, Section 4, November 10, 1978

**Freeman, R. Austin** 1862–1943

British physician and mystery novelist

...in scientific research there is no...division of function. The investigator is at once judge, jury, and witness. His knowledge is first-hand, and hence he knows the exact value of his evidence. He can hold a suspended

judgment. He can form alternative opinions and act upon both alternatives. He can construct hypotheses and try them out. He is hampered by no rules but those of his own making. Above all, he is able to interrogate things as well as persons.

*A Certain Dr. Thorndyke*

Thorndyke Connects the Links (pp. 277–278)

Dodd, Mead & Company. New York, New York, USA. 1928

**George, William H.**

No biographical data available

Scientific research is not itself a science: it is still an art or craft.

*The Scientist in Action: A Scientific Study of His Methods*

Four Qualities of Scientific Research (p. 29)

Williams & Norgate Ltd. London, England. 1936

**Gibbs, J. Willard** 1839–1903

American mathematician

One of the principal objects of theoretical research in any department of knowledge is to find the point of view from which the subject appears in its greatest simplicity.

In G. K. Batchelor

Preoccupations of a Journal Editor

*Journal of Fluid Mechanics*, Volume 106, 1981

**Green, Celia** 1935–

English philosopher and psychologist

Research is a way of taking calculated risks to bring about incalculable consequences.

*The Decline and Fall of Science*

Aphorisms (p. 1)

Hamilton. London, England. 1976

The way to do research is to attack the facts at the point of greatest astonishment.

*The Decline and Fall of Science*

Aphorisms (p. 1)

Hamilton. London, England. 1976

**Gregg, Alan** 1890–1957

American medical educator and philosopher

Research has been defined as a guerrilla warfare on the unknown. In the rigorous uncertainties of such campaigns the investigator must be prepared to swap horses in mid-stream and to discard some very dear items of accumulated baggage of belief or personal pride, whenever intellectual honesty calls for such sacrifices.

*The Furtherance of Medical Research*

Chapter III (pp. 87–88)

Yale University Press. New Haven, Connecticut, USA. 1941

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

If I were asked what was Christopher Columbus' greatest achievement in discovering America, my answer would

not be that he took advantage of the spherical shape of the earth to get to India by the western route — this idea had occurred to others before him — or that he prepared his expeditions meticulously and rigged his ships most expertly — that, too, others could have done equally well. His most remarkable feat was the decision to leave the known regions of the world and to sail westward, far beyond the point from which provisions could have gotten him back home again.

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 70)

Harper & Row, Publishers. New York, New York, USA. 1971

...the subject matter of research is no longer nature in itself, but nature subjected to human questioning...

In Aldous Huxley

*Literature and Science*

Chapter 25 (p. 76)

Harper & Row, Publishers. New York, New York, USA. 1963

**Heschel, Abraham J.** 1907–72

Jewish theologian

Scientific research is an entry into the endless, not a blind alley; Solving one problem, a greater one enters our sight. One answer breeds a multitude of new questions; explanations are merely indications of greater puzzles. Everything hints at something that transcends it; the detail indicates the whole, the whole, its idea, the idea, its mysterious root. What appears to be a center is but a point on the periphery of another center. The totality of a thing is actual infinity.

*Analog Science Fiction/Science Fact Magazine*, Volume CIV, Number 12, December 1984 (p. 63)

**Hubble, Edwin Powell** 1889–1953

American astronomer

Research men attempt to satisfy their curiosity, and are accustomed to use any reasonable means that may assist them toward the receding goal. One of the few universal characteristics is a healthy skepticism toward unverified speculations. These are regarded as topics for conversation until tests can be devised. Only then do they attain the dignity of subjects for investigation.

*The Realm of the Nebulae*

Introduction (p. 6)

Dover Publications, Inc. New York, New York, USA. 1958

**Hurston, Zora Neale** 1891–1960

American author and anthropologist

Research is formalized curiosity. It is poking and prying with a purpose.

*Dust Tracks on a Road*

Chapter X (p. 174)

University of Illinois Press. Urbana, Illinois, USA. 1984

**Jaffe, Bernard** 1896–1968

American science writer

There is no last word or ultimate solution in the adventure of scientific research.

*Michelson and the Speed of Light*

Chapter XII (p. 171)

Doubleday & Company, Inc. Garden City, New York, USA. 1960

**Jevons, William Stanley** 1835–82

English economist and logician

So-called original research is now regarded as a profession, adopted by hundreds or men, and communicated by a system of training.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book IV, Chapter XXVI (p. 574)

Macmillan & Company Ltd. London, England. 1887

**Johnson, Harry G.** 1923–79

American economist

To an important extent, indeed, scientific research has become the secular religion of materialistic society; and it is somewhat paradoxical that a country whose constitution enforces the strict separation of church and state should have contributed so much public money to the establishment and propagation of scientific pessimism.

In National Academy of Sciences

*Basic Research and National Goals: A Report to the Committee on Science and Astronautics Federal Support of Basic Research: Some Economic Issues*

Note 4 (p. 141)

U.S. Government Printing Office. Washington, D.C. 1965

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

We find that in research a certain amount of intelligent ignorance is essential to progress; for if you know too much, you won't try the thing.

In T.A. Boyd

*Professional Amateur*

Part II (p. 106)

E.P. Dutton & Company, Inc. New York, New York, USA. 1957

**Kettering, Charles Franklin** 1876–1958

American engineer and inventor

**Smith, Beverly**

No biographical data available

[Research] may use a laboratory or it may not. It is purely a principle, and everybody can apply it in his own life. It is simply a way of trying to find new knowledge and ways of improving things which you are not satisfied with.

Ten Paths to Fame and Fortune

*The American Magazine*, December 1937 (p. 14)

**Kline, Morris** 1908–92

American mathematics professor and writer

Mathematical research is also becoming highly professionalized in the worst sense of that term. Research



performed voluntarily and sincerely by devoted souls, research as a relish of knowledge, is to be welcomed even if the results are minor. But hothouse-grown research, which crowds the journals and promotes only promotion, is a drag on science.

*Why the Professor Can't Teach: Mathematics and the Dilemma of University Education*

Chapter 3 (p. 67)

St. Martin's Press. New York, New York, USA. 1977

**Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

...all great researches, all discoveries revolutionizing science, have been made outside academies and universities, wither by men rich enough to remain independent, like Darwin and Lyell, or by men who undermined their health by working in poverty, and often in great straits, losing endless time for want of a laboratory, and unable to procure the instruments or books necessary to continue their researches, but persevering against hope, and often dying before they had reached the end in view. Their name is legion.

*The Conquest of Bread*

Chapter IX, Section IV (p. 103)

Vanguard Press. New York, New York, USA. 1926

**Lasker, Albert D.** 1901–70

“Research,” he said, “is something that tells you that a jackass has two ears.”

In John Gunther

*Taken at the Flood: The Story of Albert D. Lasker* (p. 96)

Harper & Brothers. New York, New York, USA. 1960

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The aim of research is the discovery of the equations which subsist between the elements of phenomena.

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 205)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

...scientific research is somewhat like unraveling complicated tangles of strings, in which luck is almost as vital as skill and accurate observation.

*Knowledge and Error: Sketches on the Psychology of Enquiry*

Chapter I (p. 10)

D. Reidel Publishing Company. Dordrecht, Netherlands. 1976

**Mallove, Eugene F.** 1947–2004

Editor

The image of a searching man held by Einstein and by Isaac Newton two hundred years before him is of a being wading in the shallows of the ocean of physical reality — trying to fathom the entirety by sampling only a part.

*The Quickening Universe: Cosmic Evolution and Human Destiny*

Prologue (p. xvi)

St. Martin's Press. New York, New York, USA. 1987

Human beings individually have only a brief time in this world to form an image of the cosmos. Their minds are like film in a camera of awareness. Birth and death are the opening and closing of the shutters. Yet generations of striving to understand have led to a picture of the universe far more complete than any of us alone could have hoped to develop.

*The Quickening Universe: Cosmic Evolution and Human Destiny*

Prologue (pp. xviii–xix)

St. Martin's Press. New York, New York, USA. 1987

**Mayr, Ernst** 1904–2005

German-born American biologist

...research not only brings us abundant joy but it also gives us a deep sense of humility.

In Walter Shropshire, Jr. (ed.)

*The Joys of Research*

Evolutionary Biology (p. 157)

Smithsonian Institution Press. Washington, D.C. 1981

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The scientist values research by the size of its contribution to that huge, logically articulated structure of ideas which is already, though not yet half built, the most glorious accomplishment of mankind.

Two Conceptions of Science

*Encounter*, Volume 143, August 1965

If politics is the art of the possible, research is surely the art of the soluble. Both are immensely practical-minded affairs.

The Act of Creation

*New Statesman*, Volume 19, June 1964 (p. 950)

**Mizner, Wilson** 1876–1933

American playwright

If you steal from one author, it's plagiarism; if you steal from many, it's research.

In Alva Johnson

*The Legendary Mizners*

Chapter 4, The Sport (p. 66)

Farrar, Straus & Young. New York, New York, USA. 1953

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Research is action; and the question I want to leave in a very raw and uncomfortable form with you is how to communicate this sense of action to our fellow men who are not destined to devote their lives to the professional pursuit of new knowledge.

*The Open Mind*

Chapter VII (p. 129)

Simon & Schuster. New York, New York, USA. 1955

We have done the devil's work. Now we have come back to our real job, which is to devote ourselves exclusively to research.

In Karl Jasper

*La Bombe Atomique et l'Avenir de L'Homme* (p. 360)  
Buchet-Chassel. Paris, France. 1963

### Peabody, A. P.

No biographical data available

No man becomes proficient in any science who does not transcend system, and gather up new truth for himself in the boundless field of research.

In James Orton

*Comparative Zoology, Structural and Systematic*  
Preceding Chapter XXI (p. 222)

Harper & Brothers. New York, New York, USA. 1877

### Perutz, Max F. 1914–2002

Austrian-born English biochemist

...research consists of formulation of imaginative hypotheses that are open to falsification by experiment.

*Is Science Necessary?*

How to Become a Scientist (p. 199)

E.P. Dutton & Company, Inc. New York, New York, USA. 1989

### Platt, Sir Robert 1900–78

English physician

The conventional picture of the research worker is that of a rather austere man in a white coat with a background of complicated glassware. My idea of a research worker, on the other hand, is a man who brushes his teeth on the left side of his mouth only so as to use the other side as a control and see if tooth-brushing has any effect on the incidence of caries.

*British Medical Journal*, Volume 1, 1953 (p. 577)

### Recorde, Robert 1510?–58

English mathematician and writer

The time seemeth longe (bee it never so shorte indeed) to hym that desirously looketh for any thing: for as the obtaining of it bringeth great pleasure, namelye the thinge itselفة being profitable, so the wante thereof causeth displeasure and cotinuall grief tyll the desire be eyther fully satisfied, other partly (at the least) accomplished.

*The Castle of Knowledge*

The First Treatise (p. 1)

Imprinted by R. Wolfe. London, England. 1556

### Reichenbach, Hans 1891–1953

German philosopher of science

The reliance on the concrete is the basis of both the charm and the power of physical research.

*Atom and Cosmos*

Chapter 4 (p. 75)

The Macmillan Company. New York, New York, USA. 1933

### Richet, Charles 1850–1935

French physiologist

Understand this clearly; that the right method, even for obtaining a useful practical result, is not to worry about the practice, but to concentrate intensely on pure investigation, without being hampered by any parasitic considerations other than whatever conduces to greater facility for research.

*The Natural History of a Savant*

Chapter XII (p. 134)

J.M. Dent & Sons Ltd. London, England. 1927

The gift for investigation appears at an early age: the demon of research speaks to men whilst they are still young.

*The Natural History of a Savant*

Chapter VI (pp. 38–39)

J.M. Dent & Sons Ltd. London, England. 1927

### Robinson, James Harvey 1863–1936

American historian

Research is mainly looking for things that are not there and attempting processes that will not occur.

*The Humanizing of Knowledge*

Chapter II (p. 32)

George H. Doran Company. New York, New York, USA. 1923

### Romanoff, Alexis Lawrence 1892–1980

Russian soldier and scientist

Scientific research is based chiefly on creative thinking.

*Encyclopedia of Thoughts*

Aphorisms 219

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Scientific research provides the shortest route to useful practice.

*Encyclopedia of Thoughts*

Aphorisms 112

Ithaca Heritage Books. Ithaca, New York, USA. 1975

### Sarewitz, Daniel

No biographical data available

A lone scientist, frizzy-haired and bespectacled — the absent-minded, benevolent genius lost in thought; or perhaps the dedicated experimentalist clad in a white coat and laboring madly among the condensers, Van de Graaf generators, computers, and even electrode-covered cadavers: These are typical public images of scientific research.

*Frontiers of Illusion*

Chapter 3 (p. 31)

Temple University Press. Philadelphia, Pennsylvania, USA. 1996

### Sarnoff, David 1891–1971

Russian-born American broadcasting executive

The wonderful thing about research is that the more of it you do, the more of it there is left to do.

*Research and Industry: Partners in Progress*

Address to the Board of Directors of the Stanford Research Institute  
November 14, 1951 (p. 13)

**Scalera, Mario**

No biographical data available

There is no practical purpose here. There is simply man's insatiable curiosity, his abhorrence of the unknown — the desire to see, in the confusing phenomena of nature, the law, the order, that underlies them. This kind of urge has its own reward...the reward that comes to a man who suddenly sees order shaping out of chaos — this is what we call fundamental research.

An Industrial Research Director Views Fundamental Research  
*Chemical and Engineering News*, April 21, 1958 (p. 85)

**Schild, Alfred** 1921–77

Physicist

If one can tell ahead of time what one's research is going to be, the research problem cannot be very deep and may be said to be almost nonexistent.

On the Matter of Freedom: The University and the Physical Sciences  
Bulletin  
*Canadian Association of University Teachers*, Volume 11, Number 4, 1963

**Schön, Donald A.** 1930–97

American philosopher of practice and learning theory

He emphasizes the key issue of the starting point of research. In real-world practice, problems do not present themselves to the practitioner as givens. They must be constructed from the materials of problematic situations which are puzzling, troubling and uncertain. In order to convert a problematic situation to a problem, a practitioner must do a certain kind of work.

*The Reflective Practitioner: How Professionals Think in Action* (p. 40)  
Basic Books, Inc. New York, New York, USA. 1983

**Smith, Homer W.**

Renal physiologist

On every scientist's desk there is a drawer labeled UNKNOWN in which he files what are at the moment unsolved questions, lest through guess-work or impatient speculation he come upon incorrect answers that will do him more harm than good. Man's worst fault is opening the drawer too soon. His task is not to discover final answers but to win the best partial answers that he can, from which others may move confidently against the unknown, to win better ones.

*From Fish to Philosopher*  
Chapter XIII (p. 210)  
Little, Brown & Company. Boston, Massachusetts, USA. 1953

**Smith, Theobald** 1859–1934

American pathologist

The joy of research must be found in doing, since every other harvest is uncertain.

Letter from Dr. Theobald Smith,  
*Journal of Bacteriology* Volume 27, Number 1, January 1934 (p. 20)

...it is the care we bestow on apparently trifling, unattractive and very troublesome minutiae which determines the results.

*New York Medical Journal*, Volume lii, 1890 (p. 485)

**Stewart, Ian** 1945–

English mathematician and science writer

The really important breakthroughs are always unpredictable. It is their very unpredictability that makes them important: they change our world in ways we didn't see coming.... There is nothing wrong with goal-oriented research as a way of achieving specific feasible goals. But the dreamers and the mavericks must be allowed some free rein, too. Our world is not static: new problems constantly arise, and old answers often stop working. Like Lewis Carroll's Red Queen, we must run very fast in order to stand still.

*Nature's Numbers: The Unreal Reality of Mathematical Imagination*  
Chapter 2 (p. 29)  
Basic Books, Inc. New York, New York, USA. 1995

**Sutherland, Jr., Earl W.** 1915–74

American pharmacologist and physiologist

I am fully convinced that medical research can offer one a happy and productive life. And if one has a little Viking spirit he can explore the world and people as no one else can do. The whole medical research area is wide open for exploration.

*Les Prix Nobel. The Nobel Prizes in 1971*  
Nobel banquet speech for award received in 1971  
Nobel Foundation. Stockholm, Sweden. 1972

**Szent-Györgyi, Albert** 1893–1986

Hungarian-born American biochemist

Research means going out into the unknown with the hope of finding something new to bring home.... The unknown is the unknown because one does not know what is there. If one knows what one will do and find in it, then it is not research any more and is not worth doing.

Research Grants  
*Perspectives in Biology and Medicine*, Volume 18, Number 1, Autumn 1974 (p. 41)

**Terence** 190 BCE–158 BCE

Roman comic dramatist

Nothing is so difficult but that it may be found out by seeking.

Translated by Alexander Harvey  
*Heauton Timorumenos*  
Act iv, Scene 2, l. 675  
Haldeman-Julius Company. Girard, Kansas, USA. 1925

**The Bible**

...seek, and you will find; knock, and the door will be opened to you.

*The Revised English Bible*

Matthew 7:7

Oxford University Press, Inc. Oxford, England. 1989

**Thomas, Lewis** 1913–93

American physician and biologist

In science in general, one characteristic feature is the awareness of error in the selection and pursuit of a problem. This is the most commonplace of criteria: if a scientist is going to engage in research of any kind, he has to have it on his mind, from the outset, that he may be on to a dud. You can tell a world-class scientist from the run-of-the-mill investigator by the speed with which he recognizes that he is heading into a blind alley. Blind alleys and garden paths leading nowhere are the principal hazards in research.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*  
Viking Press. New York, New York, USA. 1983

**Thompson, Elihu** 1853–1937

American electrical engineer

Physical research by experimental methods is both a broadening and a narrowing field. There are many gaps yet to be filled, data to be accumulated, measurements to be made with great precision, but the limits within which we must work are becoming, at the same time, more and more defined.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1899*

The Field of Experimental Research (p. 119)

Government Printing Office. Washington, D.C. 1901

**Thorne, Kip S.** 1940–

American theoretical physicist

In scientific research, as in life, many themes are pursued simultaneously by many different people; and the insights of one decade may spring from ideas that are several decades old but were ignored in the intervening years.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 18)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

**Veblen, Thorstein** 1857–1929

Economist, social critic, and author

...the outcome of any serious research can only be to make two questions grow where only one grew before.

*The Place of Science in Modern Civilization and Other Essays*

The Evolution of the Scientific Point of View (p. 33)

The Viking Press, Inc. New York, New York, USA. 1942

**von Braun, Wernher** 1912–77

German-American rocket scientist

Basic research is when I'm doing what I don't know I'm doing.

In Jefferson Hane Weaver

*The World of Physics* (Volume 2)

K.6 (p. 63)

Simon & Schuster. New York, New York, USA. 1987

**von Liebig, Justus** 1803–73

German organic chemist

We were the first pioneers in unknown regions, and the difficulties in the way of keeping on the right path were sometimes insuperable. Now, when the paths of research are beaten roads, it is a much easier matter; but all the wonderful discoveries which recent times have brought forth were then our own dreams, whose realization we surely and without doubt anticipated.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1891*

Autobiography (p. 267)

Government Printing Office. Washington, D.C. 1893

**Weber, Robert L.**

No biographical data available

Much of the misunderstanding of scientists and how they work is due to the standard format of articles in scientific journals. With their terse accounts of successful experiments and well-supported conclusions they show little of the untidy nature of research at the frontiers of knowledge.

*A Random Walk in Science*

Introduction (p. xv)

Institute of Physics Publishing. Bristol, England. 1973

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

It is difficult to distinguish clearly between fundamental and applied science, and any considerations of this kind can lead to dangerous oversimplifications. The success of basic research derives to a large extent from the close cooperation of basic and applied science. This close relation — often within the same scientist — provided tools of high quality, without which many fundamental discoveries could not have been made.

*Physics in the Twentieth Century: Selected Essays*

The Significance of Science (pp. 354–355)

The MIT Press. Cambridge, Massachusetts, USA. 1972

**Wells, Carolyn** 1862–1942

American writer

I think, for the rest of my life, I shall refrain from looking up things. It is the most ravenous time-snatcher I know. You pull one book from the shelf, which carries a hint or a reference that sends you posthaste to another book, and that to successive others. It is incredible, the number of books you hopefully open and disappointedly close, only to take down another with the same results.

*The Rest of My Life*

Chapter 8

J.B. Lippincott. Philadelphia, Pennsylvania, USA. 1937

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The whole difference of modern scientific research from that of the Middle Ages, the secret of its immense success, lies in its collective character, in the fact that every fruitful experiment is published, every new discovery of relationships explained.

*New Worlds For Old*

Chapter II (p. 22)

The Macmillan Company. New York, New York, USA. 1918

In a sense scientific research is a triumph over natural instinct, over that mean instinct that makes men secretive, that makes a man keep knowledge to himself and use it slyly to his own advantage.

*New Worlds for Old*

Chapter II (pp. 22–23)

The Macmillan Company. New York, New York, USA. 1918

**Wheeler, John Archibald** 1911–

American physicist and educator

There is an age-old longing to understand the inner mystery of this strange and beautiful world of ours and our own little place in the scheme of things. Whoever knows a little and can give a little to the search wants to know more and give more.

*At Home in the Universe*

Be the Best to Give the Most (p. 80)

The American Institute of Physics. Woodbury, New York, USA. 1994

**Whitney, Willis Rodney** 1868–1958

American chemical and electrical engineer

The valuable attributes of [researchers] are conscious ignorance and active curiosity.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry

*Science*, Volume LXV, Number 1862, March 25, 1927 (p. 289)**Wilson, Jr., E. Bright** 1908–92

American physical chemist

Though the road may seem long and arduous, with many stretches of pure drudgery, when the end of a particular stage is reached, where the bits of evidence all fall together into a clear and unexpected pattern, there are few other human activities which can provide as much satisfaction; especially if, as is so often the case, the results turn out later to have applications in all sorts of unanticipated directions and help to give a clearer picture of the universe we live in and to make life in that universe more worth while.

*An Introduction to Scientific Research*

Conclusion (p. 364)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

**Wittig, Georg** 1897–1987

German chemist

Chemical research and mountaineering have much in common. If the goal or the summit is to be reached, both initiative and determination as well as perseverance are required. But after the hard work it is a great joy to be at the goal or the peak with its splendid panorama.

*Nobel Lectures, Chemistry 1971–1980*

Nobel lecture for award received in 1979

From Diyls to Ylides to My Idyll (p. 368)

World Scientific Publishing Company. Singapore. 1993

**Wordsworth, William** 1770–1850

English poet

Lost in the gloom of uninspired research.

*The Complete Poetical Works of William Wordsworth*

The Excursion, Dependancy Corrected, l. 626

Crowell. New York, New York, USA. 1888

**Yang, Chen Ning** 1922–

Chinese-born American theoretical physicist

The necessary tendency toward bigness is unfortunate, as it hinders free and individual initiative. It makes research less intimate, less inspiring, and less controllable. However, it must be accepted as a fact of life. Let us take courage then in the knowledge that despite their physical bigness, the machines, the detectors, and indeed the experiments themselves are still based on ideas that have the same simplicity, the same intimacy and controllability that have always made research so exciting and inspiring.

*Elementary Particles: A Short History of Some Discoveries in Atomic Physics*

Chapter 2 (p. 40)

Princeton University Press. Princeton, New Jersey, USA. 1962

**Yeats, William Butler** 1865–1939

Irish poet and playwright

I had discovered, early in my researches, that their doctrine was no mere chemical fantasy, but a philosophy they applied to the world, to the elements, and to man himself.

*Stories of Red Hanrahan, the Secret Rose, Rosa Alchemica*

Rosa Alchemica (p. 192)

The Macmillan Company. New York, New York, USA. 1914

**RESEARCH PLAN****van Noordwijk, A. J.** 1949

Dutch-Canadian genetical ecologist

...however excellent multiannual planning, research-project management, and time recording may be, the scientist should always have some opportunity to test the idea that he got that morning while shaving.

The Bioassyst

*Perspectives in Biology and Medicine*, Volume 29, Number 2, Winter 1986 (p. 307)

**Richter, Curt P.** 1894–1988  
American psychobiologist

...good researchers use research plans merely as starters and are ready to scrap them at once in the light of actual findings...

Free Research versus Design Research  
*Science*, Volume 118, Number 3056, July 24, 1953 (p. 92)

**Waksman, Selman A.** 1888–1973  
Ukrainian-born American biochemist

Good scientists use research plans merely as outlines to begin their investigations and are ready to give them up once they are not justified by actual findings. Experimental designs tend to give rise to “team research”, which serves a purpose in developing and applying ideas; it rarely produces new ideas.

Searchers and Researchers  
*Perspectives in Biology and Medicine*, Volume 7, Number 3, Spring 1964 (p. 312)

...a new problem has arisen — namely “planned research” versus the “individual investigator.” There is a place for planned research. It can take a defined body of knowledge and lay out a set of experiments which will exploit this knowledge to its foreseeable limits. It can take a set of postulates and drive them home to their logical conclusions. It can do this with exhaustive thoroughness, economy, and speed. Within its limitations, it is efficient, expeditious, and authoritative. But there is a place also and a more important place for the random investigator. The role of planned research is to consolidate ground already won; the role of the random investigator is to seek out new worlds to conquer.

Searchers and Researchers  
*Perspectives in Biology and Medicine*, Volume 7, Number 3, Spring 1964 (p. 311)

## RESIDUAL

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

Almost all the greatest discoveries in astronomy have resulted from the consideration of what we have elsewhere termed RESIDUAL PHENOMENA, of a quantitative or numerical kind, that is to say, of such portions of the numerical or quantitative results of observations as remain outstanding and unaccounted for after subducting and allowing for all that would result from the strict application of known principles.

*Outlines of Astronomy*  
Part III, Chapter XVI (856) (p. 584)  
Longman, Brown, Green & Longmans. London, England. 1849

## RESPIRATION

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

Of all the phenomena of animal economy, none are more striking, nor more worthy of attention from physicists and physiologists than those accompanying respiration. If, on the other hand, we know little of the object of this singular function, we know, on the other hand, that it is so essential to life that it cannot be suspended for any time without exposing the animal to danger of immediate death.

*Experiments on the Respiration of Animals and the Changes Which Happen to Air in Its Passage Through Their Lungs*  
Read to the Academie des Sciences  
3 May, 1777

## RESPONSIBILITY

**Teller, Edward** 1908–2003  
Hungarian-born American nuclear physicist

Beyond the scientific responsibility to search the horizon of human knowledge, the responsibilities of scientists cannot be any greater than those of any other citizen in our democratic society. The consequences of scientific discoveries are the responsibility of the people.

*Better a Shield than a Sword: Perspectives in Defense and Technology*  
Chapter 9 (p. 85)  
The Free Press. New York, New York, USA. 1987

## REST

**Born, Max** 1882–1970  
German-born English physicist

It is odd to think that there is a word for something which, strictly speaking, does not exist, namely, “rest.”

*The Restless Universe*  
Chapter I (p. 1)  
Dover Publications, Inc. New York, New York, USA. 1951

## RESULT

**Dante, Alighieri** 1265–1321  
Italian poet

Great flame follows a little spark.

In *Great Books of the Western World* (Volume 21)  
*The Divine Comedy of Dante Alighieri*  
Paradise  
Canto I, l. 34  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist and astronomer

I have had my results for a long; but I do not yet know how I am to arrive at them.

In L. Nelson

*Socratic Method and Critical Philosophy*

Attributed

Chapter IV (p. 89)

Yale University Press. New Haven, Connecticut, USA. 1949

### **Gay-Lussac, Joseph Louis** 1778–1850

French chemist and physicist

I only present these conclusions with the greatest reserve, knowing myself how I have still to vary my experiments and how easy it is to err in the interpretation of results.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 4 (p. 87)

Cambridge University Press. Cambridge, England. 1978

### **Maxwell, James Clerk** 1831–79

Scottish physicist

The first process therefore in the effectual study of science must be one of simplification and reduction of results of previous investigation to a form in which the mind can grasp them. The results of this simplification may take the form of a purely mathematical formula or of a physical hypothesis.

On Faraday's Lines of Force

*Transactions of the Cambridge Philosophical Society*, 1856

### **Pauli, Wolfgang** 1900–58

Austrian-born physicist

Never work too closely with experimenters. Allow the results to settle.

In Silvan S. Schweber

*QED and the Men Who Made It: Dyson, Feynman, Schwinger, and Tomonaga*

Chapter 10 (p. 594)

Princeton University Press. Princeton, New Jersey, USA. 1994

### **Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

To obtain a result of real worth it will not suffice to grind it out or to have a machine for putting our facts in order. It is not alone order but the unexpected order which is of real worth. The machine may grind upon the mere fact, but the soul of the fact will always escape it.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1909

The Future of Mathematics (p. 127)

Government Printing Office. Washington, D.C. 1910

### **Sagan, Carl** 1934–96

American astronomer and author

Every scientist feels an affection for his or her ideas and scientific results. You feel protective of them. But you don't reply to critics: "Wait a minute, wait a minute; this is a really good idea. I'm very fond of it. It's done you

no harm. Please don't attack it." That's not the way it goes. The hard but just rule is that if the ideas don't work, you must throw them away. Don't waste any neurons on what doesn't work. Devote those neurons to new ideas that better explain the data. Valid criticism is doing you a favor.

Wonder and Skepticism

*Skeptical Inquirer*, January/February 1995 (p. 24)

### **Wilson, Jr., E. Bright** 1908–92

American physical chemist

One of the most difficult decisions which an experimenter has to make is whether or not to reject a result which seems unreasonably discordant.... The best procedure to use depends on what is known about the frequency of occurrence of wild values, on the cost of additional observations, and on the penalties for the various types of errors.... There is often a desire to disregard negative results on the grounds that conditions were not right or that the operator was not in the right mood. This is undoubtedly responsible for much pseudo science, psychic phenomena, and similar material.

*An Introduction to Scientific Research*

Chapter 9 (p. 256, 257, 257)

McGraw-Hill Book Company, Inc. New York, New York USA. 1952

## RETROGRADE MOTION

### **Shakespeare, William** 1564–1616

English poet, playwright, and actor

HELENA: Monsieur Parolles, you were born under a charitable star.

PAROLLES: Under Mars, I.

HELENA: I especially think, under Mars.

PAROLLES: Why under Mars?

HELENA: The wars have so kept you under that you must needs be born under Mars.

PAROLLES: When he was predominant.

HELENA: When he was retrograde, I think, rather.

PAROLLES: Why think you so?

HELENA: You go so much backward when you fight.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

All's Well That Ends Well

Act I, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## REVOLUTION

### **Krauss, Lawrence M.** 1954–

American theoretical physicist

Physics progresses not by revolutions, which do away with all that went before, but rather by evolutions, which exploit the best about what is already understood. Newton's laws will continue to be as true a million years

from now as they are today, no matter what we discover at the frontiers of science.

*The Physics of Star Trek*

Chapter One (p. 8)

Harp Perennial Publishers. New York, New York, USA. 1995

## RIDDLE

**Einstein, Albert** 1879–1955

German-born physicist

Out yonder there was this huge world, which exists independently of us human beings and which stands before us like a great, eternal riddle...

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 5)

Open Court. La Salle, Illinois, USA. 1979

## RIEMANN HYPOTHESIS

**Berry, M. V.**

No biographical data available

**Keating, J. P.**

No biographical data available

If the Riemann Hypothesis is true...the function  $f(u)$  constructed from the primes has discrete spectrum; that is, the support of its Fourier transform is discrete. If the Riemann Hypothesis is false this is not the case. The frequencies then are reminiscent of the decomposition of a musical sound into its constituent harmonics. Therefore there is a sense in which we can give a one-line non technical statement of the Riemann hypothesis: "The primes have music in them."

The Riemann Zeros and Eigenvalue Asymptotics

*SIAM Review*, 41, Number 2 (1999) (p. 238)

**Bombieri, Enrico** 1940–

Italian mathematician

The failure of the Riemann hypothesis would create havoc in the distribution of prime numbers. This fact alone singles out the Riemann hypothesis as the main open question of prime number theory.

Prime Territory: Exploring the Infinite Landscape at the Base of the Number System

*The Sciences*, Sept/Oct 1992

**Conrey, J. Brian**

The Riemann Hypothesis (RH) has been around for more than 140 years, and yet now is arguably the most exciting time in its history to be working on RH. Recent years have seen an explosion of research stemming from the confluence of several areas of mathematics and physics.

*The Riemann Hypothesis*

Notices of the AMS (March 2003)

**du Sautoy, Marcus** 1965–

English mathematician and writer

[The Riemann] zeros did not appear to be scattered at random. Riemann's calculations indicated that they were lining up as if along some mystical ley line running through the landscape.

*The Music of the Primes*

Chapter 4 (p. 99)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

As we shall see, Riemann's Hypothesis can be interpreted as an example of a general philosophy among mathematicians that, given a choice between an ugly world and an aesthetic one, Nature always chooses the latter.

*The Music of the Primes*

Chapter 2 (p. 55)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

We have all this evidence that the Riemann zeros are vibrations, but we don't know what's doing the vibrating.

*The Music of the Primes*

Chapter 11 (p. 280)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

As mathematicians navigate their way across the mathematical terrain, it as though all paths will necessarily lead at some point to the same awesome vista of the Riemann Hypothesis.

*The Music of the Primes*

Chapter 1 (p. 10)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

In an interview, Hilbert explained that he believed the Riemann Hypothesis to be the most important problem "not only in mathematics but absolutely the most important."

*The Music of the Primes*

Chapter 5 (p. 114)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

A solution to the Riemann Hypothesis offers the prospect of charting the misty waters of the vast ocean of numbers. It represents just a beginning in our understanding of Nature's numbers. If we can only find the secret of how to navigate the primes, who knows what else lies out there, waiting for us to discover?

*The Music of the Primes*

Chapter 1 (p. 18)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

Until [the RH is proved], we shall listen enthralled by this unpredictable mathematical music, unable to master its twists and turns. The primes have been a constant companion in our exploration of the mathematical world yet they remain the most enigmatic of all numbers. Despite the best efforts of the greatest mathematical minds to explain the modulation and transformation of this mystical music, the primes remain an unanswered riddle. We still await the person whose name will live for ever as the mathematician who made the primes sing.



*The Music of the Primes*

Chapter 12 (p. 312)

HarperCollins Publisher, Inc. New York, New York, USA. 2003

### **Erdős, Paul** 1913–96

Hungarian mathematician

To conclude, a somewhat daunting quote about the prime numbers from someone who was as familiar with them as anyone has ever been: “It will be millions of years before we’ll have any understanding, and even then it won’t be a complete understanding, because we’re up against the infinite.”

Interview with P. Hoffman

*Atlantic Monthly*, November 1987 (p. 74)

### **Heath-Brown, R.**

Mathematician

[The Riemann Hypothesis has] no longer just analytic number theorists involved, but all mathematicians know about the problem, and many realize that they may have useful insights to offer. As far as I can see, a solution is as likely to come from a probabilist, geometer or mathematical physicist, as from a number theorist.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 17 (pp. 267–268)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### **Ivic, A.**

No biographical data available

...I don’t believe or disbelieve the Riemann Hypothesis. I have a certain amount of data and a certain amount of facts. These facts tell me definitely that the thing has not been settled. Until it’s been settled it’s a hypothesis, that’s all. I would like the Riemann Hypothesis to be true, like any decent mathematician, because it’s a thing of beauty, a thing of elegance, a thing that would simplify many proofs and so forth, but that’s all.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 17 (p. 269)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### **Klarreich, E.**

No biographical data available

Proving the Riemann hypothesis won’t end the story. It will prompt a sequence of even harder, more penetrating questions. Why do the primes achieve such a delicate balance between randomness and order? And if their patterns do encode the behavior of quantum chaotic systems, what other jewels will we uncover when we dig deeper? Those who believe mathematics holds the key to the Universe might do well to ponder a question that goes back to the ancients: What secrets are locked within the primes?

Prime Time

*New Scientist*, November 11, 2000

### **Montgomery, H.**

No biographical data available

So if you could be the Devil and offer a mathematician to sell his soul for the proof of one theorem — what theorem would most mathematicians ask for? I think it would be the Riemann Hypothesis.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 2 (p. 36)

Farrar, Straus & Giroux. New York, New York, USA. 2002

Sometimes I think that we essentially have a complete proof of the Riemann Hypothesis except for a gap. The problem is, the gap occurs right at the beginning, and so it’s hard to fill that gap because you don’t see what’s on the other side of it.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 17 (p. 267)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### **Motohashi, Yoichi**

No biographical data available

...the Riemann Hypothesis will be settled without any fundamental changes in our mathematical thoughts, namely, all tools are ready to attack it but just a penetrating idea is missing.

In K. Sabbagh

*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*

Chapter 17 (p. 268)

Farrar, Straus & Giroux. New York, New York, USA. 2002

### **Sabbagh, K.**

No biographical data available

For many mathematicians working on it, \$1m is less important than the satisfaction that would come from finding a proof. Throughout my researches among the mathematicians’ tribe (I have interviewed 30 in the past year), Riemann’s Hypothesis was often described to me in awed terms. Hugh Montgomery of the University of Michigan said this was the proof for which a mathematician might sell his soul. Henryk Iwaniec, a Polish-American mathematician, sounded as if he were already discussing terms with Lucifer.

“I would trade everything I know in mathematics for the proof of the Riemann Hypothesis. It’s gorgeous stuff. I’m only worried that I’ll be unable to understand it. That would be the worst...”

Beautiful Mathematics

*Prospect*, January 2002

**Sarnak, P.** 1953–  
South African-born American mathematician

Right now, when we tackle problems without knowing the truth of the Riemann hypothesis, it's as if we have a screwdriver. But when we have it, it'll be more like a bulldozer.

In E. Klarreich  
*New Scientist*  
Prime Time, November 11, 2000

The Riemann Hypothesis is the central problem and it implies many, many things. One thing that makes it rather unusual in mathematics today is that there must be over five hundred papers — somebody should go and count — which start Assume the Riemann Hypothesis, and the conclusion is fantastic. And those [conclusions] would then become theorems...With this one solution you would have proven five hundred theorems or more at once.

In K. Sabbagh  
*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 14 (p. 222)  
Farrar, Straus & Giroux. New York, New York, USA. 2002

If [the Riemann Hypothesis is] not true, then the world is a very different place. The whole structure of integers and prime numbers would be very different to what we could imagine. In a way, it would be more interesting if it were false, but it would be a disaster because we've built so much round assuming its truth.

In K. Sabbagh  
*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 2 (p. 37)  
Farrar, Straus & Giroux. New York, New York, USA. 2002

**Stewart, Ian** 1945–  
English mathematician and science writer

One of the biggest problems of mathematics is to explain to everyone else what it is all about.

*The Problems of Mathematics*  
Chapter 1 (p. 5)  
Oxford University Press, Inc. Oxford, England. 1987

## RIGHTS OF ANIMALS

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

I believe I am not interested to know whether Vivisection produces results that are profitable to the human race or doesn't. To know that the results are profitable to the race would not remove my hostility to it. The pains which it inflicts upon unconsenting animals is the basis of my enmity towards it, and it is to me sufficient justification

of the enmity without looking further. It is so distinctly a matter of feeling with me, and is so strong and so deeply-rooted in my make and constitution, that I am sure I could not even see a vivisector vivisected with anything more than a sort of qualified satisfaction. I do not say I should not go and look on; I only mean that I should almost surely fail to get out of it the degree of contentment which it ought, of course, to be expected to furnish.

Letter, London Anti-Vivisection Society, May 26, 1899

## RIGOR

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

In mathematics rigor is not everything, but without it there would be nothing; a demonstration which is not rigorous is void.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 127)  
Government Printing Office. Washington, D.C. 1910

## RISK

**Fisher, Irving** 1867–1947  
American economist

Risk varies inversely with knowledge.

*The Theory of Interest*  
Chapter IX (p. 221)  
Porcupine Press. Philadelphia, Pennsylvania, USA. 1977

**Florman, Samuel C.** 1925–  
Author and professional engineer

Good intentions and high moral standards do not help an engineer establish the limits of acceptable risk.

*Blaming Technology*  
Moral Blueprints (p. 173)  
St. Martin's Press. New York, New York, USA. 1981

## RIVER

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

For the rest of the afternoon, keeping to the shady side, we drift down the splendid river, deeper and deeper and deeper into the fantastic.

*Desert Solitaire*  
Down the River (p. 205)  
Ballantine Books. New York, New York, USA. 1968

**Burroughs, John** 1837–1921  
American naturalist and writer

The river idealizes the landscape. It multiplies and heightens the beauty of the day and season. A fair day it

makes more fair, and a wild, tempestuous day it makes more wild. The face of winter makes it doubly rigid and corpse-like, and to the face of spring it adds new youth and sparkle.

*The Heart of Burrough's Journal* (p. 94)

Houghton Mifflin Company. Boston, Massachusetts, USA.

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

From dark and icy caverns called you forth,  
Down those precipitous, black, jagged rocks,  
Forever shattered, and the same for ever?  
Who gave you your invulnerable life,  
Your strength, your speed, your fury and your joy,  
Unceasing thunder and eternal foam?

*A Library of Poetry*

Hymn, Before Sunrise In the Vale of Chamouni, l. 41–46

J.B. Ford & Company. New York, New York, USA. 1874

**Confucius** 551 BCE–479 BCE

Chinese philosopher and reformer

Men of practical knowledge find their gratification among rivers.

In Lionel Giles (ed.)

*The Analects of Confucius*

Chinese University Press. Hong Kong. 1983

**Dyer, John** 1700?–58

Welsh clergyman and poet

And see the rivers how they run  
Through woods and meads, in shade and sun,  
Sometimes swift, sometimes slow, —  
Wave succeeding wave, they go  
A various journey to the deep,  
Like human life to endless sleep!

In Thomas Campbell

*Specimens of the British Poets*

Granger Hill, l. 93

John Murray. London, England. 1841

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

I do not know much about gods; but I think that the river  
Is a strong brown god — sullen, untamed and intractable

Patient to some degree, at first recognized as a frontier;  
Useful, untrustworthy as a conveyor of commerce;  
Then only a problem confronting the builder of bridges.  
The problem once solved, the brown god is almost forgotten

By the dwellers in cities — ever, however, implacable,  
Keeping his seasons and rages, destroyer, reminder

Of what men choose to forget.

Unhonoured, unpropitiated

By worshippers of the machine.

*The Collected Poems and Plays 1909–1950*

The Dry Salvages (p. 130)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The river knows the way to the sea:

Without a pilot it runs and falls,

Blessing all lands with its charity.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)

Woodnotes

Part ii, Line 272 (p. 57)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Lubbock, Sir John** 1834–1913

English banker, author, and scientist

It is as difficult for a river as for a man to get out of a groove.

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter VIII (p. 279)

The Macmillan Company. New York, New York, USA. 1893

**Maury, Matthew Fontaine** 1806–73

American hydrographer and naval officer

There is a river in the ocean. In the severest droughts it never fails, and in the mightiest floods it never overflows. Its banks and its bottoms are of cold water, while its current is of warm. The Gulf of Mexico is its fountain, and its mouth is in the Arctic Seas. It is the Gulf Stream. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or the Amazon.

*The Physical Geography of the Sea*

Chapter I (p. 25)

Harper & Brothers. New York, New York, USA. 1855

**Muir, John** 1838–1914

American naturalist

Tracing rivers to their fountains makes the most charming of travels. As the life blood of the landscapes, the best of the wilderness comes to their banks, and not one dull passage is found in all their eventful histories.

*Steep Trails*

Chapter V (p. 101)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Palmer, Tim** 1948–

No biographical data available

Rivers are exquisite in their abilities to nurture life, sublime in functioning detail, impressive in contributions of global significance.

*Lifelines: The Case for River Conservation*

Chapter One (p. 10)

Island Press. Washington, D.C. 1994

...rivers are magnets for the imagination, for conscious pondering and subconscious dreams, thrills, fears. People stare into the moving water, captivated, as they are when

gazing into a fire. What is it that draws and holds us? The rivers' reflections of our lives and experiences are endless.

*Lifelines: The Case for River Conservation*  
Chapter One (p. 8)  
Island Press. Washington, D.C. 1994

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Rivers are roads which move, and which carry us whither we desire to go.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section I, 17  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Playfair, John** 1748–1819  
Scottish geologist, physicist, and mathematician

A river, of which the course is both serpentine and deeply excavated in the rock, is among the phenomena by which the slow waste of the land, and also the cause of that waste, are most directly pointed out.

*Illustrations of the Huttonian Theory of the Earth*  
Section 101 (p. 104)  
Dover Publications, Inc. New York, New York, USA. 1964

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

The face of the water, in time, became a wonderful book...which told its mind to me without reserve, delivering its most cherished secrets as clearly as if it uttered them with a voice. And it was not a book to be read once and thrown aside, for it had a new story to tell every day.

*Life on the Mississippi*  
Chapter IX (p. 77)  
Harper & Row, Publishers. New York, New York, USA. 1951

**Wallace, Alfred Russel** 1823–1913  
English humanist, naturalist, and geographer

These various-coloured waters may, we believe, readily be accounted for by the nature of the country the stream flows through. The fact that the most purely black-water rivers flow through districts of dense forest, and have granite beds, seems to show that it is the percolation of the water through decaying vegetable matter which gives it its peculiar colour. Should the stream, however, flow through any extent of alluvial country, or through any districts where it can gather much light-coloured sedimentary matter, it will change its aspect, and we shall have the phenomenon of alternating white and black water rivers. The Rio Branco and most of its tributaries rise in an open, rocky country, and the water there is pure and uncoloured; it must, therefore, be in the lower

part of its course that it obtains the sediment that gives it so remarkably light a colour; and it is worthy of note, that all the other white-water tributaries of the Rio Negro run parallel to the Rio Branco, and, therefore, probably obtain their sediment from a continuation of the same deposits; only as they flow entirely through a forest district producing brown water, the result is not such a strikingly light tint as in the case of that river.

*Journal of the Royal Geographical Society*, Volume 23, 1853 (p. 213)

## ROBOT

**Hey, Nigel S.** 1936–  
American science writer

The craft is a space robot that is invested with the equivalents of eyes, ears, voice, and muscle. Each spacecraft takes with it the hopes and dreams of thousands of scientists and engineers and, most importantly, the special sense of wonder and imagination that is so great a part of human nature.

*Solar System*  
Chapter 5 (p. 120)  
Weidenfield & Nicolson. London, England. 2002

## ROCK

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

Rocks, like louseworts and snail darters and pupfish and 3<sup>rd</sup> -world black, lesbian, feminist, militant poets, have rights, too. Especially the right to exist.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
Chapter 9 (p. 86)  
St. Martin's Press. New York, New York, USA. 1989

**Alvarez, Luis Walter** 1911–88  
American experimental physicist

Rocks are the key to Earth history, because solids remember but liquids and gasses forget. Retrieving these long-lost memories is the business of geologists and paleontologists, of people who have chosen to be the historians of the Earth.

*T. Rex and the Crater of Doom*  
Chapter I (p. 17)  
Princeton University Press. Princeton, New Jersey, USA. 1997

## Author undetermined

There are no books like a rock,  
And nothing looks like a rock;  
There are no meals like a rock,  
And nothing feels like a rock;  
Nothing stays like a rock,  
Or decays like a rock.  
There is nothing wrong with any man here

That can't be cured by putting him near  
A lithic, igneous, metamorphic, sedimentary rock.  
Roquiescat (Sung to "There Is Nothing Like a Dame")  
*The Pick and Hammer Club*, Washington, D.C., May 2, 1952

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Rocks are the graveyards of the past, and the student of fossil shells and bones sees the grim phenomenon in every guise.

*Parade of the Living*  
Part III, Chapter XVII (p. 238)  
Coward-McCann, Inc. New York, New York, USA. 1930

**Burroughs, John** 1837–1921  
American naturalist and writer

The rocks have a history; gray and weather-worn, they are veterans of many battles; they have most of them marched in the ranks of vast stone brigades during the ice age; they have been torn from the hills, recruited from the mountain-tops, and marshaled on the plains and in the valleys; and now the elemental war is over, there they lie waging a gentle but incessant warfare with time, and slowly, oh, so slowly, yielding to its attacks!

*Under the Apple-Trees*  
Chapter II (p. 42)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

**Daly, Reginald Aldworth** 1871–1957  
Canadian-American geologist

A final philosophy of the Earth's crust must be largely founded upon the unshakable facts known about igneous rocks.

*Igneous Rocks and the Depths of the Earth: Containing Some Revised Chapters of "Igneous Rocks and their Origin"*  
Chapter I (p. 1)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1933

**Darwin, Charles Robert** 1809–82  
English naturalist

On first examining a new district nothing can appear more hopeless than the chaos of rocks; but by recording the stratification and nature of the rocks and fossils at many points, always reasoning and predicting what will be found elsewhere, light soon begins to dawn on the district, and the structure of the whole becomes more or less intelligible.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II (p. 52)  
D. Appleton & Company. New York, New York, USA. 1896

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

A rock pile ceases to be a rock pile the moment a single man contemplates it, bearing within him the image of a

cathedral.  
Translated by Bernard Lamotte  
*Flight to Arras*  
Chapter XXII (p. 219)  
Reynal & Hitchcock. New York, New York, USA. 1942

**Fort, Charles** 1874–1932  
American writer

"I shall be scientific about it." Said Sir Isaac Newton — or virtually said he — "If there is no change in the direction of a moving body, the direction of a moving body is not changed." "But," continued he, "if something be changed, it is changed as much as it is changed." How do geologists determine the age of rocks? By the fossils in them. And how do they determine the age of fossils? By the rocks they're in. Having started with the logic of Euclid, I go on to the wisdom of Newton.

*The Books of Charles Fort*  
Lo! (pp. 547–548)  
Henry Holt & Company. New York, New York, USA. 1941

**Le Guin, Ursula K.** 1929–  
American writer of science fiction and fantasy

The first thing about rocks is, they're old.... Rocks are in time in a different way than living things are, even the ancient trees. But then, the other thing about rocks is that they are place. Rocks are what a place is made of to start with and after all.... The stone is at the center.

*Buffalo Gals and Other Animal Presences*  
Capra Press. Santa Barbara, California, USA. 1987

**LeConte, John** 1818–91  
American physician and physicist

Here, then, we have the oldest known rocks. Are they, then, absolutely the oldest — the primitive rocks, as some imagine? By no means. They are stratified rocks, and therefore consolidated sediments, and therefore, also, the debris of still older rocks, of which we know nothing. Thus, we seek in vain for the absolutely oldest, the primitive crust.

*A Compend of Geology*  
Part III, Chapter II (pp. 263–264)  
American Book Company. New York, New York, USA. 1884

**Levenson, Thomas**  
No biographical data available

Rock is the ultimate historian — what it is, and what remnants it contain are the only records of what the earth was like through virtually its entire lifetime.

*Ice Time: Climate, Science, and Life on Earth*  
Chapter 1 (p. 3)  
Harper & Row, Publishers. New York, New York, USA. 1989

**Linnaeus, Carl (von Linné)** 1707–78  
Swedish botanist

The stony rocks are not primeval, but daughters of Time.

*Systema Naturae*

Ed. 5, Stockholm, 1748 (p. 219)

**Muir, John** 1838–1914

American naturalist

Patient observation and constant brooding above the rocks, lying upon them for years as the ice did, is the way to arrive at the truths which are graven so lavishly upon them.

In William Frederic Badé

*The Life and Letters of John Muir* (Volume 1)

Letter to Mrs. Ezra S. Carr, October 1871 (p. 300)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1924

...all the rocks seemed talkative, and more telling and lovable than ever. They are dear friends, and seemed to have warm blood gushing through their granite flesh; and I love them with a love intensified by long and close companionship.

*Steep Trails*

Chapter II (p. 19)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**O'Keefe, J. A.**

No biographical data available

Liquids and gases forget, but rocks remember.

In G. Brent Dalrymple

*The Age of the Earth*

Chapter 7 (p. 305)

Stanford University Press. Stanford, California, USA. 1991

**Read, Herbert Harold** 1899–1970

English geologist

**Watson, Janet**

No biographical data available

...the best geologist is the one who has seen the most rocks.

*Beginning Geology*

Preface

Macmillan & Company Ltd. London, England. 1966

**Seward, A. C.** 1863–41

No biographical data available

Rocks are the source-books of geological history...

*Plant Life Through the Ages*

Chapter II (p. 5)

Hafner Publishing Company. New York, New York, USA. 1959

**von Bubnoff, S.**

No biographical data available

The materials from which the geologist draws his conclusions are rocks.

*Fundamentals of Geology*

Chapter II (p. 12)

Oliver & Boyd. Edinburgh, Scotland. 1963

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The Record of the Rocks is like a great book that has been carelessly misused. All its pages are torn, worn, and defaced, and many are altogether missing.

*The Outline of History* (Volume 1)

Book I, Chapter III, Section 3 (p. 29)

Garden City Books. Garden City, New York, USA. 1961

**White, Bailey** 1950–

American writer

My Aunt Belle loves rocks. Her whole house used to be filled with rocks. Every flat surface was covered with slabs of amethyst crystal, piles of rainbow-colored labradorite, bowls full of fossilized sharks' teeth as big as a child's hand, and agate geodes lined with quartz crystals.... Every afternoon my Aunt Belle takes a bagful of rocks down to Shoney's Restaurant where she spreads them out on the Formica tabletop and says incantations over them while she drinks iced tea.

*Sleeping at the Starlite Motel and Other Adventures on the Way Back Home*

Rocks (p. 63)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1995

## ROCKET

**Goddard, Robert H.** 1882–1945

American physicist

...I still seem to be alone in my enthusiasm for liquid-fueled rockets, but have a hunch that the time is coming when a good many will want to get aboard the bandwagon...

*The Papers of Robert H. Goddard* (Volume 3)

R.H. Goddard to T.E. Thompson

March 7, 1941 (p. 1386)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Woolley, Richard** 1906–1986

Astronomer Royal of England

The whole procedure [of shooting rockets into space]... presents difficulties of so fundamental a nature, that we are forced to dismiss the notion as essentially impracticable, in spite of the author's insistent appeal to put aside prejudice and to recollect the supposed impossibility of heavier-than-air flight before it was actually accomplished.

Reviewing P.E. Cleator's "Rockets in Space"

*Nature*, March 14, 1936

## ROCKFALL

**Muir, John** 1838–1914

American naturalist

The sound was inconceivably deep and broad and earnest, as if the whole earth, like a living creature, had at last found a voice and were calling to her sister planets.

*Our National Parks*

Chapter VIII (p. 263)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## ROTATION OF EARTH

**Archimedes of Syracuse** 287 BCE–212 BCE

Sicilian mathematician

But Aristarchus of Samos brought out a book consisting of certain hypotheses, in which the premises lead to the conclusion that the universe is many times greater than that now so called. His hypotheses are that the fixed stars and the sun remain motionless, that the earth revolves about the sun in the circumference of a circle, the sun lying in the middle of the orbit, and that the sphere of the fixed stars, situated about the same center as the sun, is so great that the circle in which he supposes the earth to revolve bears such a proportion to the distance of the fixed stars as the center of the sphere bears to its surface.

In *Great Books of the Western World* (Volume 11)

*The Sand-Reckoner* (p. 520)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Nevertheless, in the system of Copernicus there are found many and great inconveniences; for both the loading of the earth with a triple motion is very incommodious, and the separation of the sun from the company of the planets, with which it has so many passions in common, is likewise a difficulty, and the introduction of so much immobility in nature, by representing the sun and stars as immoveable, especially being of all bodies the highest and most radiant, and making the moon revolve about the earth in an epicycle, and some other assumptions of his, are the speculations of one who cares not what fictions he introduces into nature, provided his calculations answer.

*Descriptio Globi Intellectualis*

Source undetermined

**Blundeville, Thomas** fl. 1561

English author

Some also deny that the earth is in the midst of the world, and some affirm that it is movable, as also Copernicus by way of supposition, and not for that he thought so in deede: who affirmeth that the earth turneth about, and that the sunne standeth still in the midst of the heauens, by help of which false supposition he hath made truer demonstrations of the motions and revolutions of the celestiall Sphaeres, than euer were made before...

*M. Blundeville His Exercises*

Source undetermined

**Brahe, Tycho** 1546–1601

Danish astronomer

If Nicolaus Copernicus, the distinguished and incomparable master, in this work had not been deprived of exquisite and faultless instruments, he would have left us this science far more well-established. For he, if anybody, was outstanding and had the most perfect understanding of the geometrical and arithmetical requisites for building up this discipline. Nor was he in any respect inferior to Ptolemy; on the contrary, he surpassed him greatly in certain fields, particularly as far as the device of fitness and compendious harmony in hypotheses is concerned. And his apparently absurd opinion that the Earth revolves does not obstruct this estimate, because a circular motion designed to go on uniformly about another point than the very center of the circle, as actually found in the Ptolemaic hypotheses of all the planets except that of the Sun, offends against the very basic principles of our discipline in a far more absurd and intolerable way than does the attributing to the Earth one motion or another which, being a natural motion, turns out to be imperceptible. There does not at all arise from this assumption so many unsuitable consequences as most people think.

Letter to Christopher Rothman, January 20, 1587

Source undetermined

**Plutarch** 46–119

Greek biographer and author

Some think that the earth remains at rest. But Philolaus the Pythagorean believes that, like the sun and moon, it revolves around the fire in an oblique circle. Heraclides of Pontus and Ephantus the Pythagorean make the earth move, not in a progressive motion, but like a wheel in rotation from west to east around its own center.

In Nicholas Copernicus

*On the Revolutions of the Heavenly Spheres*

Preface (p. 508)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## RUIN

**Macaulay, Rose** 1881–1958

English writer

Of all ruins, possibly the most moving are those of long-deserted cities, fallen century by century into deeper decay, their forsaken streets grown over by forest and shrubs, their decadent buildings quarried and plundered down the years, gaping ruinous, the haunts of lizards and owls...the marble and gold of palaces, the laurel and jasmine of gardens, are now brambles and lagoons; the house built for Caesar is now dwelt in by lizards...

*Pleasure of Ruins*

Chapter III (p. 255)

Walker & Company. New York, New York, USA. 1953

**RULE**

**Arnheim, Rudolf** 1904–  
German-born author, film theorist, and psychologist

An orgy of self-expression is no more productive than blind obedience to rules.

*Art and Visual Perception*

Introduction (p. vii)

University of California Press. Berkeley, California, USA. 1957

**Burton, Robert** 1577–1640  
English clergyman and scholar

No rule is so general, which admits not some exception...

*The Anatomy of Melancholy* (Volume 1)

Part I, Sect. II, Memb. II, Subsec. 3 (p. 264)

AMS Press, Inc. New York, New York, USA. 1973

**de Cervantes, Miguel** 1547–1616  
Spanish novelist, playwright, and poet

There is no rule without an exception.

In *Great Books of the Western World* (Volume 29)

*The History of Don Quixote de la Mancha*

Part II, Chapter 18 (p. 258)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Feyerabend, Paul K.** 1924–94  
Austrian-born American philosopher of science

...given any rule, however “fundamental” or “necessary” for science, there are always circumstances when it is advisable not only to ignore the rule, but to adopt its opposite.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 1 (p. 23)

Verso. London, England. 1978

**Feynman, Richard P.** 1918–88  
American theoretical physicist

...the fact that there are rules at all to be checked is a kind of miracle; that it is possible to find a rule, like the inverse square law of gravitation, is some sort of miracle. It is not understood at all, but it leads to the possibility of prediction — that means it tells you what you would expect to happen in an experiment you have not yet done.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 23)

Perseus Books. Reading, Massachusetts, USA. 1998

**Galsworthy, John** 1867–1933  
English novelist and dramatist

KEITH: ...I don't see the use in drawin' hard and fast rules. You only have to break 'em.

*Eldest Son*

Act I, Scene 2 (p. 13)

Charles Scribner's Sons. New York, New York, USA. 1913

**Gardner, Martin** 1914–  
American writer and mathematics games editor

I shall add only the fantasy that God or Nature may be playing thousands, perhaps a countless number, of simultaneous Eleusis games [card games with secret rules] with intelligences on planets in the universe...Prophets and False Prophets come and go, and who knows when one round will end and another begin? Searching for any kind of truth is an exhilarating game. It is worth remembering that there would be no game at all unless the rules were hidden.

*Mathematical Games*

*Scientific American*, Volume 237, Number 4, October 1977 (p. 25)

**Norton, Robert** 1875–1932  
No biographical data available

...every Art hath certain Rules and Principles...without the knowledge of which no man can attain unto a necessary perfection for practice thereof...

*The Gunner*

The Preface to the Courteous Readers (second page)

J. Long. London, England. 1928

**Wilson, John** 1626–96  
No biographical data available

...the Exception proves the Rule.

*The Cheats*

Appendix, The Author to the Reader, l. 27

W. Patterson. Edinburgh, Scotland. 1874

**RUST**

**Chaucer, Geoffrey** 1343–1400  
English poet

If gold ruste, what shal iren do?

In *Great Books of the Western World* (Volume 22)

*The Canterbury Tales*

Prologue

The Parson, l. 50

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Kreutzberg, E. C.**  
No biographical data available

Rust and corrosion mean an enormous loss to Americans, greater than that caused by fire and flood combined, a loss of at least one billion dollars a year. Rust is a skin disease. Corrosion is an infectious internal disease like tuberculosis.

Nickel-Chromium Steels More Widely Used

*Iron Trade Review*, Volume 86, Number 16, 17 April 1930

**Tennyson, Alfred (Lord)** 1809–92  
English poet

How dull it is to pause, to make an end,  
To rust unburnish'd, not to shine in use.

*Alfred Tennyson's Poetical Works*

Ulysses, l. 22–23

Oxford University Press, Inc. London, England. 1953



## S

### SAGACITY

**Diderot, Denis** 1713–84

French encyclopedist and philosopher of materialism

I picture the vast realm of the sciences as an immense landscape scattered with patches of dark and light. The goal towards which we must work is either to extend the boundaries of the patches of light, or to increase their number. One of these tasks falls to the creative genius; the other requires a sort of sagacity combined with perfectionism.

In D. Adams (ed.)

*Thoughts on the Interpretation of Nature and Other Philosophical Works*  
Section XIV (p. 42)

Clinamen Press. Manchester, England. 1999

**Locke, John** 1632–1704

English philosopher and political theorist

Those intervening ideas, which serve to show the agreement of any two others, are called proofs; and where the agreement or disagreement is by this means plainly and clearly perceived, it is called demonstration; it being shown to the understanding, and the mind made to see that it is so. A quickness in the mind to find out these intermediate ideas, (that shall discover the agreement or disagreement of any other) and to apply them right, is, I suppose, that which is called sagacity.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Book VI, Chapter II, Section 3 (p. 310)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whewell, William** 1794–1866

English philosopher and historian

The Conceptions by which Facts are bound together, are suggested by the sagacity of discoverers. This sagacity cannot be taught. It commonly succeeds by guessing; and this success seems to consist in framing several tentative hypotheses and selecting the right one. But a supply of appropriate hypotheses cannot be constructed by rules, nor without inventive talent.

*The Philosophy of the Inductive Sciences Founded Upon Their History*  
(Volume 2)

Aphorisms, Aphorisms Concerning Science, VIII (pp. 467–468)

John W. Parker. London, England. 1847

### SAMPLE

**Bloch, Arthur** 1948–

American humorist

After painstaking and careful analysis of a sample, you are always told that it is the wrong sample and doesn't apply to the problem.

*Murphy's Law*

Fourth Law of Revision (p. 48)

Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Cochran, William G.** 1909–80

Scottish-born American statistician

Our knowledge, our attitudes, and our actions are based to a very large extent on samples.

*Sampling Techniques* (p. 1)

John Wiley & Sons. New York, New York, USA. 1953

A person's opinion of an institution that conducts thousands of transactions every day is often determined by the one or two encounters which he has had with the institution in the course of several years.

*Sampling Techniques* (p. 1)

John Wiley & Sons. New York, New York, USA. 1953

**Cochran, William G.** 1909–80

Scottish-born American statistician

**Mosteller, Frederick** 1916–2006

American statistician

In 1905, a physicist measuring the thermal conductivity of copper would have faced, unknowingly, a very small systematic error due to the heating of his equipment and sample by the absorption of cosmic rays, then unknown to physics. In early 1946, an opinion poller, studying Japanese opinion as to who won the war, would have faced a very small systematic error due to the neglect of the 17 Japanese holdouts, who were discovered later north of Saipan. These cases are entirely parallel. Social, biological and physical scientists all need to remember that they have the same problem, the main difference being the decimal place in which they appear.

*Principles of Sampling*

*Journal of the American Statistical Association*, Volume 49, 1954 (p. 31)

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

Sampling is the science and art of controlling and measuring the reliability of useful statistical information through the theory of probability.

*Some Theory of Sampling* (p. 3)

John Wiley & Sons. New York, New York, USA. 1950

If the cost of classifying a sampling unit were zero, one could always safely recommend fantastic plans of stratified sampling, with no worry about costs. The fact is, though, that there is always a price to pay...

*Sample Design in Business Research* (p. 320)

John Wiley & Sons. New York, New York, USA. 1960

A good sample-design is lost if it is not carried out according to plans.

*Some Theory of Sampling* (p. 241)

John Wiley & Sons. New York, New York, USA. 1950

**Diconis, Persi** 1945–

American mathematician

**Mosteller, Frederick** 1916–2006

American statistician

The law of truly large numbers states: With a large enough sample, any outrageous thing is likely to happen.

Methods for Studying Coincidences

*Journal of the American Statistical Association*, Volume 84, 1989 (p. 859)

**Gilbert, Sir William Schwenck** 1836–1911

English playwright and poet

**Sullivan, Arthur** 1842–1900

English composer

I've got a little list — I've got a little list...

I've got him on the list...

They never would be missed — they never would be missed!

*The Complete Plays of Gilbert and Sullivan*

The Mikado

Act I

The Modern Library. New York, New York, USA. 1936

**Gissing, George** 1857–1903

English novelist

He pointed to a heap of five or six hundred letters, and laughed consumedly.

“Impossible to read them all, you know. It seemed to me that the fairest thing would be to shake them together, stick my hand in, and take our one by chance. If it didn't seem very promising, I would try a second time.”

*New Grub Street*

The Way Hither (p. 62)

The Modern Library. New York, New York, USA. 1926

**McNemar, Quinn** 1900–86

American statistician

One does not have to read much of the current research literature in psychology, particularly in individual and social psychology, to realize that there exists a great deal of confusion in the minds of investigators as to the necessity of obtaining a truly representative sample, describing carefully how the sample was secured, and restricting generalizations to the universe, often ill-defined, from which the sample was drawn.

*Psychological Bulletin*

Sampling in Psychological Research

*Journal of the American Statistical Association*, Volume 37, Number 6, June 1940 (p. 33)

**Mosteller, Frederick** 1916–2006

American statistician

...weighing a sample appropriately is no more fudging the data than is correcting a gas volume for barometric pressure.

Principles of Sampling

*Journal of the American Statistical Association*, Volume 49, Number 265, 1964 (p. 33)

**Slonim, Morris James**

No biographical data available

Everyone who has poured a highball into the nearest potted plant after taking one sip has had some experience in sampling.

*Sampling in a Nutshell* (p. 1)

Simon &amp; Schuster. New York, New York, USA. 1960

Sampling is only one component, but undoubtedly the most important one, of that broad based field of scientific method known as statistics.

*Sampling in a Nutshell* (p. 7)

Simon &amp; Schuster. New York, New York, USA. 1960

**SAND****Carson, Rachel** 1907–64

American marine biologist and author

Sand is a substance that is beautiful, mysterious, and infinitely variable; each grain on a beach is the result of processes that go back into the shadowy beginnings of life, or of the earth itself.

*The Edge of the Sea*

Chapter IV (p. 125)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

**Charlie Chan**

Fictional character

Earthquake may shatter the rock, but sand upon which rock stood, in same old place.

*Dark Alibi*

Film (1946)

**McCord, David** 1897–1997

American poet

A handful of sand is an anthology of the universe...

*Once and For All*

Once and For All (p. 1)

Coward-McCann. New York, New York, USA. 1929

**Simon, Anne W.**

No biographical data available

The end product, rock's irreducible minimum, is sand. Hold it in your hands and you are in touch with the planet's essence. Each grain has been part of the Earth's solid crust at one time or another, eventually to be freed from rock to exist as a grain again, its particular structure intact.

*The Thin Edge: Coast and Man in Crisis*

Chapter 2 (pp. 17–18)

Harper &amp; Row, Publishers. New York, New York, USA. 1978

**SAVANT**

**Richet, Charles** 1850–1935  
French physiologist

For the savant, Science must be a religion. Everything that is discovered, be it great or small, has its origin in this faith.

Translated by Sir Oliver Lodge  
*The Natural History of a Savant*  
Chapter VI (p. 47)  
J.M. Dent & Sons Ltd. London, England. 1927

**SCATTERING**

**Rutherford, Ernest** 1871–1937  
English physicist

It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you. On consideration, I realized that this scattering backward must be the result of a single collision, and when I made calculations I saw that it was impossible to get anything of that order of magnitude unless you took a system in which the greater part of the mass of the atom was concentrated in a minute nucleus. It was then that I had the idea of an atom with a minute massive center carrying a charge.

In Joseph Needham and W. Pagel (ed.)  
*Background to Modern Science*  
From Aristotle to Galileo  
The Development of the Theory of Atomic Structure (p. 68)  
The Macmillan Company. New York, New York, USA. 1938

**SCAVENGER**

**Austin, Mary Hunter** 1868–1934  
American novelist and essayist

Once at Red Rock, in a year of green pasture, which is a bad time for the scavengers, we saw two buzzards, five ravens, and a coyote feeding on the same carrion, and only the coyote seemed ashamed of the company.

*The Land of Little Rain*  
The Scavengers (pp. 53–54)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

**SCENERY**

**Muir, John** 1838–1914  
American naturalist

The scenery is mostly of a comfortable, assuring kind, grand and inspiring without too much of that dreadful overpowering sublimity and exuberance which tend to discourage effort and cast people into inaction and superstition.

*Steep Trails*  
Chapter XXI (p. 272)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**SCIATICA**

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Thou cold sciatica,  
Cripple our senators, that their limbs may halt  
As lamely as their manners!

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Timon of Athens  
Act IV, Scene i, l. 23–25  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Which of your hips has the most profound sciatica?

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
Measure for Measure  
Act I, Scene ii, l. 58  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**SCIENCE**

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

That which today calls itself science gives us more and more information, an indigestible glut of information, and less and less understanding.

*Down the River*  
Part I  
Down the River with Henry Thoreau  
7 November 1980 (p. 29)  
E.P. Dutton & Company. New York, New York, USA. 1982

Science is the whore of industry and the handmaiden of war.

*A Voice Crying in the Wilderness: Notes from a Secret Journal*  
Chapter 10 (p. 93)  
St. Martin's Press. New York, New York, USA. 1989

**Adams, Henry Brooks** 1838–1918  
American man of letters

No sand-blast of science had yet skimmed off the epidermis of history, thought, and feeling.

In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
Chapter VI (p. 90)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

Man has mounted science, and is now run away with. I firmly believe that before many centuries more, science will be the master of men.

In J.C. Levenson, E. Samuels, C. Vandersee and V. Hopkins (eds.)  
*The Letters of Henry Adams: 1858–1868* (Volume 1)  
Letter to Charles Francis Adams, Jr.  
April 11, 1862 (p. 290)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

My belief is that science is to wreck us, and that we are like monkeys monkeying with a loaded shell; we don't in the least know or care where our practically infinite energies come from or will bring us to.

*Letters of Henry Adams* (Volume 2)

Letter, August 10, 1902, to Brooks Adams (p. 392)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

**Akenside, Mark** 1721–70

English poet and physician

Speak, ye, the pure delight, whose favour'd steps  
The lamp of science, through the jealous maze  
Of nature guides, when haply you reveal

Her secret honours.

*The Poetical Works of Mark Akenside*

The Pleasures of Imagination, Part II

Associated University Presses. Cranbury, New Jersey, USA. 1996

**Alighieri, Dante** 1265–1321

Italian poet and writer

...no Science demonstrates its own subject, but presupposes it.

*The Convivio of Dante Alighieri*

The Second Treatise, Chapter XIV (p. 114)

J.M. Dent & Sons Ltd. London, England. 1912

**Allport, Susan** 1950–

Naturalist and science writer

Science advances, it seems, less through scientific consensus than by means of a scientific melee, a free-for-all in which every scientist pushes his or her piece of the truth, knowing that only time will tell which piece best fits reality.

*Explorers of the Black Box: The Search for the Cellular Basis of Memory*

Chapter Ten (p. 263)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Alves, Reuben**

No biographical data available

Science is what it is, not what scientists think they do.

*New York Times*, July 13, 1979, A8 (p. 128)

**Amiel, Henri-Frédéric** 1821–81

Swiss philosopher, poet, and critic

Society lives by faith, develops by science.

Translated by Mrs. Humphrey Ward

*Amiel's Journal*

May 7, 1870 (p. 216)

A.L. Burt Company, Publishers. New York, New York, USA. 1897

**Appleyard, Bryan** 1951–

English author and journalist

Science is not a neutral or innocent commodity which can be employed as a convenience.... Rather it is spiritually corrosive, burning away at ancient authorities and traditions. It has shown itself unable to coexist with anything.

*Understanding the Present: Science and the Soul of Modern Man*

Chapter 1 (p. 9)

Doubleday. New York, New York, USA. 1992

**Arabic Proverb**

Science is a plant whose roots indeed are at Mecca, but its fruit ripens at Herat.

In Robert Christy

*Proverbs, Maxims and Phrases of All Ages* (p. 236)

G.P. Putnam's Sons. New York, New York, USA. 1888

**Asimov, Isaac** 1920–92

American author and biochemist

Science does not promise absolute truth, nor does it consider that such a thing necessarily exists. Science does not even promise that everything in the Universe is amenable to the scientific process.

*"X" Stands for Unknown*

Introduction (p. 10)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

The process of science...involves a slow forward movement through the reachable portions of the Universe — a gradual unfolding of parts of the mystery.

*"X" Stands for Unknown*

Introduction (p. 10)

Doubleday & Company, Inc. Garden City, New York, USA. 1984

**Astbury, William Thomas** 1898–1961

English crystallographer and molecular biologist

...science is truly one of the highest expressions of human culture — dignified and intellectually honest, and withal a never-ending adventure. Personally, I feel much the same with regard to the more ecstatic moments in science as I do with regard to music. I see little difference between the thrill of scientific discovery and what one experiences when listening to the opening bars of the Ninth Symphony.

Science in Relation to the Community

*School Science Review*, Number 109, 1948 (p. 279)

**Author undetermined**

Science has no fear for dissent or for heresy. She collects facts eagerly, steadily, from generation to generation, the labors of one investigator being added to those of another, the speculations of one coalescing with those of another, in virtue of a necessary and admirable solidarity. Then, from these facts patiently observed, brought together, coordinated, classified, science deduces a law, a positive law, which is the expression of reality, of truth itself.

Scientific Miscellany

*The Galaxy*, Volume 17, January 1874 (p. 130)

The wonders of the heavens seem inexhaustible; each new adventure of science tasks the imagination and almost staggers the reason.

Scientific Miscellany  
*The Galaxy*, Volume 11, February 1871 (p. 297)

...science has given us a new reading of nature, has opened the higher questions of life and human relations, has furnished a new method to the mind, and is fast becoming a new power in literature.

Scientific Miscellany  
*The Galaxy*, Volume 11, January 1871 (p. 135)

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

Those who have treated of the sciences have been either empirics or dogmatical. The former like ants only heap up and use their store, the latter like spiders spin out their own webs. The bee, a mean between both, extracts matter from the flower of the garden and the field, but works and fashions it by its own efforts.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
 First Book, Aphorism 95 (p. 126)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The divisions of the sciences are not like different lines that meet in one angle, but rather like the branches of trees that join in one trunk.

In J.A. Thomson  
*Introduction to Science*  
 Chapter IV (p. 92)  
 Williams & Norgate Ltd. London, England. 1916

Science, being the wonder of the ignorant and unskillful, may be not absurdly called a monster. In figure and aspect it is represented as many-shaped, in allusion to the immense variety of matter with which it deals. It is said to have the face and voice of a woman, in respect of its beauty and facility of utterance. Wings are added because the sciences and the discoveries of science appeared and fly-aboard in an instant; the communication of knowledge being like that of one candle with another, which lights up at once. Claws, sharp and hooked, are ascribed to it with great elegance, because the axioms and arguments of science penetrate and hold fast the mind, so that it has no means of evasion or escape.

In Hugh Dick (Ed(ed.)  
*Selected Writings of Francis Bacon*  
 Sphinx on Science (pp. 418–419)  
 Random House, Inc. New York, New York, USA. 1955

Even the effects already discovered are due to chance and experiment, rather than to the sciences; for our present sciences are nothing more than peculiar arrangements of matters already discovered, and not methods for discovery or plans for new operations.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
 First Book, Aphorism 8 (p. 107)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the real and legitimate goal of the sciences is the endowment of human life with new inventions and riches.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
 First Book, Aphorism 81 (p. 120)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Balard, Antoine-Jérôme** 1802–76

French chemist

Science appears to have as its mission not merely the satisfaction of man's need of learning and understanding everything, which characterizes the noblest of our faculties; it has another aim, doubtless less brilliant but perhaps more moral, I would almost say more sacred, which consists in coordinating the forces of nature to increase production and make men more nearly equal by the universality of comfort.

In Mary Elvira Weeks  
*The Discovery of the Elements* (p. 438)  
 Journal of Chemical Education. Easton Pennsylvania, USA. 1956

**Barnett, Lincoln** 1909–79

American science writer

The quick harvest of applied science is the useable process, the medicine, the machine. The shy fruit of pure science is Understanding.

*Life*, January 9, 1950

**Baruch, Bernard M.** 1870–1965

American presidential advisor

Science has taught us how to put the atom to work. But to make it work for good instead of evil lies in the domain dealing with the principles of human duty. We are now facing a problem more of ethics than physics.

The Baruch Plan for Banning the Atom Bomb  
*Life*, 24 June, 1946 (p. 35)

**Barzun, Jacques** 1907–

French-born American educator, historian, and educator

It is not clear to anyone, least of all the practitioners, how science and technology in their headlong course do or should influence ethics and law, education and government, art and social philosophy, religion and life of the affections. Yet science is an all-pervasive energy, for it is at once a mode of thought, a source of strong emotion, and a faith as fanatical as any in history.

*Science: The Glorious Entertainment*  
 To the Reader (p. 3)  
 Harper & Row, Publishers. New York, New York, USA. 1964

**Baskerville, Charles**

No biographical data available

I like to fancy scientific endeavor as the sea — calm and serene, supporting and mirroring that which is below it, bearing that which is upon it, reaching to and reflecting

that which is above it, moving all the while; yet, torn and rent at times by conflict from without and contest within, it runs; it beats against the shores of the unknown, making rapid progress here, meeting stubborn resistance there, compassing it, to destroy but to rebuild elsewhere; and the existence of those within it!

The Elements: Verified and Unverified  
*Science*, New Series, Volume 19, Number 472, 15 January 1904 (p. 100)

### **Bass, William M.**

American forensic anthropologist

Always think of the consequences of your actions both in the field and in the laboratory.

*Human Osteology: A Laboratory and Field Manual of the Human Skeleton* (3<sup>rd</sup> edition)  
Missouri Archaeological Society. Columbia, Missouri, USA. 1987

### **Bates, Marston** 1906–74

American zoologist

Science has put man in his place; one among the millions of kinds of living things crawling around on the surface of a minor planet circling a trivial star.

*The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*  
Chapter 1 (p. 5)  
Random House, Inc. New York, New York, USA. 1960

### **Baudrillard, Jean** 1929–

French cultural theorist

We can no longer say things appear unintelligible because science does not know enough about them. It seems that the more we know about them, the more unintelligible they become.

Translated by Chris Turner  
*Cool Memories*  
October 1983 (p. 144)  
Verso. London, England. 1990

### **Bauer, Henry H.** 1931–

American chemist

Quite in general, it is not the case that, because science has changed its mind in the past, therefore it might change its mind again in any direction and by any amount.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 4 (p. 66)  
University of Illinois Press. Urbana, Illinois, USA. 1992

That science is inescapably a human activity does not mean that it is only or just a human activity, essentially similar to all other human activities.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 7 (p. 141)  
University of Illinois Press. Urbana, Illinois, USA. 1992

That science is not everything should not blind us to the fact that it is the very best of what we do have. Just as those who benefit from individual therapy can take pride

from the persistent acts of will they exerted along the way, so humankind can take collective pride from the persistent determination to submit to reality therapy that has produced not only the science we now know but also an understanding of how to go about learning more.

*Scientific Literacy and the Myth of the Scientific Method*  
Chapter 7 (p. 150)  
University of Illinois Press. Urbana, Illinois, USA. 1992

### **Beard, Charles A.** 1874–1948

American historian

A revolution in thought is at hand, a revolution as significant as the Renaissance: the subjection of science to ethical and esthetic purpose. Hence the next great survey undertaken in the name of the social sciences may begin boldly with a statement of values agreed upon, and then utilize science to discover the conditions, limitations, and methods involved in realization.

Limitations to the Application of Social Science Implied in Recent Social Trends  
*Social Forces*, Volume 11, Number 4, May 1933 (p. 510)

### **Beattie, James** 1735–1803

Scottish poet and essayist

‘Twas thus by the glare of false science betray’d,  
That leads, to bewilder; and dazzles, to blind...

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*  
The Hermit, Stanza 5  
J. Blackwood. London, England. 1800

### **Beebe, William** 1877–1962

American ornithologist

Thus was the ending still unfinished, the finale buried in the future — and in this we find the fascination of Nature and of Science. Who can be bored for a moment in the short existence vouchsafed us here; with dramatic beginnings barely hidden in the dust, with the excitement of every moment of the present, and with all of cosmic possibility lying just concealed in the future, whether of Betelgeuze, of Amoeba or — of ourselves?

*Edge of the Jungle*  
Chapter XII (p. 294)  
Garden City Publishing Company, Inc. Garden City, New York, USA. 1925

### **Bennett, William Cox** 1820–95

American poet

To what new realms of marvel, say,  
Will conquering science war its way?

*Poems*  
To a Boy  
Stanza 1  
Chapman & Hall. London, England. 1850

### **Bernal, John Desmond** 1901–71

Irish-born physicist and x-ray crystallographer

Science is one of the most absorbing and satisfying pastimes, and as such it appeals in different ways to different types of personality. To some it is a game against the unknown where one wins and no one loses; to others, more humanly minded, it is a race between different investigators as to who should first wrest the prize from nature. It has all the qualities which make millions of people addicts of the crossword puzzle or the detective story, the only difference being that the problem has been set by nature or chance and not by man, that the answer cannot be got with certainty, and when they are found often raise far more questions than the original problem.

*The Social Function of Science* (p. 97)

The Macmillan Company. New York, New York, USA. 1939

...it is not possible in any published book to speak freely and precisely about the way science is run. The law of liable, reasons of State, and still more the unwritten code of the scientific fraternity itself forbid particular examples being held up alike for praise or blame.

*The Social Function of Science* (p. xv)

The Macmillan Company. New York, New York, USA. 1939

### **Bernard, Claude** 1813–78

French physiologist

...my idea of the science of life...it is a superb and dramatically lighted hall which may be reached only by passing through a long and ghastly kitchen.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part One, Chapter III, Section iii (p. 15)

Henry Schuman, Inc. New York, New York, USA. 1927

### **Berthelot, Marcellin** 1827–1907

French chemist

Science is essentially a collective work, pursued during the course of time by the efforts of a multitude of workers of every age and of every nation, succeeding themselves and associating by virtue of a tacit understanding for the search for pure truth and for the applications of that truth to the continuous betterment of the condition of all mankind.

In Camille Matignon

*Annual Report of the Board of Regents of the Smithsonian Institution, 1907*

Marcellin Berthelot (p. 684)

Government Printing Office. Washington, D.C. 1908

### **Birch, Arthur J.** 1915–95

Australian chemist

Some people derive satisfaction from accumulating data, whereas others are content to dream and leave experiments to colleagues. Still others flit from flower to flower rather than learning more and more about one situation. The difference in approach is a matter of temperament, and we all must understand our own strengths. All workers ultimately contribute to the matrix of facts, ideas,

understandings, techniques, and visions that we know as science.

*To See the Obvious*

Random Conversations with the Editor (p. 195)

American Chemical Society. Washington, D.C. 1995

### **Black, Hugh**

No biographical data available

The limits of science are not limits of its methods, but limits of its spheres.

Our Made-Over World

*Everybody's Magazine*, November 1914 (p. 710)

### **Black, Joseph** 1728–99

Scottish chemist and physician

...if science be the discovery of the laws of nature, the knowledge of these laws will enable us to foresee what will be the result of any process, and must point out to us, in all cases, the means, and the best means, for producing any desired chemical effect: and here does our science repay, with a liberality unparalleled in any other science, all her former obligations to the arts of life. From them did she borrow the many facts which excited her to speculate; and her occupation has at last enabled her to repay her debts with large interest, while she has grown rich in knowledge almost beyond hope.

*Lectures on the Elements of Chemistry* (Volume 1)

Lectures on Chemistry

Definitions (p. 20)

Printed for Mathew Carey. Philadelphia, Pennsylvania, USA. 1807

### **Blake, William** 1757–1827

English poet, painter, and engraver

Art is the Tree of Life; Science is the Tree of Death

*The Complete Poetry and Prose of William Blake*

The Laocoön

University of California Press. Berkeley, California, USA. 1982

### **Blavatsky, Elena Petrovna** 1831–91

Russian-born American theosophist

If there were such a thing as a void, a vacuum in Nature, one ought to find it produced, according to a physical law, in the minds of helpless admirers of the "lights" of Science, who pass their time in mutually destroying their teachings.

*The Secret Doctrine*

Section 17

Theosophy Company. Los Angeles, California, USA. 1925

### **Bloom, Allan** 1930–92

American philosopher

Science, in freeing men, destroys the natural condition that makes them human. Hence, for the first time in history, there is the possibility of a tyranny grounded not on ignorance, but on science.

*The Closing of the American Mind: How Higher Education Has Failed Democracy and Impoverished the Souls of Today's Students*

Part Three, Swift's Doubts (p. 295)  
Simon & Schuster. New York, New York, USA. 1987

**Boas, George** 1891–1980  
American philosophy professor

Science is the art of understanding nature.  
In Laurence M. Gould  
Science and the Culture of Our Times  
*UNESCO Courier*, February 1968 (p. 6)

**Bohm, David** 1917–92  
American physicist

**Peat, D.**  
No biographical data available

Science is essentially a public and social activity.  
*Science, Order, and Creativity*  
Chapter Two (p. 67)  
Bantam Books. New York, New York, USA. 1987

Science is an attempt to understand the universe and humanity's relationship to nature.  
*Science, Order, and Creativity*  
Chapter One (p. 16)  
Bantam Books. New York, New York, USA. 1987

Science is, however, at least in principle, dedicated to seeing any fact as it is, and to being open to free communication with regard not only to the fact itself, but also to the point of view from which it is interpreted.  
*Science, Order, and Creativity*  
Chapter Six (pp. 241–242)  
Bantam Books. New York, New York, USA. 1987

Although science literally means “knowledge,” the scientific attitude is concerned much more with rational perception through the mind and with testing such perceptions against actual fact, in the form of experiments and observations.  
*Science, Order, and Creativity*  
Chapter Six (p. 260)  
Bantam Books. New York, New York, USA. 1987

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

The importance of physical science for the development of general philosophical thinking rests not only on its contributions to our steadily increasing knowledge of that nature of which we ourselves are part, but also on the opportunities which time and again it has offered for examination and refinement of our conceptual tools.  
*Atomic Physics and Human Knowledge*  
Introduction (p. 1)  
John Wiley & Sons, Inc. New York, New York, USA. 1958

The task of science is both to extend the range of our experience and reduce it to order.  
*Atomic Theory and the Description of Nature*  
Introductory Survey (p. 1)  
Cambridge University Press. Cambridge, England. 1934

It is, indeed, perhaps the greatest prospect of humanistic studies to contribute through an increasing knowledge of the history of cultural development to that gradual removal of prejudices which is the common aim of all science.

*Atomic Physics and Human Knowledge*  
Natural Philosophy and Human Cultures (p. 31)  
John Wiley & Sons, Inc. New York, New York, USA. 1958

**Bolton, Henry Carrington** 1843–1903  
American chemist, bibliographer, and historian

So rapid are the strides made by science in this progressive age and so boundless is its range, that those who view its career from without find great difficulty in following its diverse and intricate pathways, while those who have secured a footing within the same road are often quite unable to keep pace with its fleet movements and would fain retire from the unequal contest. It is not surprising, then, that those actually contributing to the advancement of science, pressing eagerly upward and onward, should neglect to look back upon the labors of those who precede them and should sometimes lose sight of the obligations which science owes to forgotten generations.  
Notes on the Early Literature of Chemistry  
Reprinted from *The American Chemist*, November 1875

**Bonaparte, Napoleon** 1769–1821  
French soldier and emperor of France

The sciences, which have revealed so many secrets and destroyed so many prejudices, are destined to render us yet greater service. New truths, new discoveries will unveil secrets still more essential to the happiness of men — but only if we give our esteem to the scientists and our protection to the sciences.  
In J. Christopher Herold (ed.)  
*The Mind of Napoleon*  
Science and the Arts (p. 135)  
Columbia University Press. New York, New York, USA. 1955

**Bondi, Sir Hermann** 1919–2005  
English mathematician and cosmologist

Throughout science there is a constant alternation between periods when a particular subject is in a state of order, with all known data falling neatly into their places, and a state of puzzlement and confusion, when new observations throw all neatly arranged ideas into disarray.  
In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today, 1966*  
Astronomy and the Physical Sciences (p. 245)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

**Born, Max** 1882–1970  
German-born English physicist

The satisfaction of the noble curiosity of the scholar is only one aspect of research. Science is also — and many say predominantly — a collective effort to obtain power over the forces of nature in the interest of human life.



*The Restless Universe*

Postscript (p. 297)

Dover Publications, Inc. New York, New York, USA. 1951

I now regard my former belief in the superiority of science over other forms of human thought and behavior as a self-deception due to youthful enthusiasm over the clarity of scientific thinking as compared with the vagueness of metaphysical systems.

Still, change of fundamental concepts and the failure to improve the moral standards of human society are no demonstration of the uselessness of science in the search for truth and for a better life.

*Physics in My Generation*

Preface (p. v)

Springer-Verlag New York, Inc. New York, New York, USA. 1969

### **Bosler, Jean**

No biographical data available

As science advances, new questions appear before indeed the older ones, often badly put, are solved. But the latter often lose their interest, and as we proceed many untenable hypotheses which darkened our path are destroyed. And so, little by little, the knowledge we have of things progresses with a tidal motion which will doubtless end only with humanity.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1914*

Modern Theories of the Sun (p. 160)

Government Printing Office. Washington, D.C. 1915

### **Bradbury, Ray** 1920–

American writer

At base, science is no more than an investigation of a miracle we can never explain, and art is an interpretation of that miracle.

Ray Bradbury: 100 of His Most Celebrated Tales

June 2001: And the Moon Still Be as Bright (p. 421)

HarperCollins Publishers, Inc. New York, New York, USA. 2003

### **Bradley, Jr., John Hodgdon** 1898–1962

American geologist

Thus along many battle fronts, the army of science advances on the strongholds of ignorance in the heart of earth. Speculations bristle like bayonets and collapse like papier-mâché. But though mistakes retard and darkness confuses, the army presses on.

*Autobiography of Earth*

Chapter VIII (p. 247)

Coward-McCann, Inc. New York, New York, USA. 1935

### **Brecht, Bertolt** 1898–1956

German writer

GALILEO: One of the main reasons why the sciences are so poor is that they imagine they are so rich. It isn't their job to throw open the door to infinite wisdom but to put a limit to infinite error.

Translated by John Willett

*Life of Galileo*

Scene 9 (p. 74)

Arcade Publishing. New York, New York, USA. 1994

ANDREA: Science makes only one demand: contribute to science.

Translated by John Willett

*Life of Galileo*

Scene 14 (p. 107)

Arcade Publishing. New York, New York, USA. 1994

### **Bremer, J.**

No biographical data available

What, then, is science according to common opinion? Science is what scientists do. Science is knowledge, a body of information about the external world. Science is the ability to predict. Science is power, it is engineering. Science explains, or gives causes and reasons.

*What Is Science? Notes on the Nature of Science* (pp. 37–38)

Harcourt, Brace & World, Inc. New York, New York, USA. 1962

### **Brewster, Edwin Tenney** 1866–1960

Educator

Science, in fact, begins only as men confine themselves to accounting for the unknown by the known — not by the unknown by something about which they know still less.

*This Puzzling Planet*

Chapter V (p. 93)

The Bobbs-Merrill Company. Indianapolis, Indiana. 1928

### **Bridgman, Percy Williams** 1882–1961

American physicist

Science is intelligence in action with no holds barred.

In Theodore Schick, Jr., and Lewis Vaughn

*How to Think About Weird Things*

Chapter 7 (p. 164)

The McGraw-Hill Companies. New York, New York, USA. 2002

### **Broad, William** 1951–

Science writer

### **Wade, Nicholas**

British-born scientific writer

In the acquisition of new knowledge, scientists are not guided by logic and objectivity alone, but also by such nonrational factors as rhetoric, propaganda, and personal prejudice. Scientists do not depend solely on rational thought, and have no monopoly on it. Science should not be considered the guardian of rationality in society, but merely one major form of its cultural expression.

*Betrayers of the Truth* (p. 9)

Simon & Schuster. New York, New York, USA. 1982

Science is not an abstract body of knowledge, but man's understanding of nature. It is not an idealized interrogation of nature by dedicated servants of truth, but a human

process governed by the ordinary human passions of ambition, pride, and greed, as well as by all the well-hymned virtues attributed to men of science.

*Betrayers of the Truth* (p. 223)

Simon & Schuster. New York, New York, USA. 1982

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

Science has nothing to be ashamed of even in the ruins of Nagasaki. The shame is theirs who appeal to other values than the human imaginative value which science has evolved.

*Science and Human Values*

The Sense of Human Dignity (p. 73)

Harper & Row, Publishers. New York, New York, USA. 1965

The world today is made, it is powered by science; and for any man to abdicate an interest in science is to walk with open eyes towards slavery.

*Science and Human Values*

The Creative Mind (p. 6)

Harper & Row, Publishers. New York, New York, USA. 1965

The discoveries of Science, the works of art are explorations — more, are explosions, of a hidden likeness.

*Science and Human Values*

The Creative Mind (p. 19)

Harper & Row, Publishers. New York, New York, USA. 1965

The values of science derive neither from the virtues of its members, nor from the finger-wagging codes of conduct by which every profession reminds itself to be good. They have grown out of the practice of science, because they are the inescapable conditions for its practice.

*Science and Human Values*

The Sense of Human Dignity (p. 60)

Harper & Row, Publishers. New York, New York, USA. 1965

Like the voyages of the Spaniards into the fabulous West, Science even at its boldest does the will of history, and in turn helps to determine its movement.

*The Common Sense of Science*

Chapter VII, Section 1 (p. 97)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

[Science] does not watch the world, it tackles it.

*The Common Sense of Science*

Chapter VII, Section 4 (p. 104)

Harvard University Press. Cambridge, Massachusetts, USA. 1953

All science is the search for unity in hidden likenesses.

*Science and Human Values*

The Creative Mind (p. 13)

Harper & Row, Publishers. New York, New York, USA. 1965

[This] is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer.

*The Ascent of Man*

Chapter 4 (p. 153)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Bryan, William Jennings** 1860–1925

American lawyer, orator, and politician

Evolution seems to close the heart to some of the plainest spiritual truths while it opens the mind to the wildest guesses advanced in the name of science.

*The New York Times*, Letter, 22 February 1922

Christians desire that their children shall be taught all the sciences, but they do not want them to lose sight of the Rock of Ages while they study the age of rocks...

Speech

Prepared for the Scopes Trial, 1925

**Bryson, Bill** 1951–

American author

The remarkable position in which we find ourselves is that we don't actually know what we actually know.

*A Short History of Nearly Everything*

Chapter 23 (p. 362)

Broadway Books. New York, New York, USA. 2003

**Buchner, Ludwig** 1824–99

German physician and philosopher

Science has gradually taken all the positions of the childish belief of the peoples; it has snatched thunder and lightning from the hands of the gods; the eclipse of the stars, and the stupendous powers of the Titans of the olden time have been grasped by the fingers of man.

*Force and Matter*

Chapter VI (p. 34)

Trubner & Company. London, England. 1864

**Buckham, John Wright**

No biographical data available

...the mind that has been trained simply or predominantly in Science is an unconsciously meager and ill-furnished mind. The range of its interests is mainly technical and specialized. To look into a mind of this type is like looking into a laboratory. It is excellent as a workshop, but there are no pictures on the walls, no books, no flowers. ... What are the resources of such a mind, its points of contact with human-kind?

The Passing of the Scientific Era

*The Century Illustrated Monthly Magazine*, August 1929 (p. 435)

**Meredith, Owen (Edward Robert**

**Bulwer-Lytton, 1<sup>st</sup> Earl Lytton)** 1831–91

English statesman and poet

...science is not a club, it is an ocean; it is open to the cockpit as the frigate. One man carries across it a freightage of ingots, another may fish there for herrings. Who can exhaust the sea? who say to intellect, "the deeps of philosophy are preoccupied?"

*The Caxtons*

Book IV, III

G. Routledge & Company. London, England. 1848

**Bunge, Mario** 1919–  
Argentine philosopher and physicist

The motto of science is not just *Pauca* but rather *Plurima ex paucissimis* — the most out of the least.

*The Myth of Simplicity: Problems of Scientific Philosophy*  
Chapter 5, Section 4 (p. 82)  
Prentice-Hall, Englewood Cliffs, New Jersey, USA. 1963

**Bunting, Basil** 1900–85  
English modernist poet

I hate Science. It denies a man's responsibility for his own deeds, abolishes the brotherhood that springs from God's fatherhood. It is a hectoring, dictating expertise, which makes the least lovable of the Church Fathers seem liberal by contrast. It is far easier for a Hitler or a Stalin to find a mock-scientific excuse for persecution than it was for Dominic to find a mock-Christian one.

In Victoria Forde  
*The Poetry of Basil Bunting*  
Chapter 6, Letter of 1 January 1947 to Louis Zukofsky (p. 156)  
Bloodaxe Books, Newcastle upon Tyne, England. 1991

**Burroughs, John** 1837–1921  
American naturalist and writer

Science has made or is making the world over for us. It has builded us a new house — builded it over our heads while we were yet living in the old, and the confusion and disruption and the wiping-out of the old features and the old associations, have been, and still are, a sore trial — a much finer, more spacious and commodious house...but new, new, all bright and hard and unfamiliar. . . .

In the Noon of Science  
*The Atlantic Monthly*, Volume 110, Number 3, September 1912 (p. 327)

Science is a capital or fund perpetually reinvested; it accumulates, rolls up, is carried forward by every new man. Every man of science has all the science before him to go upon, to set himself up in business with. What an enormous sum Darwin availed himself of and reinvested! Not so in literature; to every poet, to every artist, it is still the first day of creation, so far as the essentials of his task are concerned. Literature is not so much a fund to be reinvested as it is a crop to be ever new-grown.

*The Writings of John Burroughs* (Volume 17)  
The Summit of the Years  
In the Noon of Science (p. 64)  
Houghton Mifflin Company, New York, New York, USA. 1913

Science enables us to understand our own ignorance and limitations, and so puts us at our ease amid the splendors and mysteries of creation.

*The Writings of John Burroughs* (Volume 17)  
The Summit of the Years  
In the Noon of Science (pp. 65–66)  
Houghton Mifflin Company, New York, New York, USA. 1913

Science puts great weapons in men's hands for good or for evil, for war or for peace, for beauty or for ugliness, for life or for death, and how these weapons are used depends upon the motives that actuate us.

*The Writings of John Burroughs* (Volume 17)  
The Summit of the Years  
In the Noon of Science (p. 67)  
Houghton Mifflin Company, New York, New York, USA. 1913

**Bury, John Bagnell** 1861–1927  
English historian and classical scholar

Science has been advancing without interruption during the last three or four hundred years; every new discovery has led to new problems and new methods of solution, and opened up new fields for exploration. Hitherto men of science have not been compelled to halt, they have always found means to advance further. But what assurance have we that they will not come up against impassable barriers?

*The Idea of Progress: An Inquiry into Its Origin and Growth*  
Introduction (p. 3)  
Dover Publications, New York, New York, USA. 1955

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

Science has a simple faith, which transcends utility. Nearly all men of science, all men of learning for that matter, and men of simple ways too, have it in some form and in some degree. It is the faith that it is the privilege of man to learn to understand, and that this is his mission. If we abandon that mission under stress we shall abandon it forever, for stress will not cease. Knowledge for the sake of understanding, not merely to prevail, that is the essence of our being. None can define its limits, or set its ultimate boundaries.

*Science Is Not Enough*  
Chapter X (p. 191)  
William Morrow & Company, Inc. New York, New York, USA. 1967

Science does not exclude faith. . . . Science does not teach a harsh materialism. It does not teach anything beyond its boundaries, and those boundaries have been severely limited by science itself.

*Modern Arms and Free Men*  
Threat and Bulwark (p. 183)  
The MIT Press, Cambridge, Massachusetts, USA. 1968

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Science is being daily more and more personified and anthropomorphized into a god. By and by they will say that science took our nature upon him, and sent down his only begotten son, Charles Darwin, or Huxley, into the world so that those who believe in him, etc.; and they will burn people for saying that science, after all, is only an expression for our ignorance of our own ignorance.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*

Science (p. 233)

Jonathan Cape. London, England. 1951

If [science] tends to thicken the crust of ice on which, as it were, we are skating, it is all right. If it tries to find, or professes to have found, the solid ground at the bottom of the water it is all wrong.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Science (p. 110)

Jonathan Cape. London, England. 1951

### Buttimer, Anne

Geographer

Strange indeed sounds the language of poets and philosophers; stranger still the refusal of science to read and hear its message.

Grasping the Dynamism of Lifeworld

*Annals of the Association of American Geographers*, Volume 66, 1976 (p. 277)

### Buzzati-Traverso, Adriano 1913–83

Italian genetic scientist

Science is a game: it can be exhilarating, it can be useful, it can be frightfully dangerous. It is a play prompted by man's irrepressible curiosity to discover the universe and himself, and to increase his awareness of the world in which he lives and operates.

*The Scientific Enterprise, Today and Tomorrow*

Part I, Chapter 1 (p. 3)

UNES Company. Paris, France. 1977

### Calder, Ritchie 1906–82

Scottish journalist

Science is a river which the explorer may encounter at any point along its course. He can follow it either to its source or to its delta or both.

*Profile of Science*

Introduction (p. 13)

George Allen & Unwin Ltd. London, England. 1951

### Calvin, Melvin 1911–97

American biochemist

There is not a "pure" science. By this I mean that physics impinges on astronomy, on the one hand, and chemistry and biology on the other. And not only does each support neighbors, but derives sustenance from them. The same can be said of chemistry. Biology is, perhaps, the example par excellence today of an "impure" Science.

In Shirley Thomas

*Men of Space. Profiles of the Scientists Who Probe for Life in Space*

(Volume 6)

Melvin Calvin (p. 35)

Chilton Books. Philadelphia, Pennsylvania, USA. 1963

### Campbell, Norman R. 1880–1949

English physicist and philosopher

...science [is] the study of those judgments concerning which universal agreement can be obtained.

*What Is Science?*

Chapter II (p. 32)

Dover Publications. New York, New York, USA. 1952

An audience of children of all ages gapes amazedly while the lecturer discourses glibly of times reckoned in millions of years and distances in thousands of millions of miles. But science has something better to offer than sensational journalism; nothing could be less characteristic of its spirit. The mere fact that the interest of the uninitiated can thus be easily stimulated with serious training suggests doubts of the value of the stimulus; nothing worth having in this world is to be had without effort.

*Physics: The Elements*

Chapter VIII (p. 226)

At The University Press. Cambridge, England. 1920

### Campbell, Thomas 1777–1844

Scottish poet

When Science from Creation's face  
Enchantment's veil withdraws,  
What lovely visions yield their place  
To cold material laws!

*The Complete Poetical Works*

To the Rainbow, l. 13–16

Chadwyck-Healey. Cambridge, England. 1992

Oh! star-eyed Science, hast thou wandered there,  
To waft us home the message of despair?

*The Complete Poetical Works*

Pleasures of Hope, Part II, l. 325

Chadwyck-Healey. Cambridge, England. 1992

### Camus, Albert 1913–60

Algerian-French novelist, author, essayist, and philosopher

At the final stage you teach me that this wondrous and multicolored universe can be reduced to the atom and that the atom itself can be reduced to the electron. All this is good and I wait for you to continue. But you tell me of an invisible planetary system in which electrons gravitate around a nucleus. You explain this world to me with an image. I realize then that you have been reduced to poetry: I shall never know. Have I the time to become indignant? You have already changed theories. So that science that was to teach me everything ends up in a hypothesis, that lucidity founders in metaphor, that uncertainty is resolved in a work of art.

Translated by Justin O'Brien

*The Myth of Sisyphus and Other Essays*

An Absurd Reasoning (pp. 19–20)

Alfred A. Knopf. New York, New York, USA. 1961

### Carlyle, Thomas 1795–1881

English historian and essayist

This world, after all our science and sciences, is still a miracle; wonderful, inscrutable, magical and more, to whosoever will think of it.

*On Heroes and Hero Worship*

Lecture I (p. 12)

John B. Alden, Publisher. New York, New York, USA. 1887

**Carrel, Alexis** 1873–1944

French surgeon and biologist

There is a strange disparity between the sciences of inert matter and those of life. Astronomy, mechanics, and physics are based on concepts which can be expressed, tersely and elegantly, in mathematical language. They have built up a universe as harmonious as the monuments of ancient Greece. They weave about it a magnificent texture of calculations and hypotheses. They search for reality beyond the realm of common thought up to unutterable abstractions consisting only of equations of symbols.

*Man the Unknown*

Chapter 1, Section 1 (p. 1)

Harper & Brothers. New York, New York, USA. 1939

**Carson, Rachel** 1907–64

American marine biologist and author

There is one quality that characterizes all of us who deal with the science of the earth and its life — we are never bored.

In Paul Brooks

*The House of Life: Rachel Carson at Work*

The Closing Journey (p. 324)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1972

We live in a scientific age, yet we assume that knowledge of science is the prerogative of only a small number of human beings, isolated and priestlike in their laboratories. This is not true. The materials of science are the materials of life itself. Science is part of the reality of living; It is the what, the how and the why of everything in our experience.

In Paul Brooks

*The House of Life: Rachel Carson at Work*

Fame (p. 128)

Houghton Mifflin. Boston, Massachusetts, USA. 1972

The winds, the sea, and the moving tides are what they are. If there is wonder and beauty and majesty in them, science will discover these qualities. If they are not there, science cannot create them.

Acceptance Speech

1952 National Book Award

**Chandrasekhar, Subrahmanyan** 1910–95

Indian-born American astrophysicist

The pursuit of science has often been compared to the scaling of mountains, high and not so high. But who amongst us can hope, even in imagination, to scale the Everest and reach its summit when the sky is blue and

the air is still, and in the stillness of the air survey the entire Himalayan range in the dazzling white of the snow stretching to infinity? None of us can hope for a comparable vision of nature and of the universe around us. But there is nothing mean or lowly in standing in the valley below and awaiting the sun to rise over Kinchinjunga.

*Truth and Beauty: Aesthetics and Motivation in Science*

Chapter 2, Section X (pp. 26–27)

The University of Chicago Press. Chicago, Illinois, USA. 1987

I am convinced that one's knowledge of the Physical Sciences is incomplete without a study of the Principia in the same way that one's knowledge of Literature is incomplete without a study of Shakespeare.

On Reading Newton's Principia at Age Apath Eighty

*Current Science*, Volume 67, Number 7, 10 October 1994 (p. 499)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

To be a pioneer in science has lost much of its attraction: significant scientific facts and, even more, fruitful scientific concepts pale into oblivion long before their potential value has been utilized. New facts, new concepts keep crowding in and are in turn, within a year or two, displaced by even newer ones.... Now, however, in our miserable scientific mass society, nearly all discoveries are born dead; papers are tokens in a power game, evanescent reflections on the screen of a spectator sport, news items that do not outlive the day on which they appeared.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part II

A Bouquet of Mortelles (p. 78, 81)

Rockefeller University Press. New York, New York, USA. 1978

To the scientist nature is like a mirror that breaks every thirty years; and who cares about the broken glass of past times?

*Voices in the Labyrinth: Nature, Man and Science*

Chapter 3 (p. 24)

The Seabury Press. New York, New York, USA. 1977

What counts, however, in science is to be not so much the first as the last.

Preface to a Grammar of Biology

*Science*, Volume 172, Number 3984, May 1971 (p. 639)

The sciences are extremely pedigree-conscious, and the road to the top of Mount Olympus is paved with letters of recommendation, friendly whispers at meetings, telephone calls at night.

*Heraclitean Fire: Sketches from a Life Before Nature*

Part I

No Hercules, No Crossroads (p. 32)

Rockefeller University Press. New York, New York, USA. 1978

In science you don't ask why, you ask how much.

*Voices in the Labyrinth: Nature, Man and Science*

Ouroboros (p. 128)

The Seabury Press. New York, New York, USA. 1977

Science cannot be a mass occupation, any more than the composing of music or the painting of pictures.

In Praise of Smallness — How Can We Return to Small Science  
*Perspectives in Biology and Medicine*, Volume 23, Number 3, Spring 1980 (p. 373)

Science has become an eye without a head, a desperate attempt to fill holes with gaps. It came up to a lock, so it looked for the key; but it was a lock without a keyhole. The priests of truth are soiled with blood; their discoveries have become inventions, their pledges far from eternal. In a science in which one can say: "this is no longer true," nothing is true.

*Voices in the Labyrinth: Nature, Man and Science*  
Chimaera (p. 151)  
The Seabury Press. New York, New York, USA. 1977

The so-called exact sciences often are not as exact as is commonly believed. How often they infer the existence of a hat from the emergence of a rabbit!

*Voices in the Labyrinth: Nature, Man and Science*  
Chapter 3 (p. 20)  
The Seabury Press. New York, New York, USA. 1977

In science we always know much less than we believe we do.

Uncertainties Great, Is the Gain Worth the Risk?  
*Chemical and Engineering News*, May 30, 1977

...in most sciences the question Why? is forbidden and the answer is actually to the question, How? Science is much better in explaining than in understanding, but it likes to mistake one for the other.

*Voices in the Labyrinth*  
*Perspectives in Biology and Medicine*, Volume 18, Spring 1975 (p. 322)

...never before has science become so alienated from the common man, and he, in turn, so suspicious of science.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Part III  
The Great Dilemma of the Life Sciences (p. 158)  
Rockefeller University Press. New York, New York, USA. 1978

### **Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

Science is the most important, the most magnificent, and the most necessary element of life.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

### **Chernin, Kim**

No biographical data available

Science is not neutral in its judgments, not dispassionate, nor detached....

*The Obsession: Reflections on the Tyranny of Slenderness*  
Chapter 3 (p. 37)  
Harper & Row, Publishers. New York, New York, USA. 1981

### **Chernyshevsky, Nikolai Gavrilovich** 1828–89

Russian socialist reformer

Science is the repository of the experience and thinking of the human race. It is mainly through science that the ideas, and then the morals and life of people, are improved.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

### **Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

When once one believes in a creed, one is proud of its complexity, as scientists are proud in the complexity of science. It shows how right it is in its discoveries. If it is right at all, it is a compliment to say that it is elaborately right. A stick might fit a hole or a stone a hollow by accident. But a key and a lock are both complex. And if a key fits a lock, you know it is the right key.

*Orthodoxy*  
Chapter VI (p. 152)  
John Lane Company. New York, New York, USA. 1918

Science, that nameless being, declared that the weakest must go to the wall; especially in Wall Street.

*The Well and the Shallows*  
The Return to Religion (p. 74)  
Sheed & Ward, Inc., New York, New York, USA. 1935

Science in the modern world has many uses; its chief use, however, is to provide long words to cover the errors of the rich.

*Heretics*  
Cells and Celtophiles (p. 171)  
Books for Libraries Press. Freeport, New York, USA. 1970

...physical science is like simple addition: it is either infallible or it is false.

*All Things Considered*  
Science and Religion (p. 187)  
John Lane Company. New York, New York, USA. 1908

...modern science cares far less for pure logic than a dancing Dervish.

*Orthodoxy*  
Chapter II (p. 36)  
John Lane Company. New York, New York, USA. 1918

[Modern science moves] toward the supernatural with the rapidity of a railway train.

*Orthodoxy*  
Chapter IX (p. 277)  
John Lane Company. New York, New York, USA. 1918

### **Churchill, Winston Spencer** 1882–1965

British prime minister, statesman, soldier, and author

The latest refinements of science are linked with the cruelties of the Stone Age.

Speech  
26 March 1942

Science bestowed immense new powers on man and at the same time created conditions which were largely beyond his comprehension and still more beyond his control.

Speech  
March 31, 1949

Science has given to this generation the means of unlimited disaster or of unlimited progress. There will remain the greater task of directing knowledge lastingly towards the purpose of peace and human good.

Speech  
New Delhi, January 3, 1944

My experience — and it is somewhat considerable — is that in these matters when the need is clearly explained by military and political authorities, science is always able to provide something. “Seek and ye shall find” has been borne out.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Commons, June 7, 1935 (p. 327)  
George Allen & Unwin Ltd. London, England. 1956

I have seldom seen a precise demand made upon science by the military which has not been met.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Commons, March 16, 1950 (p. 327)  
George Allen & Unwin Ltd. London, England. 1956

In the fires of science, burning with increasing heat every year, all the most dearly loved conventions are being melted down; and this is a process which is going continually to spread. In view of the inventions and discoveries which are being made for us, one might almost say every month, a unified direction of the war efforts of the three services would be highly beneficial.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Commons, March 21, 1934 (p. 327)  
George Allen & Unwin Ltd. London, England. 1956

It is arguable whether the human race have been gainers by the march of science beyond the steam engine. Electricity opens a field of infinite conveniences to ever greater numbers, but they may well have to pay dearly for them. But anyhow in my thought I stop short of the internal combustion engine which has made the world so much smaller. Still more must we fear the consequences of entrusting to a human race so little different from their predecessors of the so-called barbarous ages such awful agencies as the atomic bomb. Give me the horse.

In F.B. Czarnomski  
*The Wisdom of Winston Churchill*  
Speech, Royal College of Physicians, July 10, 1951 (p. 327)  
George Allen & Unwin Ltd. London, England. 1956

**Cobbe, Frances P.** 1822–1904  
English author

Then the Sorcerer Science entered, and where e'er he waved his wand

Fresh wonders and fresh mysteries rose on every hand.  
*The Pageant of Time*, Stanza 1  
Source undetermined

**Coggan, Donald** 1909–2000  
101<sup>st</sup> archbishop of Canterbury

My ignorance of science is such that if anyone mentioned copper nitrate I should think he was talking about policeman's overtime.

*New York Journal–American*, September 20, 1961

**Cohen, I. Bernard** 1914–2003  
American physicist and science historian

...all revolutionary advances in science may consist less of sudden and dramatic revelations than a series of transformations, of which the revolutionary significance may not be seen (except afterwards, by historians) until the last great step. In many cases the full potentiality and force of a most radical step in such a sequence of transformations may not even be manifest to its author.

*The Newtonian Revolution: With Illustrations of the Transformation of Scientific Ideas*  
Chapter 4 (p. 162)  
Cambridge University Press. Cambridge, England. 1980

**Colbert, Edwin H.** 1905–2001  
American vertebrate paleontologist

It is too easy to think of science as something large and impersonal, as something outside the understanding of most of us, as something rather distant, and removed from the affairs of the average person. Even in this day, when the lives of all of us are touched every hour, and almost every minute, by the products of technology, the handmaiden of science, we are still inclined to accept the impersonal view of science. Science is so manifestly complex, so compartmentalized by specialization, and to all but those who are initiated into the priesthoods of these specializations, so largely incomprehensible, that we can hardly think of it in other than impersonal terms.

*Men and Dinosaurs*  
Preface (p. v)  
E.P. Dutton & Company, Inc. New York, New York, USA. 1968

**Coles, Abraham** 1813–91  
American physician, hymnist, and poet

I value science — none can prize it more —  
It gives ten thousand motives to adore.  
Be it religious, as it ought to be,  
The heart it humbles, and it bows the knee.

*The Microcosm: And Other Poems*

Christian Science

D. Appleton & Company, New York, New York, USA. 1880

**Commoner, Barry** 1917–

American biologist, ecologist, and educator

Science is triumphant with far-ranging success, but its triumph is somehow clouded by growing difficulties in providing for the simple necessities of human life on the earth.

*Science and Survival*

Chapter 2 (p. 9)

The Viking Press, New York, New York, USA. 1966

We seem to be entering a new world of technology, but the vehicle which is carrying us — science — shows dangerous signs of inadequacy for the voyage ahead.

*Science and Survival*

Chapter 4 (p. 63)

The Viking Press, New York, New York, USA. 1966

**Compton, Karl Taylor** 1887–1954

American educator and physicist

Fundamentally, science means simply knowledge of our environment. Combined with ingenuity, science becomes power.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

*During the Years 1930–1949* (p. 2)

Undergraduate Association, MIT, Cambridge, Massachusetts, USA. 1955

I believe that the advent of modern science is the most important social event in all history.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

*During the Years 1930–1949* (p. 2)

Undergraduate Association, MIT, Cambridge, Massachusetts, USA. 1955

**Conant, James Bryant** 1893–1978

American educator and scientist

There is only one proved method of assisting the advancement of pure science — that of picking men of genius, backing them heavily, and leaving them to direct themselves.

Letter

*New York Times*, August 13, 1945

Science is an interconnected series of concepts and schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation.

*Science and Common Sense*

Chapter Two (p. 25)

Yale University Press, New Haven, Connecticut, USA. 1951

Science is a dynamic undertaking directed to lowering the degree of the empiricism involved in solving problems.

*Modern Science and Modern Man*

Science and Human Conduct (p. 62)

Columbia University Press, New York, New York, USA. 1952

[Science is] the activity of people who work in laboratories and whose discoveries have made possible modern industry and medicine.

*Science and Common Sense*

Chapter Two (p. 23)

Yale University Press, New Haven, Connecticut, USA. 1951

**Condon, Edward Uhler** 1902–74

American physicist

Society is at this moment at the threshold of an undreamed-of mastery of our material environment, for science, which provides that mastery, is in its Golden Age.

*Selected Popular Writings of E.U. Condon*

Science and the National Welfare (p. 145)

Springer-Verlag, New York, New York, USA. 1991

The sciences, like those other truth-seeking activities of man, require a free environment, an environment, above all, free from fear, petty arbitrariness, and tyranny.

*Selected Popular Writings of E.U. Condon*

Science and the National Welfare (p. 155)

Springer-Verlag, New York, New York, USA. 1991

**Condorcet, Marie Jean** 1749–1827

French mathematician, astronomer, and physicist

This adventure of the physical sciences...could not be observed without enlightened men seeking to follow it up in the other sciences; at each step it held out to them the model to be followed.

In K.M. Baker

*Condorcet: From Natural Philosophy to Social Mathematics*

Chapter 2 (p. 85)

The University of Chicago Press, Chicago, Illinois, USA. 1975

In every century Princes have been found to love the sciences and even to cultivate them, to attract Savants to their palaces and to reward by their favors and their amity men who afforded them a sure and constant refuge from world-weariness, a sort of disease to which supreme power seems particularly prone.

*Eloge des académiciens de l'Académie royal des sciences*

Forward, I

Publisher undetermined

**Constitution of the United States**

The Congress shall have the Power...to promote the Progress of Science and useful Arts...

*United States Constitution*

Article I, Section 8

**Cooper, Bernard** 1951–

Physicist

At the rate science proceeds, rockets and missiles will one day seem like buffalo — slow, endangered grazers in the black pasture of outer space.

*Harper's*, January 1990



**Cooper, Leon** 1930–  
American physicist

To say that science is logical is like saying that a painting is paint...

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*

The Memory Machine (p. 194)

Alfred A. Knopf. New York, New York, USA. 1991

**Cossons, Sir Neil** 1939–  
Chairman of English Heritage

Science's function is to describe how things work, not what they mean. That is a role for philosophers, artists, and writers.

*Lancet*, Volume 339, 1992

**Crichton, Michael** 1942–  
American novelist

Finally, I would remind you to notice where the claim of consensus is invoked. Consensus is invoked only in situations where the science is not solid enough. Nobody says the consensus of scientists agrees that  $E = mc^2$ . Nobody says the consensus is that the sun is 93 million miles away. It would never occur to anyone to speak that way.

Lecture

Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

I expected science to be, in Carl Sagan's memorable phrase, "a candle in a demon haunted world." And here, I am not so pleased with the impact of science. Rather than serving as a cleansing force, science has in some instances been seduced by the more ancient lures of politics and publicity. Some of the demons that haunt our world in recent years are invented by scientists.

Lecture

Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

In recent years, much has been said about the post-modernist claims about science to the effect that science is just another form of raw power, tricked out in special claims for truth-seeking and objectivity that really have no basis in fact. Science, we are told, is no better than any other undertaking. These ideas anger many scientists, and they anger me. But recent events have made me wonder if they are correct.

Lecture

Aliens Cause Global Warming, California Institute of Technology, January 17, 2003

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

One of the striking characteristics of modern science is that it often moves so fast that a research worker can see

rather clearly whether his earlier ideas, or those of his contemporaries, were correct or incorrect.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Introduction (p. 3)

Basic Books, Inc. New York, New York, USA. 1988

**Cromer, Alan** 1935–  
American physicist and educator

Science is the search for a consensus of rational opinion among all competent researchers.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 8 (pp. 143–144)

Oxford University Press, Inc. New York, New York, USA. 1993

Science is the heretical belief that the truth about the real nature of things is to be found by studying the things themselves.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 1 (p. 18)

Oxford University Press, Inc. New York, New York, USA. 1993

Science is overwhelmingly cumulative, not revolutionary, in its structure. This means that most of its established results — even those established recently — will be around forever. A particular result may be found to be an instance of a more general result, but its factualness, as far as it goes, will never change.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 1 (p. 6)

Oxford University Press, Inc. New York, New York, USA. 1993

The notion that science and objective thinking are unnatural human activities seems quite radical at first. But when you think about it, monogamy, honesty, and democratic government are unnatural human behaviors as well. We are truly a species that has invented itself out of rather unpromising material. Our only claim to greatness is that we have at times gone against the grain of our own egocentrism to forge a higher vision of the world.

*Uncommon Sense: The Heretical Nature of Science*

Preface (p. ix)

Oxford University Press, Inc. New York, New York, USA. 1993

**Cromie, William J.** 1930–  
American journalist and writer

Science is not a mere "lump" of knowledge. It is disciplined thought, it is curiosity, it is creativity, it is the scientists themselves and the methods they use. It is the hope — the religion — that there is order in the universe; that man shall find that order; that someday he will be able to control the environment to which he is now little more than a slave. All this and more make up the dynamic, ever-changing whole called "science."

*Exploring the Secrets of the Sea*

Conclusion (p. 280)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1962

**Crothers, Samuel McChord** 1857–1927  
American clergyman and writer

On the coasts of the Dark Continent of Ignorance the several sciences have gained a foothold. In each case there is a well-defined country carefully surveyed and guarded. Within its frontiers the laws are obeyed, and all affairs are carried on in an orderly fashion. Beyond it is a vague "sphere of influence," a Hinter-land over which ambitious claims of suzerainty [foreign authority] are made; but the native tribes have not yet been exterminated, and life goes on very much as in the olden time.

*The Gentle Reader*

The Hinter-Land of Science (p. 231)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

Science will not tolerate half knowledge nor pleasant imaginings, nor sympathetic appreciations; it must have definite demonstrations. The knowledge of the best that has been said and thought may be consoling, but it implies an unscientific principle of selection. It can be proved by statistics that the best things are exceptional.

*The Gentle Reader*

The Hinter-Land of Science (p. 228)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1903

### **Crowley, Aleister** 1875–1947

Poet and author

...science is always discovering odd scraps of magical wisdom and making a tremendous fuss about its cleverness!

*The Confessions of Aleister Crowley: An Autobiography*

Part Four, Chapter 64 (p. 593)

Arkana. 1989

### **Cudmore, Lorraine Lee**

American cell biologist

Almost anyone can do science; almost no one can do good science.

*The Center of Life: A Natural History of the Cell*

Biochemical Evolution (p. 35)

New York Times Book Company. New York, New York, USA. 1977

...good science is almost always so very simple. After it has been done by someone else, of course.

*The Center of Life: A Natural History of the Cell*

Biochemical Evolution (p. 36)

New York Times Book Company. New York, New York, USA. 1977

### **Curie, Eve** 1904–

French concert pianist and journalist

What does it matter to Science if her passionate servants are rich or poor, happy or unhappy, healthy or ill? She knows that they have been created to seek and to discover, and that they will seek and find until their strength dries up at its source. It is not in a scientist's power to struggle against his vocation: even on his days of disgust or rebellion his steps lead him inevitably back to his laboratory apparatus.

*Madame Curie*

Chapter XV (p. 193)

The Literary Guild of America, Inc. New York, New York, USA. 1937

### **Curie, Marie Skłodowska** 1867–1934

Polish-born French physicist and chemist

In science we must be interested in things, not in persons.

In Eve Curie

*Madame Curie*

Chapter XVI (p. 222)

The Literary Guild of America, Inc. New York, New York, USA. 1937

After all, science is essentially international, and it is only through lack of the historical sense that national qualities have been attributed to it.

*Memorandum*

Intellectual Cooperation, June 16, 1926

### **da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

Science is the captain, practice the soldiers.

*Leonardo da Vinci's Note Books* (p. 54)

Duckworth & Company. London, England. 1906

All science which end in words are dead the moment they come to life, except for their manual part, that is to say, the writing, which is the mechanical part.

*The Literary Works of Leonardo da Vinci* (Volume 1)

7a1148 (p. 35)

University of California Press. Berkeley, California, USA. 1977

### **d'Abro, Abraham**

No biographical data available

Practically the whole of physical science is thus one mass of inference based ultimately, but not immediately, on direct knowledge.

*The Rise of the New Physics* (Volume 1)

Chapter II (p. 15)

Dover Publications, Inc. New York, New York, USA. 1951

### **Darwin, Charles Robert** 1809–82

English naturalist

As for myself, I believe that I have acted rightly in steadily following, and devoting my life to Science. I feel no remorse from having committed any great sin, but have often and often regretted that I have not done more direct good to my fellow creatures.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter XVI (p. 530)

D. Appleton & Company. New York, New York, USA. 1896

### **Darwin, Sir Francis** 1848–1925

English botanist

Forgive me for suggesting one caution; as Demosthenes said, "Action, action, action," was the soul of eloquence, so is caution almost the soul of science.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)  
To Dohrn, January 4, 1870 (p. 444)  
D. Appleton & Company. New York, New York, USA. 1903

But in science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs.  
First Galton Lecture Before the Eugenics Society  
*Eugenics Review*, Volume 6, Number 1, 1914

How grand is the onward rush of science; it is enough to console us for the many errors which we have committed, and for our efforts being overlaid and forgotten in the mass of new facts and new views which are daily turning up.  
In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
Darwin to Wallace, August 28, 1872 (p. 348)  
D. Appleton & Company. New York, New York, USA. 1896

## Data

Fictional character

Captain, the most elementary and valuable statement in science: "The beginning of wisdom is 'I do not know.'" *Star Trek: The Next Generation*  
Where Silence Has Lease  
Television program  
Season 2, 1988

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

There is a popular misconception that science is an impersonal, dispassionate, and thoroughly objective enterprise. Whereas most other human activities are dominated by fashions, fads, and personalities, science is supposed to be constrained by agreed rules of procedure and rigorous tests. It is the results that count, not the people who produce them.

This is, of course, manifest nonsense.  
In Richard Feynman  
*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*  
Preface (p. ix)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

Science may explain all the processes whereby the universe evolves its own destiny, but that still leaves room for there to be a meaning behind it all.  
*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*  
Chapter 14 (p. 203)  
Simon & Schuster. New York, New York, USA. 1988

Science remains a sort of witchcraft, its practitioners regarded with a mixture of awe and suspicion...  
*God and the New Physics*  
Chapter 1 (p. 3)  
Simon & Schuster. New York, New York, USA. 1983

Conventional science attempts to explain things exactly, in terms of general principles. Any sort of explanation

for the shape of a snowflake or a coastline could not be of this sort.

*The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe*  
Chapter 3 (p. 22)  
Simon & Schuster. New York, New York, USA. 1988

...it is the job of science to solve mysteries without recourse to divine intervention.  
*The Fifth Miracle: The Search for the Origin of Life*  
Chapter 1 (p. 31)  
Simon & Schuster. New York, New York, USA. 1996

**Davies, Robertson** 1913–95  
Canadian novelist

Science, during the past hundred and fifty years, has gained formidable new authority, and it is to Science that we owe the increased longevity of the race, and the control of many of the terrible ills that afflict mankind. Science may cure disease, but can it confer health? Like all powerful gods, Science seeks to be the One True God, and as it writhes about the staff of Hermes it seeks to diminish and perhaps drive out the other god, the god of Humanism.  
*The Merry Heart*  
Chapter 5 (p. 98)  
McClelland & Stewart. Toronto, Ontario, Canada. 1996

**Davis, Kenneth S.** 1912–99  
American historian

In our time it has become all too easy to regard science as a vast impersonal force — a kind of Frankenstein's monster that, escaping human control, has forcibly seized us and carries us at terrifying speeds in directions we have not chosen towards ends unknown.  
*The Cautionary Scientists: Priestley, Lavoisier, and the Founding of Modern Chemistry*  
Introduction (p. 7)  
Putnam. New York, New York, USA. 1966

**Davis, Watson** 1896–1967  
No biographical data available

Science is a grand procession through the ages. Blaring trumpets, waving flags, and pomp are not its accompaniment. It travels the quieter roads of the intellect.  
*The Advance of Science*  
Chapter 32 (p. 375)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1934

**Davis, William Morris** 1850–1934  
American geomorphologist

Science is therefore not final any more than it is infallible.  
In H. Shapley, H. Wright, and S. Rappoport (eds.)  
*Readings in the Physical Sciences*  
The Reasonableness of Science (p. 25)  
Appleton-Century-Crofts. New York, New York, USA. 1948

**Davy, Sir Humphry** 1778–1829  
English chemist

There is now before us a boundless prospect of novelty in science; a country unexplored, but noble and fertile in aspect; a land of promise in philosophy.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter III (p. 117)

Smith, Elder & Company. London, England. 1839–1840

There are very few persons who pursue science with true dignity.

*Consolations in Travel, or the Last Days of a Philosopher*

Dialogue V (p. 226)

J. Murray. London, England. 1830

Science has done much for man, but it is capable of doing still more; its sources of improvement are not yet exhausted; the benefits that it has conferred ought to excite our hopes of its capability of conferring new benefits; and, in considering the progressiveness of our nature, we may reasonably look forwards to a state of greater cultivation and happiness than that which we at present enjoy.

*A Discourse, Introductory to a Course of Lectures on Chemistry* (p. 17)

Press of the Royal Institution of Great Britain. London. 1802

### **Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

Science, like proper literary studies, can be hard and challenging but science is — also like proper literary studies — wonderful.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 2 (p. 25)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

Far from science not being useful, my worry is that it is so useful as to overshadow and distract from its inspirational and cultural value. Usually even its sternest critics concede the usefulness of science, while completely missing the wonder. Science is often said to undermine our humanity, or destroy the mystery on which poetry is thought to thrive.

*Science, Delusion and the Appetite for Wonder*

Richard Dimpleby Lecture, BBC1 Television, November 12<sup>th</sup>, 1996

### **de Balzac, Honoré** 1799–1850

French novelist

Science is the language of the temporal world; love is that of the spiritual world. Man, indeed, describes more than he explains; while the angelic spirit sees and understands. Science saddens man; love enraptures the angel; science is still seeking, love has found. Man judges of nature in relation to itself; the angelic spirit judges of it in relation to heaven. In short to the spirits everything speaks.

*The Works of Honoré Balzac* (Volume 2)

Seraphita

Part II (p. 58)

Nottingham Society. New York, New York, USA. 1901

### **de Bono, Edward** 1933–

Maltese psychologist and writer

When you have got somewhere interesting, that is the time to look back and pick out the surest way of getting there again. Sometimes it is very much easier to see the surest route to a place only after you have arrived. You may have to be at the top of a mountain to find the easiest way up.

*New Think: The Use of Lateral Thinking in the Generation of New Ideas*  
(p. 132)

Avon Books. New York, New York, USA. 1971

### **de Gourmont, Rémy** 1858–1915

French critic and novelist

Science is the only truth and it is the great lie. It knows nothing, and people think it knows everything. It is misrepresented. People think that science is electricity, automobilism, and dirigible balloons. It is something very different. It is life devouring itself. It is the sensibility transformed into intelligence. It is the need to know stifling the need to live. It is the genius of knowledge vivisectioning the vital genius.

Translated by Glenn S. Burne

*Selected Writings*

Art and Science (p. 172)

The University of Michigan Press, Ann Arbor, Michigan, USA. 1966

Science is the food of the intelligence.

Translated by Glenn S. Burne

*Selected Writings*

Art and Science (p. 171)

The University of Michigan Press, Ann Arbor, Michigan, USA. 1966

### **de Unamuno, Miguel** 1864–1936

Spanish philosopher and writer

True science teaches, above all, to doubt and be ignorant.

Translated by J.E. Crawford Fritch

*The Tragic Sense of Life in Men and in Peoples*

Chapter V (p. 93)

Macmillan & Company Ltd. London, England. 1921

Science is a cemetery of dead ideas, even though life may issue from them.

Translated by J.E. Crawford Fritch

*The Tragic Sense of Life in Men and in Peoples*

Chapter V (p. 90)

Macmillan & Company Ltd. London, England. 1921

Science exists only in personal consciousness and thanks to it; astronomy, mathematics, have no other reality than that which they possess as knowledge in the minds of those who study and cultivate them.

Translated by J.E. Crawford Fritch

*The Tragic Sense of Life in Men and in Peoples*

The Starting-Point (pp. 30–31)

Macmillan & Company Ltd. London, England. 1921

### **del Rio, A. M.**

No biographical data available

It is impossible that he who has once imbibed a taste for science can ever abandon it.

Analysis of an Alloy of Gold and Rhodium from the Parting House at Mexico  
*Annals of Philosophy*, Volume 10, Number 2, October 1825

**Delbrück, Max** 1906–81  
 German-born American biologist

With science we can transcend our intuitions, just as with electronics we can transcend our eyes and ears. To the question of how such transcendence can have arisen in the course of biological evolution I have no satisfactory answer.

*Mind from Matter*

Twenty (p. 280)

Blackwell Scientific Publications, Inc. Palo Alto, California, USA. 1986

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Science is like a woman: if she stays faithful to her husband she is respected; if she becomes common property she grows to be despised.

In William R. Shea

*The Magic of Numbers and Motion: The Scientific Career of René Descartes*

Chapter Five (p. 114)

Science History Publications. Canton, Massachusetts, USA. 1991

The sciences are now masked, but when the masks are lifted, they will be seen in their beauty. Upon inspecting the chain of the sciences, it will not appear more difficult to remember them than a series of numbers.

In William R. Shea

*The Magic of Numbers and Motion: The Scientific Career of René Descartes*

Chapter Five (p. 101)

Science History Publications Canton, Massachusetts, USA. 1991

**Dewar, James** 1842–1923

English physicist and chemist

To serve in the scientific army, to have shown some initiative, and to be rewarded by the consciousness that in the eyes of his comrades he bears the accredited accolade of successful endeavor, is enough to satisfy the legitimate ambition of every earnest student of nature.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

History of Cold and the Absolute Zero (p. 240)

Government Printing Office. Washington, D.C. 1903

**Dickinson, Emily** 1830–86

American lyric poet

I climb the “Hill of Science,”

I view the landscape o’er;

such transcendental prospects,

I ne’er beheld before!

*The Complete Poems of Emily Dickinson*

No. 3 (p. 5)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Dickinson, G. Lowes** 1862–1932

English historian and political activist

Science hangs in a void of nescience, a planet turning in the dark.

*A Modern Symposium* (p. 159)

Doubleday, Page & Company. Garden City, New York, USA. 1920

**Disraeli, Benjamin, 1<sup>st</sup> Earl of Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

What Art was to the ancient world, Science is to the modern...

*Coningsby*

Book IV, Chapter I (p. 126)

J.M. Dent & Sons Ltd. London, England. 1911

...the pursuit of science leads only to the insoluble.

*Lothair*

Chapter XVII (p. 70)

Longmans, Green & Company London, England. 1920

**Dobie, J. Frank** 1888–1964

American folklorist

Putting on the spectacles of science in expectation of finding the answer to everything looked at signifies inner blindness.

*The Voice of the Coyote*

Introduction (p. xvi)

Little, Brown & Company. Boston, Massachusetts, USA. 1949

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

Science has been called “the endless frontier.” The more we know, the better we realize that our knowledge is a little island in the midst of an ocean of ignorance.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1974*

Advancement and Obsolescence in Science (p. 61)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1974

Science does more than collect facts; it makes sense of them. Great scientists are virtuosi of the art of discovering the meaning of what otherwise might seem barren observations.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1974*

Advancement and Obsolescence in Science (p. 56)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1974

Science is cumulative knowledge. Each generation of scientists works to add to the treasury assembled by its predecessors. A discovery made today may not be significant or even comprehensible by itself, but it will make sense in conjunction with what was known before. Indeed this will usually have been necessary to its achievement.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1974*

Advancement and Obsolescence in Science (p. 52)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1974

**Dott, Jr., Robert H.**

No biographical data available

**Batten, Henry L.**

No biographical data available

Science consists simply of the formulation and testing of hypotheses based on observational evidence; experiments are important where applicable, but their function is merely to simplify observation by imposing controlled conditions.

*Evolution of the Earth* (2<sup>nd</sup> edition)

Chapter 3 (p. 40)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Douglas, Mary** 1921–

No biographical data available

**Wildavsky, A.**

No biographical data available

In our modern world people are supposed to live and die subject to known, measurable natural forces, not subject to mysterious moral agencies. That mode of reasoning, indeed, is what makes modern man modern. Science wrought this change between us and nonmoderns. It is hardly true, however, that their universe is more unknown than ours. For anyone disposed to worry about the unknown, science has actually expanded the universe about which we cannot speak with confidence. . . . This is the double-edge thrust of science, generating new ignorance with new knowledge. The same ability to detect causes and connections or parts per trillion can leave more unexplained than was left by cruder measuring instruments.

*Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers*

Chapter III (p. 49)

University of California Press. Berkeley, California, USA. 1982

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Science seeks knowledge. Let the knowledge lead us where it will, we still must seek it. To know once for all what we are, why we are, where we are, is that not in itself the greatest of all human aspirations?

*The Land of Mist; The Maracot Deep; and Other Stories*

When the World Screamed (p. 430)

Doubleday, Doran &amp; Company, Inc. Garden City, New York, USA. 1930

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Science distinguishes a Man of Honour from one of those Athletick Brutes whom undeservedly we call Heroes.

*Fables Ancient and Modern*

Dedication

Printed for Jacob Tonson. London, England. 1700

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

Science is very young when compared to the moral, spiritual, and religious ideas of humanity. It enjoys the prestige

of a new toy. But we must not be misled. In spite of its youth and imperfections, it constitutes the best means of convincing us of the immensity and harmonious beauty of the universe, revealed by the infinite complexity of the apparently most simple phenomena. It is an orderly and confounding complexity which is a thousand times better qualified than ignorance to make us feel the omnipotence of the Creator.

*Between Knowing and Believing*

The Future of Spirit 1941 (p. 216)

McKay. New York, New York, USA. 1967

Either we have absolute confidence in our science and in the mathematical and other reasonings which enable us to give a satisfactory explanation of the phenomena surrounding us — in which case we are forced to recognize that certain fundamental problems escape us and that their explanation amounts to admitting a miracle — or else we doubt the universality of our science and the possibility of explaining all natural phenomena by chance alone; and we fall back on a miracle or a hyperscientific intervention.

*Human Destiny*

Chapter 3 (p. 36)

Longmans, Green &amp; Company. London, England. 1947

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Science is not the product of lofty meditations and genteel behavior, it is fertilized by heartbreaking toil and long vigils — even if, only too often, those who harvest the fruit are but the laborers of the eleventh hour.

*Louis Pasteur: Free Lance of Science*

Chapter XIV (p. 389)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1950

Science shows us what exists but not what to do about it.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 14 (p. 325)

Simon &amp; Schuster. New York, New York, USA. 1988

Science is still the versatile, unpredictable hero of the play, creating endless new situations, opening romantic vistas and challenging accepted concepts.

*Louis Pasteur: Free Lance of Science*

Chapter I (p. 15)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1950

Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of the nation because that nation will remain the first which carries the furthest the works of thought and intelligence.

*Louis Pasteur: Free Lance of Science*

Chapter III (p. 85)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1950

**Dyson, Freeman J.** 1923–

American physicist and educator

Science is even more unpredictable than history. Every important discovery in science is by definition unpredictable. If it were predictable, it would not be an important discovery. The purpose of science is to create opportunities for unpredictable things to happen. When nature does something unexpected, we learn something about how nature works.

*From Eros to Gaia*

Chapter 6 (p. 68)

Pantheon Books. New York, New York, USA. 1992

It used to be said, before the recent era of revolutionary discoveries, that science was organized common sense. In the modern era it would be more accurate to define science as organized unpredictability.

*From Eros to Gaia*

Chapter 6 (p. 68)

Pantheon Books. New York, New York, USA. 1992

### **Eakin, Richard M.**

American zoologist

If I had any advice to [give] you it is just this: love science but do not worship it. Put science in its proper place, ranking it along with philosophy and history, music and religion, literature and art. If I had my life to live again (Darwin says), I would make it a rule to read some poetry and listen to some music at least once every week.

*Great Scientists Speak Again*

Chapter 6 (p. 107)

University of California Press, Berkeley, California, USA, 1975

### **Eben, Aubrey**

No biographical data available

Science is not a sacred cow. Science is a horse. Don't worship it. Feed it.

*Reader's Digest*, March 1963 (p. 67)

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

To imagine that Newton's great scientific reputation is tossing up and down in these latter-day revolutions is to confuse science with omniscience.

*The Nature of the Physical World*

Chapter X (p. 202)

The Macmillan Company. New York, New York, USA. 1930

Science has its showrooms and its workshops. The public today, I think rightly, is not content to wander round the showrooms where the tested products are exhibited; they demand to see what is going on in the workshops. You are welcome to enter; but do not judge what you see by the standards of the showroom. We have been going round a workshop in the basement of the building of science. The light is dim, and we stumble sometimes. About us is confusion and mess which there hasn't been time to sweep away. The workers and their machines are enveloped in murkiness. But I think that something is being shaped here — perhaps

something rather big. I do not quite know what twill be when it is completed and polished for the showroom.

*The Expanding Universe*

Chapter IV, Section VII (p. 126)

The University Press. Cambridge, England. 1933

...unless science is to degenerate into idle guessing, the test of value of any theory must be whether it expresses with as little redundancy as possible the facts which it intended to cover.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter I (p. 29)

At The University Press. Cambridge, England. 1921

### **Edelman, Gerald M.** 1929–

American biochemist and neuroscientist

Science is imagination in the service of the verifiable truth and that service is indeed communal. It cannot be rigidly planned. Rather, it requires freedom and courage and the plural contributions of many different kinds of people who must maintain their individuality while giving to the group.

*Les Prix Nobel. The Nobel Prizes in 1972*

Nobel banquet speech for award received in 1972

Nobel Foundation. Stockholm, Sweden. 1973

### **Egler, Frank E.** 1911–96

American botanist and ecologist

Science is a product of man, of his mind; and science creates the real world in its own image.

*The Way of Science*

Science Concepts (p. 22)

Hafner Publishing Company. New York, New York, USA. 1970

...science...ever [reflects] a faith in the intelligibility of nature.

*The Way of Science*

The Nature of Science (p. 2)

Hafner Publishing Company. New York, New York, USA. 1970

### **Einstein, Albert** 1879–1955

German-born physicist

One thing I have learned in a long life: that all our science, measured against reality, is primitive and childlike — and yet it is the most precious thing we have.

In Banesh Hoffman

*Albert Einstein: Creator and Rebel*

Preface (p. v)

The Viking Press. New York, New York, USA. 1972

Science as something existing and complete is the most objective thing known to man. But science in the making, science as an end to be pursued, is as subjective and psychologically conditioned as any other branch of human endeavor — so much so, that the question “what is the purpose and meaning of science?” receives quite different answers at different times and from different sorts of people.

*The World as I See It*

Address at Columbia University, New York (p. 137)  
Philosophical Library. New York, New York, USA. 1949

Strange that science, which in the old days seemed harmless, should have evolved into a nightmare that causes everyone to tremble.

In G.J. Whitrow

*Einstein: The Man and His Achievement*

Chapter III (p. 89)

BBC. London, England. 1967

Science will stagnate if it is made to serve practical goals.

In Otto Nathan and Heinz Norden

*Einstein on Peace*

Chapter Thirteen (p. 402)

Simon & Schuster. New York, New York, USA. 1960

The whole of science is nothing more than a refinement of everyday thinking.

*Out of My Later Years*

Physics and Reality, I (p. 59)

Thames & Hudson. London, England. 1950

...science can only ascertain what is, but not what should be, and outside of its domain value judgments of all kinds remain necessary.

*Out of My Later Years*

Science and Religion, II (p. 25)

Thames & Hudson. London, England. 1950

...the fact that in science we have to be content with an incomplete picture of the physical universe is not due to the nature of the universe itself but rather to us.

In Max Planck

*Where Is Science Going?*

Prologue (p. 10)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

Science is a wonderful thing if one does not have to earn one's living at it.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter to a California student March 24, 1951 (p. 57)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

Science is not just a collection of laws, a catalogue of unrelated facts. It is a creation of the human mind, with its freely invented ideas and concepts.

*The Evolution of Physics*

Physics and Reality (p. 294)

Simon & Schuster. New York, New York, USA. 1961

**Eisenschiml, Otto** 1880–1963

Austrian-American chemist and historian

Science seeks to build, not to destroy; to aid, not to hinder.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*

Part One (p. 8)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Emelyanov, A. S.**

No biographical data available

Science provides mankind with a great tool of cognition which makes it possible to reach unprecedented heights of abundance and equality. This determines the most important and most fruitful aspect of the social role of science, and as a result the social responsibility of scientists is growing.

In E.H.S. Burhop In Maurice Goldsmith and Alan Mackay (eds.)

*Society and Science*

Scientist and Public Affairs (p. 31)

Simon & Schuster. New York, New York, USA. 1965

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

All science has one aim, namely, to find a theory of nature.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Introduction (p. 7)

The Library of America. New York, New York, USA. 1983

You must have eyes of science to see in the seed its nodes. . . .

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Chapter I (p. 71)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

When science is learned in love, and its powers are wielded by love, they will appear the supplements and continuations of the material creation.

*The Complete Works of Ralph Waldo Emerson* (Volume 2)

Essays: First Series

Art (p. 369)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

What drops of all the sea of our science are baled up! and by what accident it is that these are exposed, when so many secrets sleep in nature!

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series

The Poet (p. 466)

The Library of America. New York, New York, USA. 1983

Science in England, in America, is jealous of theory, hates the name of love and moral purpose. There's revenge for this humanity. What manner of man does science make? The boy is not attracted. He says, I do not wish to be such a kind of man as my professor is.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

The Conduct of Life

Beauty (p. 284)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Something is wanting to science until it has been humanized.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)



Representative Men

Chapter I (p. 10)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Scraps of science, of thought, of poetry are in the coarsest sheet, so that in every house we hesitate to burn a newspaper until we have looked it through.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

Society and Solitude

Chapter II (p. 24)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Science has shown the great circles in which Nature works....

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

Society and Solitude

Chapter VI (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Science is cold.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses and Lectures

An Address (p. 143)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Science is a search after identity, and the scientific whim is lurking in all corners.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Beauty (p. 1108)

The Library of America. New York, New York, USA. 1983

Science surpasses the old miracles of mythology....

*The Complete Works of Ralph Waldo Emerson* (Volume 8)

Letters and Social Aims

Chapter VII (p. 207)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

Empirical science is apt to cloud the sight, and, by the very knowledge of functions and processes, to bereave the student of the manly contemplation of the whole. The savant becomes unpoetic.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Prospects (p. 43)

The Library of America. New York, New York, USA. 1983

The motive of science was the extension of man, on all sides, into Nature, till his hands should touch the stars, his eyes see through the earth, his ears understand the language of beast and bird, and the sense of the wind; and, through his sympathy, heaven and earth should talk with him. But that is not our science.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Beauty (p. 1100)

The Library of America. New York, New York, USA. 1983

Intellectual science has been observed to beget invariably a doubt of the existence of matter.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses and Lectures

Nature (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

It is the last lesson of modern science that the highest simplicity of structure is produced, not by few elements, but by the highest complexity.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

Representative Men

Goethe; or, The Writer (p. 290)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

...the path of science and of letters is not the way into nature. The idiot, the Indian, the child, and unschooled farmer's boy, stand nearer to the light by which nature is to be read, than the dissector or the antiquary.

*Ralph Waldo Emerson: Essays and Lectures*

Essays: First Series

History (p. 256)

The Library of America. New York, New York, USA. 1983

...as the power or genius of nature is ecstatic, so must its science or the description of it be.

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses and Lectures

The Method of Nature (p. 213)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

It is this domineering temper of the sensual world that creates the extreme need of the priests of science....

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses and Lectures

Literary Ethics (p. 186)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Emmeche, Claus** 1956–

Danish theoretical biologist

It has been said that science demystifies the world. It is closer to the truth to say that science, when it is at its best, opens the world up for us, bringing daily realities under a kind of magic spell and providing the means to see the limits of what we think we know, and the scope of what we do not at all understand.

Translated by Steven Sampson

*The Garden in the Machine: The Emerging Science of Artificial Life*

Chapter One (p. 13)

Princeton University Press. Princeton, New Jersey, USA. 1994

**Everett, Edward** 1794–1865

American statesman, educator, and orator

It usually happens in scientific progress, that when a great fact is at length discovered, it approves itself at once to all competent judges. It furnishes a solution to so many problems, and harmonizes with so many other facts, — that all the other data as it were crystallize at once about it.

*The Uses of Astronomy*

An Oration Delivered at Albany on the 28<sup>th</sup> of July, 1856 (p. 30)

Ross & Tousey. New York, New York, USA. 1856

**Feigl, H.**

No biographical data available

...science, properly interpreted, is not dependent on any sort of metaphysics. It merely attempts to cover a maximum of facts by a minimum of laws.

Naturalism and Humanism

*American Quarterly*, Volume 1, Number 2, Summer 1949 (p. 148)

**Ferré, Nels F. S.** 1908–71

Swedish-American theologian

Science is supposed by many to have banished every realm of the sacred; and behold, science becomes the sacred cow.

*Faith and Reason*

Chapter II (p. 43)

Harper & Brothers. New York, New York, USA. 1946

It is a sad experience to hear someone denounce science as the cause of modern chaos and destruction. Our technological advance may be abused and make of what could be a near heaven a near hell, but that is surely not the fault of science as such. Science has not failed man, but man has failed science.

*Faith and Reason*

Chapter II (p. 38)

Harper & Brothers. New York, New York, USA. 1946

**Ferris, Timothy** 1944–

American science writer

Far too many students accept the easy belief that they need not bother learning much science, since a revolution will soon disprove all that is currently accepted anyway. In such a climate it may be worth affirming that science really is progressive and cumulative, and that well-established theories, though they may turn out to be subsets of larger and farther-reaching ones — as happened when Newtonian mechanics was incorporated by Einstein into general relativity — are seldom proved wrong....

*The Whole Shebang: A State-of-the Universe's Report*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1996

Science is not perfect, but neither is it just one more sounding board for human folly.

*The Whole Shebang: A State-of-the Universe's Report*

Preface (p. 13)

Simon & Schuster. New York, New York, USA. 1996

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Science is neither a single tradition, nor the best tradition there is, except for people who have become accustomed to its presence, its benefits and its disadvantages. In a democracy it should be separated from the state just as churches are now separated from the state.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

(p. 238)

Verso. London, England. 1978

Science is an essentially anarchistic enterprise....

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Analytical Index (p. 10)

Verso. London, England. 1978

Science is not a closed book that is understood only after years of training. It is an intellectual discipline that can be examined and criticised by anyone who is interested, and that looks difficult and profound only because of a systematic campaign of obfuscation carried out by many scientists...

In E.D. Klemke, Robert Hollinger and A. David Kline

*Introductory Reading in the Philosophy of Science*

How to Defend Society Against Science (p. 62)

Prometheus Books. Buffalo, New York, USA. 1980

**Feynman, Richard P.** 1918–88

American theoretical physicist

We must, incidentally, make it clear from the beginning that if a thing is not a science, it is not necessarily bad. For example, love is not a science. So, if something is said not to be a science, it does not mean that there is something wrong with it; it just means that it is not a science.

*Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher*

The Relation of Physics to Other Sciences (p. 47)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

All science is intelligent inference; excessive literalism is a delusion, not a humble bowing to evidence.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 12 (p. 156)

Random House, Inc. New York, New York, USA. 1995

[An] aspect of science is its contents, the things that have been found out. This is the yield. This is the gold. This is the excitement, the pay you get for all the disciplined thinking and hard work. The work is not done for the sake of an application. It is done for the excitement of what is found out. ...it is almost impossible for me to convey in a lecture this important aspect, this exciting part, the real reason for science. And without understanding this you miss the whole point.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 9)

Perseus Books. Reading, Massachusetts, USA. 1998

You cannot understand science and its relation to anything else unless you understand and appreciate [it as] the great adventure of our time. You do not live in your time unless you understand that this is... a wild and exciting thing.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 9)

Perseus Books. Reading, Massachusetts, USA. 1998

Science can be defined as a method for, and a body of information obtained by, trying to answer only questions which can be put into the form: If I do this, what will happen?

*Engineering and Science*, Volume 19, 1956 (p. 23)

Science is a way to teach how something gets to be known, what is not known, to what extent things are known (for nothing is known absolutely), how to handle doubt and uncertainty, what the rules of evidence are, how to think about things so that judgments can be made, how to distinguish truth from fraud, and from show.

The Problem of Teaching Physics in Latin America  
*Engineering and Science*, November 1963

Science alone of all the subjects contains within itself the lesson of the danger of belief in the infallibility of the greatest teachers in the preceding generation.... As a matter of fact, I can also define science another way: Science is the belief in the ignorance of experts.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 8 (p. 188)

Perseus Books. Cambridge, Massachusetts, USA. 1999

Although it is uncertain, it is necessary to make science useful. Science is only useful if it tells you about some experiment that has not been done; it is not good if it only tells you what just went on.

*The Character of Physical Law*

Chapter 7 (p. 164)

BBC. London, England. 1965

And so it is with Science. In a way it is key to the gates of heaven, and the same key opens the gates of hell, and we do not have any instructions as to which is which gate. Shall we throw away the key and never have a way to enter the gates of heaven? Or shall we struggle with the problem of which is the best way to use the key? That is, of course, a very serious question, but I think that we cannot deny the value of the key to the gates of heaven.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 6–7)

Perseus Books. Reading, Massachusetts, USA. 1998

Is science of any value?

I think a power to do something is of value. Whether the result is a good thing or a bad thing depends on how it is used, but the power is a value.

Once in Hawaii I was asked to see a Buddhist temple. In the temple a man said, "I am going to tell you something that you will never forget." And then he said, "To every man is given the key to the gates of heaven. The same key opens the gates of hell."

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 6)

Perseus Books. Reading, Massachusetts, USA. 1998

It is necessary to teach both to accept and to reject the past with a kind of balance that takes considerable skill. Science alone of all the subjects contains within itself the

lesson of the danger of belief in the infallibility of the greatest teachers of the preceding generation.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 8 (p. 188)

Perseus Books. Cambridge, Massachusetts, USA. 1999

If you thought before that science was certain — well, that is just an error on your part.

*The Character of Physical Law*

Chapter 3 (p. 77)

BBC. London, England. 1965

...it is imperative in science to doubt; it is absolutely necessary, for progress of science, to have uncertainty as a fundamental part of your inner nature.

*Engineering and Science*, Volume 19, 1956 (p. 21)

...science is of value because it can produce something.

*What Do You Care What Other People Think?*

The Value of Science (p. 241)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

### **Fischer, Emil** 1852–1919

German chemist

The sciences are not abstract constructions, but rather the result of human endeavor; they are closely connected with the personalities and the fates of the dedicated researchers who developed them.

In Rolf Huisgen

Adolf von Baeyer's Scientific Achievements — A Legacy

*Angewandte Chemie International Edition in English*, Volume 25, Number 4, April 1986 (p. 297)

...science is and remains international.

In Albert Einstein

*The World as I See It*

The International Science (p. 50)

Philosophical Library. New York, New York, USA. 1949

### **Fiske, John** 1842–1901

American philosopher and historian

...all human science is but the increment of the power of the eye....

*The Destiny of Man Viewed in the Light of His Origin*

Chapter VII (p. 60)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1912

...there are moments when one passionately feels that this cannot be all. On warm June mornings in green country lanes, with sweet pine-odours, wafted in the breeze which sighs through the branches, and cloud-shadows flitting over far-off blue mountains, while little birds sing their love-songs, and golden-haired children weave garlands of wild roses; or when in the solemn twilight we listen to wondrous harmonies of Beethoven and Chopin that stir the heart like voices from an unseen world; at such times one feels that the profoundest answer which

science can give to our questionings is but a superficial answer after all.

*The Unseen World, and Other Essays*

I. The Unseen World, Part II (p. 56)

Houghton Mifflin Company. New York, New York, USA. 1876

**Flaubert, Gustave** 1821–90

French novelist

My kingdom is as wide as the world, and my desire has no limit. I go forward always, freeing spirits and weighing worlds, without fear, without compassion, without love, and without God. Men call me science.

*The Temptation of Saint Anthony* (p. 161)

The Modern Library. New York, New York, USA. 2001

**Forbes, Edward** 1815–54

English naturalist

People without independence have no business to meddle with science. It should never be linked with lucre.

In George Wilson and Archibald Geikie

*Memoir of Edward Forbes, F.R.S.*

Chapter XII (p. 392)

Macmillan & Company Ltd. Cambridge, England. 1861

**Fort, Charles** 1874–1932

American writer

Every science is a mutilated octopus. If its tentacles were not clipped to stumps, it would feel its way into disturbing contacts.

In Damon Knight

*Charles Fort: Prophet of the Unexplained*

A Charles Fort Sampler (p. vi)

Gollancz. London, England. 1971

**Fox, Robin** 1934–

English anthropologist, poet, and essayist

The conduct of science can lead to boring triviality. Even great results can be used to evil ends.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 329)

New York Academy of Sciences. New York, New York, USA. 1996

Since science has no value agenda of its own it is always subject to hijacking by fanaticism and idealism.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 329)

New York Academy of Sciences. New York, New York, USA. 1996

The point that science can be used for evil purposes is beside the point. Art and music can be used for evil purposes, but no one proposes abandoning either. Anything can be used for evil purposes. I am not going to stop listening to Wagner just because Hitler liked him.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 332)

New York Academy of Sciences. New York, New York, USA. 1996

**Franck, Georg** 1946–

No biographical data available

Success in science is rewarded with attention. You gain full membership in the scientific community only by receiving the attention of your fellow scientists. Earning this attention “income” is a prime motive for becoming a scientist and for practicing science. In order to maximize this income, you have to employ your own attention in the most productive way. It does not pay to find things out anew that have been discovered already. Nor is reinvention rewarding in terms of the attention paid. It pays no pay attention to the work done by others.

Scientific Communication — A Vanity Fair?

*Science*, Volume 286, Number 5437, 1 October 1999 (p. 53)

**Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

The rapid progress true Science now makes occasions my regretting sometimes that I was born so soon. It is impossible to imagine the heights to which may be carried, in a thousand years, the power of man over matter. O that moral Science were in as fair a way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity.

In Linus Pauling

*College Chemistry*

Letter to Joseph Priestley, 8 February 1780

Chapter 1 (p. 3)

W.H. Freeman & Company. San Francisco, California, USA. 1964

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

No, our science is no illusion. But an illusion it would be to suppose that what science cannot give us we can get elsewhere.

*The Future of an Illusion*

Chapter X (p. 56)

W.W. Norton & Company, Inc. New York, New York, USA. 1961

Science in her perpetual incompleteness and insufficiency is driven to hope for her salvation in new discoveries and new ways of regarding things. She does well, in order not to be deceived, to arm herself with skepticism and to accept nothing new unless it has withstood the strictest examination.

*Collected Papers*

The Resistance to Psycho-Analysis (p. 4121)

The Hogarth Press. London, England. 1953

**Freund, Ida** 1863–1914

Austrian-born chemist

The object of all the Natural Sciences is the acquisition of knowledge concerning the natural objects surrounding us, as we apprehend them by our senses; of the changes occurring in these objects, together with the laws govern-

ing these changes; and of the more proximate or more ultimate causes to the operation of which are due the individual phenomena and the general laws comprising these.

*The Study of Chemical Composition*

Introduction (p. 1)

At The University Press. Cambridge, England. 1904

### **Friend, Julius W.**

European historian

**Feibleman, James K.** 1904–87

American philosopher

The modern world, which has lost faith in so many causes, still accepts science nearly unchallenged. Science today occupies the position held by the Roman Church in the Middle Ages: as the single great authority in a world divided on almost every object of loyalty.

*What Science Really Means*

Chapter I (p. 11)

George Allen & Unwin Ltd. London, England. 1937

### **French Apothegm**

*Le scepticisme est le vrai flambeau de la science.*

Doubt is the true torch of science.

In John Epps

*The Life of Dr. Walker*

Chapter IV (p. 101)

Whittaker, Treacher. London, England. 1831

**Fromm, Erich** 1900–80

German psychoanalyst

The pace of science forces the pace of the technique. Theoretical physics forces atomic energy on us; the successful production of the fission bomb forces upon us the manufacture of the hydrogen bomb. We do not choose our problems, we do not choose our products; we are pushed, we are forced — by what? By a system which has no purpose and goal transcending it, and which makes man its appendix.

*The Sane Society*

Chapter Five, Nineteenth-Century Capitalism (p. 83)

Fawcett Publications. Greenwich, Connecticut, USA. 1955

**Frost, Robert** 1874–1963

American poet

And how much longer a story has science  
Before she must put out the light on the children  
And tell them the rest of the story is dreaming?

*Complete Poems of Robert Frost*

Too Anxious for Rivers

Henry Holt & Company. New York, New York, USA. 1949

Where have those flowers and butterflies all gone  
That science may have staked the future on?

He seems to say the reason why so much

Should come to nothing must be fairly faced....

*Complete Poems of Robert Frost*

Pod of the Milkweed

Henry Holt & Company. New York, New York, USA. 1949

Sarcastic Science, she would like to know,  
In her complacent ministry of fear,  
How we propose to get away from here  
When she has made things so we have to go  
Or be wiped out.

*Complete Poems of Robert Frost*

Why Wait for Science

Henry Holt & Company. New York, New York, USA. 1949

**Fulbright, James William** 1905–95

American politician

What a curious picture it is to find man, *Homo sapiens*, of divine origin, we are told, seriously considering going underground to escape the consequences of his own folly. With a little wisdom and foresight, surely it is not yet necessary to forsake life in the fresh air and in the warmth of the sunlight. What a paradox if our own cleverness in science should force us to live underground with the moles.

The Effect of the Atomic Bomb on American Foreign Policy

*Congressional Record*, November 2, 1945, Volume 91, Appendix (p. A4654)

Science has radically changed the conditions of human life on earth. It has expanded our knowledge and our power but not our capacity to use them with wisdom.

*Old Myths and New Realities*

Conclusion (p. 142)

Random House, Inc. New York, New York, USA. 1964

**Gäbor, Dennis** 1900–79

Hungarian-English physicist

Science has never quite given man what he desired, not even in applied science. Man dreamt of wings; science gave him an easy chair which flies through the air.

*Inventing the Future*

The Future of the Uncommon Man (p. 162)

Secker & Warburg. London, England. 1963

**Galbraith, John Kenneth** 1908–2006

Canadian-American economist

The real accomplishment of modern science and technology consists in taking ordinary men, informing them narrowly and deeply, and then, through appropriate organization, arranging to have their knowledge combined with that of other specialized but equally ordinary men. This dispenses with the need for genius. The resulting performance, though less inspiring, is far more predictable.

*The New Industrial State*

Chapter VI, Section 2 (p. 62)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

**Gardner, Martin** 1914–

American writer and mathematics games editor

...modern science should indeed arouse in all of us a humility before the immensity of the explored and a tolerance for crazy hypotheses.

*Science: Good, Bad and Bogus*

Chapter 22 (p. 246)

Prometheus Books. Buffalo, New York, USA. 1981

**Garrod, Archibald** 1857–1936

English physician

Science is not, as so many seem to think, something apart, which has to do with telescopes, retorts, and test tubes, and especially with nasty smells, but it is a way of searching out by observation, trial, and classification; whether the phenomenon investigated be the outcome of human activities, or of the more direct workings of nature's laws. Its methods admit of nothing untidy or slipshod, its keynote is accuracy and its goal is truth.

In Alexander G. Bearn

*Archibald Garrod and the Individuality of Man*

Chapter 8 (p. 97)

Clarendon Press. Oxford, England. 1993

**Gerould, Katherine Fullerton** 1879–1944

American writer

The great danger of the scientific obsession is not the destruction of all things that are not science, but the slow infection of those things.

*Modes and Morals*

The Extirpation of Culture (p. 87)

Charles Scribner's Sons. New York, New York, USA. 1920

Science has done great things for us; it has also pushed us hopelessly back. For, not content with filling its own place, it has tried to supersede everything else. It has challenged the super-eminence of religion; it has turned all philosophy out of doors except that which clings to its skirts; it has thrown contempt on all learning that does not depend on it; and it has bribed the skeptics by giving us immense material comforts.

*Modes and Morals*

The Extirpation of Culture (p. 85)

Charles Scribner's Sons. New York, New York, USA. 1920

The insidiousness of science lies in its claim to be not a subject, but a method. You could ignore a subject; no subject is all-inclusive. But a method can plausibly be applied to anything within the field of consciousness.

*Modes and Morals*

The Extirpation of Culture (p. 86)

Charles Scribner's Sons. New York, New York, USA. 1920

**Gideonse, H. D.**

No biographical data available

Science, as usually taught to liberal arts students, emphasizes results rather than method, and tries to teach technique rather than to give insight into and understanding of the scientific habit of thought. What is needed, however, is not a dose of metaphysics but a truly humanistic teaching of science.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 2)

Chapter 36 (p. 529)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Gill, Eric** 1882–1940

English sculptor

Science is analytical, descriptive, informative. Man does not live by bread alone, but by science he attempts to do so. Hence the deadliness of all that is purely scientific.

*It All Goes Together: Selected Essays* (p. 117)

The Devin-Adair Company. New York, New York, USA. 1944

**Ginger, Ray** 1924–75

American historian

Science has explained everything it could explain, and it will continue to do so. Every effort to bar science from some areas on the ground that they were not susceptible to empirical investigation has had the effect of inhibiting science in other areas also. Man has progressed by exercising a humble confidence in the might of his own mind, not by throwing up his hands and shrugging his shoulders.

*Six Days or Forever: Tennessee v. John Thomas Scopes*

Chapter 11, Section III (p. 231)

Quadrangle Books. Chicago, Illinois, USA. 1958

**Glass, H. Bentley** 1906–2005

American geneticist

Science is not only to know, it is to do, and in the doing it has found its soul.

*Science and Ethical Values*

Chapter 3 (p. 101)

University of North Carolina Press. Chapel Hill, North Carolina, USA. 1965

...the general citizen of his country, the man in the street, must learn what science is, not just what it can bring about. Surely this is our primary task. If we fail in this, then within a brief period of years we may expect either nuclear devastation or worldwide tyranny. It is not safe for apes to play with atoms. Neither can men who have relinquished their birthright of scientific knowledge expect to rule themselves.

In Hilary J. Deason

*A Guide to Science Reading*

Revolution in Biology (pp. 25–26)

The New American Library. New York, New York, USA. 1966

**Gluckman, Max** 1911–75

English anthropologist

Science is cumulative. The apprentice in this generation can outdo his master of the last.

*Politics, Law & Ritual*

Chapter VII (p. 303)

Aldine Publishing Company, Chicago, Illinois, USA. 1965

**Goddard, Robert H.** 1882–1945

American physicist

Each must remember that no one can predict to what heights of wealth, fame, or usefulness he may rise until he has honestly endeavored, and he should derive courage from the fact that all sciences have been, at some time, in the same condition as he, and that it has often proved true that the dream of yesterday is the hope of today and the reality of tomorrow.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted

Graduation oration (p. 66)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Gorky, Maxim** 1868–1938

Russian writer

Science is becoming the nervous system of our time.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Progress Publishers. Moscow, Russia. 1979

Science is humanity's superior reason, the sun which man has created of his own flesh and blood and has lit to illuminate the darkness of his hard life and to show the way to freedom, justice, and beauty.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Progress Publishers. Moscow, Russia. 1979

For us natural science is the Archimedes' screw that alone can turn the world to face the sun of reason.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Progress Publishers. Moscow, Russia. 1979

Humanity has no force more powerful and victorious than science.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiereson

Progress Publishers. Moscow, Russia. 1979

**Gortner, Ross Aiken**

No biographical data available

Science will stagnate only when all will agree that only one interpretation can be drawn from a given series of data.

*Selected Topics in Colloid Chemistry with Especial Reference to Biochemical Problems*

Preface (p. vii)

Cornell University Press. Ithaca, New York, USA. 1937

**Gould, Laurence M.** 1896–1995

American polar explorer and geologist

Today, there is no other influence comparable with science in changing the foundations, indeed the very character of our lives. Science and its products determine our economy, dominate our industry, affect our health and welfare, alter our relations to all other nations, and determine the conditions of war and peace. Everyone who breathes is affected, and cannot remain impervious to them.

Science and the Culture of Our Times

*UNESCO Courier*, February 1968 (p. 4)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

No factual discovery of science (statements about how nature "is") can, in principle, lead us to ethical conclusions (how we "ought" to behave) or to convictions about intrinsic meaning (the "purpose" of our lives).

Dorothy, It's Really Oz

*Time*, August 23, 1999 (p. 59)

Science is an integral part of culture. It's not this foreign thing, done by an arcane priesthood. It's one of the glories of the human intellectual tradition.

*Independent* (London), January 24, 1990

Science does progress toward more adequate understanding of the empirical world, but no pristine, objective reality lies "out there" for us to capture as our technologies improve and our concepts mature.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Four, Chapter 16 (p. 214)

Random House, Inc. New York, New York, USA. 1995

Creative science is always a mixture of facts and ideas. Great thinkers are not those who can free their minds from cultural baggage and think or observe objectively (for such a thing is impossible), but people who use their milieu creatively rather than as a constraint.

*An Urchin in the Storm: Essays About Books and Ideas*

Chapter 6 (p. 103)

W.W. Norton & Company, Inc. New York, New York, USA. 1987

The net of science covers the empirical universe: What is it made of (fact) and why does it work this way (theory).

Non Overlapping Magisteria

*Natural History*, Volume 106, Number 2, March 1997 (p. 61)

Humanity has in course of time had to endure from the hand of science two great outrages upon its naive self-love. The first was when it realized that our earth was not the center of the universe, but only a speck in a world-system of a magnitude hardly conceivable.... The second was when biological research robbed man of his particular privilege of having been specially created and relegated him to a descent from the animal world.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*  
Chapter 1 (p. 1)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

**Grassé, Pierre P.** 1895–1985  
French zoologist

There is no law against day dreaming, but science must not indulge in it.

*Evolution of Living Organisms: Evidence for a New Theory of Transformation*  
Chapter IV (p. 104)  
Academic Press. New York, New York, USA. 1977

**Gray, Thomas** 1716–71  
English poet

Here rests his head upon the lap of Earth,  
A youth to fortune and to fame unknown.  
Fair Science frown's not on his humble birth,  
And Melancholy mark's him for her own.

*The Complete Poetical Works of Gray, Beattie, Blair, Collins, Thomson, and Kirke White*  
Elegy Written in a Country Churchyard, The Epitaph, Stanza 1  
J. Blackwood. London, England. 1800

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

Science advances by opening completely new fields of knowledge upon which the literary man or investigator may exercise their intellectual activities, and the directions in which these domains are to be found are rarely indicated with success in romantic or in scientific literature.

*Discovery; or, The Spirit and Service of Science*  
Chapter VI (p. 164)  
Macmillan & Company Ltd. London, England. 1918

...I hope that my children, at least, if not I myself, will see the day, when ignorance of the primary laws and facts of science will be looked on as a defect, only second to ignorance of the primary laws of religion and morality.

*Discovery; or, The Spirit and Service of Science*  
Chapter V (p. 92)  
Macmillan & Company Ltd. London, England. 1918

...science is not to be measured by practical service alone, though it may contribute to material prosperity: it is an intellectual outlook, a standard of truth and a gospel of light.

*Discovery; or, The Spirit and Service of Science*  
Preface (p. vi)  
Macmillan & Company Ltd. London, England. 1918

**Grove, Sir William** 1811–96  
English chemist

For my part I must say that science to me generally ceases to be interesting as it becomes useful.

In H.B.G. Casimir  
*Haphazard Reality: Half a Century of Science*  
Chapter 8 (p. 226)  
Harper & Row, Publishers. New York, New York, USA. 1983

It would be vain to attempt specifically to predict what may be the effect of Photography on future generations. A Process by which the most transient actions are rendered permanent, by which facts write their own annals in a language that can never be obsolete, forming documents which prove themselves, — must interweave itself not only with science but with history and legislature.

Lecture  
Progress of Physical Science Since the Opening of the London Institution, (19 January 1842)

**Gruber, Howard E.** 1922–2005  
American psychology scholar and professor

The power and the beauty of science do not rest upon infallibility, which it has not, but on corrigibility, without which it is nothing.

The Origin of "The Origin of Species"  
*The New York Times Book Review*, 22 July, 1979 (p. 7)

**Gruenberg, Benjamin C.**  
No biographical data available

To vast numbers of men and women science appears as something altogether too remote from their interests or capacities to justify even a glance or a hope of grasping. It is something for the "highbrows" or wizards.

*Science and the Public Mind*  
Chapter XIV (p. 152)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1935

**Guth, Alan** 1947–  
American physicist

...science is not merely a collection of facts, but is instead an ongoing detective story, in which scientists passionately search for clues in the hope of unraveling the mysteries of the universe.

*The Inflationary Universe; the Quest for a New Theory of Cosmic Origins*  
Chapter 3 (p. 34)  
Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

**Guye, Charles Eugene**  
Swiss scientist

It is because we do not possess "science" that we have "sciences."

*Physico-Chemical Evolution* (p. 8)  
Methuen & Company Ltd. London, England. 1925

**Haggard, Howard W.**  
Physician

There is another class of explorers whose exploits are rarely heralded by the waving of flags, to whom few monuments are erected, and whose names find small place in world history. They are the explorers in science. They change no maps, but they change our ways of living.

In Bernard Jaffe



*New World of Chemistry*

Chapter 10 (p. 113)

Silver, Burdett & Company. New York, New York, USA. 1935

### Hall, A. D.

No biographical data available

The true aim of science is the enrichment of life.

*Nature*, Volume 138, 1936 (p. 576)

### Hall, Alfred Rupert 1920–

English historian of science

### Hall, Marie Boas 1919–

English historian of science

It is hardly too much to say that the Middle Ages studied science as though it were theology and Aristotle's Physics as though it were the Bible.

*A Brief History of Science*

Chapter 6 (p. 78)

Iowa State University Press. Ames, Iowa, USA. 1988

### Handler, Philip 1917–81

No biographical data available

My own belief is that science remains the most powerful tool we have yet generated to apply leverage for our future. It is the instrument which is most useful for guiding our own destinies, for assuring the condition of man in the years to come. I have much to hope that we will not abandon that tool, leaving us to our own brute devices.

*Hearings*

1971 National Science Foundation Authorization, Subcommittee on Science, Research and Development, House Committee on Science and Astronautics, 91st Congress, 2nd Session 1970 (p. 16)

### Harari, Josué V.

No biographical data available

### Bell, David F.

No biographical data available

Science is the totality of the world's legends. The world is the space of their inscription. To read and to journey are one and the same act.

In Michel Serres

*Hermes: Literature, Science, Philosophy*

Introduction (p. xxi)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1982

### Hardy, Thomas 1840–1928

English poet and regional novelist

Well: what we gain by science is, after all, sadness, as the Preacher saith. The more we know of the laws & nature of the Universe the more ghastly a business we perceive it all to be — & the non-necessity of it.

In Richard Little Purdy and Michael Millgate (eds.)

*The Collected Letters of Thomas Hardy* (Volume 3)

Letter, February 27, 1902

Clarendon Press. Oxford, England. 1978

### Harman, Willis

No biographical data available

Science is all about cause. That's why you have science; you're trying to find the explanation, the causes, for the phenomena. Now, if really everything is connected to everything, if there really is only a oneness, everything then affects everything, and everything is the cause of everything in a certain sense, so that the whole idea of causality has to be revised.

*Thinking Allowed: Conversations on the Leading Edge of Knowledge and Discovery*

Metaphysics and Modern Science, Part I: Consciousness and Science  
Thinking Allowed Productions. Berkeley, California, USA.

### Harrington, John W.

American geologist

Science is the progressive discovery of the nature of nature.

*Dance of the Continents*

The Lure of the Hunt (p. 30)

J.P. Tarcher. Los Angeles, California, USA. 1983

### Harris, Errol E.

No biographical data available

Accordingly there are two main types of science, exact science...and empirical science...seeking laws which are generalizations from particular experiences and are verifiable (or, more strictly, "probabilities") only by observation and experiment.

*Hypothesis and Perception: The Roots of Scientific Method*

Prevalent Views of Science (p. 25)

George Allen & Unwin Ltd. London, England. 1970

### Harrison, Jane 1850–1928

English classical scholar

Science has given us back something strangely like a World-Soul...

*Ancient Art and Ritual*

Chapter VII (p. 238)

Henry H. Holt. New York, New York, USA. 2002

### Harvey, William 1578–1657

English physician

Although there is but one road to science, that, to wit, in which we proceed from things more known to things less known, from matters more manifest to matters more obscure; and universals are principally known to us, science bringing by reasoning from universals to particulars; still the comprehension of universals by the understanding is based upon the perception of individual things by the senses.

In *Great Books of the Western World* (Volume 28)

*Anatomical Exercises on the Generation of Animals*

Of the Manner and Order of Acquiring Knowledge (p. 332)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Hauge, Philip 1913–2004

American scientist, editor, and administrator

Part of the strength of science is that it has tended to attract individuals who love knowledge and the creation of it. Just as important to the integrity of science have been the unwritten rules of the game. These provide recognition and approbation for work which is imaginative and accurate, and apathy or criticism for the trivial or inaccurate. ... Thus, it is the communication process which is at the core of the vitality and integrity of science. ... The system of rewards and punishments tends to make honest, vigorous, conscientious, hardworking scholars out of people who have human tendencies of slothfulness and no more rectitude than the law requires.

The Roots of Scientific Integrity  
*Science*, Volume 139, 1963 (p. 3561)

**Havel, Václav** 1936–  
Czech dramatist and essayist

Modern science abolishes as mere fiction the innermost foundations of our natural world: it kills God and takes his place on the vacant throne so henceforth it would be science that would hold the order of being in its hand as its sole legitimate guardian and so be the legitimate arbiter of all relevant truth. People thought they could explain and conquer nature — yet the outcome is that they destroyed it and disinherited themselves from it.

In L. Wolpert  
*The Unnatural Nature of Science*  
Introduction (p. ix)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Hawking, Stephen William** 1942–  
English theoretical physicist

The whole history of science has been the gradual realization that events do not happen in an arbitrary manner, but that they reflect a certain underlying order, which may or may not be divinely inspired.

*A Brief History of Time: From the Big Bang to Black Holes*  
Chapter 8 (p. 122)  
Bantam Books. Toronto, Ontario, Canada. 1988

In effect, we have redefined the task of science to be the discovery of laws that will enable us to predict events up to the limits set by the uncertainty principle.

*A Brief History of Time: From the Big Bang to Black Holes*  
Chapter 11 (p. 173)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Hayward, Jeremy**  
American physicist

Like Christianity, modern science teaches that these things of the world of senses are not really real, but that there is a more real reality, in Nature, behind these appearances, a permanent, unchanging reality in comparison to which the world of appearance is ever changing and is an accidental product of our sense organs. Unlike the “other world” of Christianity, which is world of spirit or mind,

altogether without body, this “other world” of science is a world of matter, altogether without spirit, life, or mind. This ultimately real world is the world of particles (little bits of dead stuff), of space and time and of forces (gravitational, electromagnetic, and more recently the strong and weak nuclear forces).

*Shifting Worlds, Changing Minds: Where the Sciences and Buddhism Meet*  
Chapter 1 (p. 14)  
New Science Library Shambhala Publications, Inc. Boston, Massachusetts, USA. 1987

**Hazlitt, William Carew** 1834–1913  
English bibliographer

The origin of all science is in the desire to know causes; and the origin of all false science and imposture is in the desire to accept false causes rather than none; or, which is the same thing, in the unwillingness to acknowledge our own ignorance.

*The Atlas*  
February 15, 1829  
Burke and the Edinburgh Phrenologists  
This article is unsigned in the atlas but appears in P.P. Howe’s *New Writings* by William Hazlitt, 1925

**Heidel, W. A.**  
No biographical data available

It is an unwarranted assumption that ancient science differed in principle at any point from that of today.

In Julius W. Friend and James Feibleman  
*What Science Really Means*  
Chapter II (p. 26)  
George Allen & Unwin Ltd. London, England. 1937

**Heinlein, Robert A.** 1907–88  
American science fiction writer

The difference between science and the fuzzy subjects is that science requires reasoning, while those other subjects merely require scholarship.

*Time Enough for Love*  
Second Intermission (p. 366)  
G.P. Putnam’s Sons. New York, New York, USA. 1973

If it can’t be expressed in figures, it is not science; it is opinion.

*Time Enough for Love*  
Intermission (p. 257)  
G.P. Putnam’s Sons. New York, New York, USA. 1973

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

The assumption [is] that in the end it will always be possible to understand nature, even in every new field of experience, but that we may make no a priori assumptions about the meaning of the word “understand.”

In Heinrich O. Proskauer  
*The Rediscovery of Color: Goethe versus Newton Today*  
Preface (p. ix)  
Anthroposophic Press. Spring Valley, New York, USA. 1986

Science no longer confronts nature as an objective observer, but sees itself as an actor in this interplay between man and nature. The scientific method of analysing, explaining, and classifying has become conscious of its limitations.... Method and object can no longer be separated.

*The Physicist's Conception of Nature*

Chapter I (p. 29)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1958

Almost every progress in science has been paid by a sacrifice, for almost every new intellectual achievement previous positions and conceptions had to be given up. Thus, in a way, the increase of knowledge and insight diminishes continually the scientist's claim to "understand" nature.

In A. Sarlemijn and M.J. Sparnaay (eds.)

*Physics in the Making: Essays on Developments in 20<sup>th</sup> Century Physics:*

*In Honour of H.B.G. Casimir on the Occasion of His 80<sup>th</sup> Birthday*

Chapter I (p. 9)

North-Holland Publishing Company. Amsterdam, Netherlands. 1989

In science... it is impossible to open up new territory unless one is prepared to leave the safe anchorage of established doctrine and run the risk of a hazardous leap forward. With his relativity theory, Einstein had abandoned the concept of simultaneity, which was part of the solid ground of traditional physics, and, in so doing, outraged many leading physicists and philosophers and turned them into bitter opponents. In general, scientific progress calls for no more than the absorption and elaboration of new ideas — and this is a call most scientists are happy to heed.

*Physics and Beyond: Encounters and Conversations*

Chapter 6 (p. 70)

Harper & Row, Publishers. New York, New York, USA. 1971

### **Henderson, Lawrence** 1878–1942

American biochemist

Science has finally put the old teleology to death. Its dismembered spirit, freed from vitalism and all material ties, immortal, alone lives on, and from such a ghost, science has nothing to fear.

*The Fitness of the Environment: An Inquiry into the Biological Significance of the Properties of Matter*

Chapter VIII, Section III, B (p. 311)

The Macmillan Company. New York, New York, USA. 1913

### **Henry, Joseph** 1797–1878

Scottish-born American scientist

...science is the pursuit above all which impresses us with the capacity of man for intellectual and moral progress and awakens the human intellect to aspiration for a higher condition of humanity.

Inscription on the National Museum of American History, Washington, D.C.

...narrow minds think nothing of importance but their own favorite pursuit, but liberal views exclude no branch of science or literature...

Inscription on the National Museum of American History, Washington, D.C.

### **Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Science is the knowledge of many, orderly and methodically digested and arranged, so as to become attainable to one.

*The Cabinet of Natural Philosophy*

Part I, Chapter II, Section 13 (p. 18)

Longman, Rees, Orme, Brown & Green. London, England. 1831

Science is of no party. Under the government, whether of Whig or Tory, she has often had to complain of the difficulty of making herself heard in recommendation of her objects; but those objects once recognized by a British government, are taken up in a spirit and with a liberality which ensures success, if success be possible.

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Terrestrial Magnetism (pp. 112–113)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

Every student who enters upon a scientific pursuit, especially if at a somewhat advanced period of life, will find not only that he has much to learn, but much also to unlearn.

*Outlines of Astronomy* (2<sup>nd</sup> edition)

Part I, Introduction (p. 1)

Longman, Brown, Green & Longmans. London, England. 1849

...if science may be vilified by representing it as opposed to religion, or trammelled by mistaken notions of the danger of free enquiry, there is yet another mode by which it may be degraded from its native dignity, and that is by placing it in the light of a mere appendage to and caterer for our pampered appetites.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 7 (p. 10)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

### **Hertz, Heinrich** 1857–94

German physicist

The rigor of science requires that we distinguish well the undraped figure of nature itself from the gay-coloured vesture with which we clothe it at our pleasure.

Letters to the Editor

In Ludwig Boltzmann

On Certain Question of the Theory of Gases

*Nature*, Volume 51, Number 1322, 28 February 1895 (p. 413)

### **Herzen, Aleksandr** 1812–70

Russian political author

Superficial dilettantism and the narrow specialization of the scientists ex officio are the two banks of science which prevent the fertilizing waters of this Nile from overflowing.

*Selected Philosophical Works*  
Dilettantism in Science (p. 52)  
Foreign Languages Publishing House. Moscow, Russia. 1956

Science is a table abundantly laid for every man whose hunger is great enough, whose craving for spiritual nourishment has grown sufficiently insistent.

*Selected Philosophical Works*  
Dilettantism in Science (p. 58)  
Foreign Languages Publishing House. Moscow, Russia. 1956

Science, in the best sense of the word, shall come to be accessible to the people, and when it does it shall claim a voice in all practical matters.

*Selected Philosophical Works*  
Dilettantism in Science (p. 69)  
Foreign Languages Publishing House. Moscow, Russia. 1956

Science is strength; it shows the relations of things, their laws and interactions.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneerson  
Progress Publishers. Moscow, Russia. 1979

### Hilts, Philip

No biographical data available

In all human activities, it is not ideas of machines that dominate; it is people. I have heard people speak of "the effect of personality on science." But this is a backward thought. Rather, we should talk about the effect of science on personalities. Science is not the dispassionate analysis of impartial data. It is the human, and thus passionate, exercise of skill and sense on such data.

*Scientific Temperaments: Three Lives in Contemporary Science*  
Preface (pp. 11–12)  
Simon & Schuster. New York, New York, USA. 1982

Science is not an exercise in which objectivity is prized.

*Scientific Temperaments: Three Lives in Contemporary Science*  
Preface (pp. 11–12)  
Simon & Schuster. New York, New York, USA. 1982

### Hinshelwood, Sir Cyril 1897–1967

English chemist

Science is not the mere collection of facts, which are infinitely numerous and mostly uninteresting, but the attempt by the human mind to order these facts into satisfying patterns.

*On the Structure of Physical Chemistry*  
Clarendon Press. Oxford, England. 1951

### Hippocrates 460 BCE–377 BCE

Greek physician

There are, indeed, two things, knowledge and opinion, of which the one makes its possessor really to know, the other to be ignorant.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*

The Law, 4 (p. 144)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Hitler, Adolf 1889–1945

Chancellor of Germany

Science is a social phenomenon, and like every other social phenomenon is limited by the injury or benefit it confers on the community.... The idea of free and unfettered science... is absurd.

In Hermann Rauschning  
*Hitler Speaks: A Series of Political Conversations with Adolf Hitler on His Real Aims* (pp. 220–221)  
Butterworth. London, England. 1939

### Hoagland, Hudson 1899–1982

American physiologist

The fictions — that is, the hypotheses and theories — of science are not sacrosanct.

Science and the New Humanism  
*Science*, Volume 143, Number 3062, 10 January 1964 (p. 112)

### Hocking, R.

No biographical data available

It is an oversimplification to compare the impersonal aspect of science with the impersonal aspects of industrial society, and to deplore both in one breath. The former is an achievement of self-forgetful concentration upon truths about nature. The latter are deplorable to the extent that they exhibit crude power of men over men. By contrast, the selflessness of the scientific calling does silent honor to personal existence.

In T.J.J. Altizer, William A. Beardslee, and J. Harvey Young (eds.)  
*Truth, Myth, and Symbol*  
The Problem of Truth (p. 5)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1962

### Hodgson, Leonard 1889–1969

English theologian

...science can only deal with what is, and can say nothing about what ought to be, which is the concern of ethics; science can tell us about means to ends, but not about what the ends should be.

*Theology in an Age of Science*  
An Inaugural Lecture, November 3, 1944 (p. 9)

### Holmes, Oliver Wendell 1809–94

American physician, poet, and humorist

Science is the topography of ignorance.

*The Writings of Oliver Wendell Holmes*  
Volume IX, Border Lines in Medical Science (p. 211)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891–1906

Go on, fair science; soon to thee  
Shall nature yield he idle boast;  
He vulgar fingers formed a tree,  
But thou hast trained it to a post.

*The Complete Poetical Works of Oliver Wendell Holmes*

The Meeting of the Dryads (p. 412)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

**Holton, Gerald** 1922–

Research professor of physics and science history

**Roller, Duane H. D.** ?–1994

Science historian

Science is an ever-unfinished quest to discover facts and establish relationships between them.

*Foundations of Modern Physical Science*

Chapter 13 (p. 214)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

...science has grown almost more by what it has learned to ignore than by what it has had to take into account.

*Foundations of Modern Physical Science*

Chapter 2 (p. 25)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1950

**Horgan, J.**

No biographical data available

...to pursue science in a speculative, postempirical mode: that I call ironic science. Ironic science resembles literary criticism in that it offers points of view, opinions, which are, at best, interesting, which provoke further comment. But it does not converge on the truth. It cannot achieve empirically verifiable surprises that force scientists to make substantial revisions in their basic description of reality.

*The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age*

Introduction (p. 7)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Science progresses by extending the territory over which its theories hold good...

*Ten Faces of the Universe*

The Origin of the Universe (p. 105)

W.H. Freeman & Company. San Francisco, California, USA. 1977

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

**Hoyle, Geoffrey** 1942–

English science fiction writer

The fragmentation of science is a source of difficulty to all teachers and to all students — the connection of one research area to another is not always apparent. This is because science is rather like a vast and subtle jig-saw puzzle, and the usual way to attack a jig-saw puzzle is to work simultaneously on several parts of it. Only at the end do we seek to fit the different parts of it together into a coherent whole.

In Eugene H. Kone and Helene J. Jordan (eds.)

*The Greatest Adventure: Basic Research that Shapes Our Lives*  
Cosmology and Its Relation to the Earth (p. 22)

Rockefeller University Press. New York, New York, USA. 1974

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

SCIENCE: 1. The knowledge of the common people classified and carried one step further. 2. Accurate organized knowledge grounded on fact. 3. Classified superstition.

*The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 134)

The Roycrofters. East Aurora, New York, USA. 1914

**Hubbard, Gardiner G.** 1822–97

American lawyer and educator

That which was unknown, science hath revealed.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1893*

Relations of Air and Water to Temperature and Life (p. 265)

Government Printing Office. Washington, D.C. 1894

**Hubbard, Ruth** 1924–

American biologist

To overturn orthodoxy is no easier in science than in philosophy, religion, economics, or any of the other disciplines through which we try to comprehend the world and the society in which we live.

*Women Look at Biology Looking at Women*

Have Only Men Evolved? (p. 10)

Schenkman Publishing Company. Cambridge, USA. 1979

**Hubble, Edwin Powell** 1889–1953

American astronomer

There is a unity in science, connecting all its various fields. Men attempt to understand the universe, and they will follow clues which excite their curiosity wherever the clues may lead.

*The Nature of Science and Other Lectures*

Part I. The Nature of Science (p. 6)

The Huntington Library. San Marino, California, USA. 1954

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Science says the first word on everything, and the last word on nothing.

*Victor Hugo's Intellectual Autobiography*

Things of the Infinite

Funk & Wagnalls. New York, New York, USA. 1907

**Huizinga, Johan** 1872–1945

Dutch historian

Science, unguided by a higher abstract principle, freely hands over its secrets to a vastly developed and commercially inspired technology, and the latter, even less restrained by a supreme culture saving principle, with

the means of science creates all the instruments of power demanded from it by the organization of Might.

Translated by J.H. Huizinga

*In the Shadow of Tomorrow*

Chapter 9 (p. 93)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

...that all science is merely a game can be easily discarded as a piece of wisdom too easily come by. But it is legitimate to enquire whether science is not liable to indulge in play within the closed precincts of its own method. Thus, for instance, the scientist's continuous penchant for systems tends in the direction of play.

*Homo Ludens*

Chapter XI (p. 203)

Roy Publishers. New York, New York, USA. 1950

### **Hume, David** 1711–76

Scottish philosopher and historian

The sweetest and most inoffensive path of life leads through the avenues of science and learning; and whoever can either remove any obstructions in this way, or open up any new prospect, ought so far to be esteemed a benefactor to mankind.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Enquiries Concerning the Human Understanding and Concerning the Principles of Morals

Section 1

Of the Different Species of Philosophy (p. 453)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Huxley, Aldous** 1894–1963

English writer and critic

To the twentieth century man of letters science offers a treasure of newly discovered facts and tentative hypotheses. If he accepts this gift and if, above all, he is sufficiently talented and resourceful to be able to transform the new materials into works of literary art, the twentieth century man of letters will be able to treat the age-old, and perennially relevant, theme of human destiny with a depth of understanding, a width of reference of which, before the rise of science, his predecessors (through no fault of their own, no defect of genius) were incapable.

*Literature and Science*

Chapter 29 (p. 87)

Harper & Row, Publishers. New York, New York, USA. 1963

We are living now, not in the delicious intoxication induced by the early successes of science, but in a rather grisly morning-after, when it has become apparent that what triumphant science has done hitherto is to improve the means for achieving unimproved or actually deteriorated ends.

*Ends and Means*

Chapter XIV (p. 268)

Chatto & Windus. London, England. 1938

Science is dangerous; we have to keep it most carefully chained and muzzled.

*Brave New World*

Chapter Sixteen (p. 270)

Harper & Brothers. New York, New York, USA. 1950

Science is a matter of disinterested observation, patient ratiocination within some system of logically correlated concepts. In real-life conflicts between reason and passion the issue is uncertain. Passion and prejudice are always able to mobilize their forces more rapidly and press the attack with greater fury; but in the long run (and often, of course, too late) enlightened self-interest may rouse itself, launch a counterattack and win the day for reason.

*Literature and Science*

Chapter 23 (p. 68)

Harper & Row, Publishers. New York, New York, USA. 1963

Science sometimes builds new bridges between universes of discourse and experience hitherto regarded as separate and heterogeneous. But science also breaks down old bridges and opens gulfs between universes that, traditionally, had been connected.

*Literature and Science*

Chapter 37 (p. 111)

Harper & Row, Publishers. New York, New York, USA. 1963

For Science in its totality, the ultimate goal is the creation of a monistic system in which — on the symbolic level and in terms of the inferred components of invisibility and intangibly fine structure — the world's enormous multiplicity is reduced to something like unity, and the endless successions of unique events of a great many different kinds get tidied and simplified into a single rational order. Whether this goal will ever be reached remains to be seen. Meanwhile we have the various sciences, each with its own system coordinating concepts, its own criterion of explanation.

*Literature and Science*

Chapter 3 (p. 9)

Harper & Row, Publishers. New York, New York, USA. 1963

...science has "explained" nothing; the more we know the more fantastic the world becomes and the profounder the surrounding darkness.

*Along the Road*

Part II. Views of Holland (p. 108)

Nan'-do. Tokyo, Japan. 1954

All science is based upon an act of faith — faith in the validity of the mind's logical processes, faith in the ultimate explicability of the world, faith that the laws of thought are laws of things.

*Ends and Means*

Chapter XIV (p. 258)

Chatto & Windus. London, England. 1938

### **Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Science...has not only turned her face outwards from man, but stripped him of all the robes of his divinity, turned him out of the palace that he had so laboriously built in the center of the world, and left him in rags, pitifully insignificant and suddenly transported to an outlying corner of the cosmos.

*Harper's Monthly Magazine*

Will Science Destroy Religion, April 1926 (p. 535)

Science, like Empires, have their rise and their time of flourishing, though not their decay.

*What Dare I Think?: The Challenge of Modern Science to Human Action and Belief, Including the Henry La Barre Jayne Foundation Lectures*

Chapter I (p. 1)

Harper & Brothers. New York, New York, USA. 1931

**Huxley, Thomas Henry** 1825–95

English biologist

Science in England does everything — but pay. You may earn praise but not pudding.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter VII

Letter to his sister, April 17, 1852 (p. 108)

D. Appleton & Company. New York, New York, USA. 1901

Whatever happens, science may bide her time in patience and in confidence.

*Collected Essays* (Volume 5)

*Science and Christian Traditions*

An Episcopal Trilogy (p. 143)

Macmillan & Company Ltd. London, England. 1904

What men of science want is only a fair day's wages for more than a fair day's work...

*Collected Essays* (Volume 1)

*Method and Result*

Administrative Nihilism (p. 287)

Macmillan & Company Ltd. London, England. 1904

You have no idea of the intrigues that go on in this blessed world of science. Science is, I fear, no purer than any other region of human activity; though it should be. Merit alone is very little good; it must be backed by tact and knowledge of the world to do very much.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 1)

Chapter VII

Letter to his sister, March 5, 1852 (p. 105)

D. Appleton & Company. New York, New York, USA. 1901

The generalizations of science sweep on in ever-widening circles, and more aspiring flights, through limitless creation.

Letter

*London Times*, December 26, 1859

Nothing great in science has ever been done by men, whatever their powers, in whom the divine afflatus [inspiration] of the truth-seeker was wanting.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 56)

Macmillan & Company Ltd. London, England. 1904

Of the affliction caused by persons who think that what they have picked up from popular exposition qualifies them for discussing the great problems of science, it may be said, as the Radical toast said of the power of the Crown in bygone days, that it "has increased, is increasing, and ought to be diminished." The oddities of "English as she is spoke" might be abundantly paralleled by those of "science as she is misunderstood" in the sermon, the novel, and the leading article; and a collection of the grotesque travesties of scientific conceptions in the shape of essays on such trifles as "the Nature of Life" and the "Origin of All Things," which reach me, from time to time, might well be bound up with them.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

Preface (p. viii)

Macmillan & Company Ltd. London, England. 1904

No delusion is greater than the notion that method and industry can make up for lack of motherwit, either in science or in practical life.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 46)

Macmillan & Company Ltd. London, England. 1904

Science reckons many prophets, but there is not even a promise of a Messiah.

In Leonard Huxley

*Life and Letters of Thomas Henry Huxley* (Volume 2)

Letter dated March 1894 (p. 396)

D. Appleton and Company. New York, New York, USA. 1901

Posterity will cry shame on us if we do not remedy this deplorable state of things. Nay, if we live twenty years longer, our own consciences will cry shame on us.

It is my firm conviction that the only way to remedy it is to make the elements of physical science an integral part of primary education. I have endeavored to show you how that may be done for that branch of science which it is my business to pursue; and I can but add, that I should look upon the day when every schoolmaster throughout this land was a centre of genuine, however rudimentary, scientific knowledge as an epoch in the history of the country.

But let me entreat you to remember my last words. Addressing myself to you, as teachers, I would say, mere book learning in physical science is a sham and a delusion-what you teach, unless you wish to be impostors, that you must first know; and real knowledge in science means personal acquaintance with the facts, be they few or many.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 227)  
Macmillan & Company Ltd. London, England. 1904

Science commits suicide when it adopts a creed.

*Collected Essays* (Volume 2)

*Darwiniana*

The Darwin Memorial (p. 252)

Macmillan & Company Ltd. London, England. 1904

So, the vast results obtained by Science are won by no mystical faculties, by no mental processes, other than those which are practised by every one of us, in the humblest and meanest affairs of life. A detective policeman discovers a burglar from the marks made by his shoe, by a mental process identical with that by which Cuvier restored the extinct animals of Montmartre from fragments of their bones.

*Collected Essays* (Volume 3)

*Science and Education*

On the Educational Value of the Natural History Sciences (p. 46)

Macmillan & Company Ltd. London, England. 1904

Extinguished theologians lie about the cradle of every science as the strangled snakes beside that of Hercules...

*Collected Essays* (Volume 2)

*Darwiniana*

The Origin of Species (p. 52)

Macmillan & Company Ltd. London, England. 1904

The whole of modern thought is steeped in science; it has made its way into the works of our best poets, and even the mere man of letters, who affects to ignore and despise science, is unconsciously impregnated with her spirit, and indebted for his best products to her methods.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

I believe that the greatest intellectual revolution mankind has yet seen is now slowly taking place by her agency. She is teaching the world that the ultimate court of appeal is observation and experiment, and not authority; she is teaching it to estimate the value of evidence; she is creating a firm and living faith in the existence of immutable moral and physical laws, perfect obedience to which is the highest possible aim of an intelligent being.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

Physical science, its methods, its problems, and its difficulties, will meet the poorest boy at every turn, and yet we educate him in such a manner that he shall enter the world as ignorant of the existence of the methods and facts of science as the day he was born. The modern world is full of artillery; and we turn out our children to do battle in it, equipped with the shield and sword of an ancient gladiator.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

The vast results obtained by Science are won by no mystical faculties, by no mental processes, other than those which are practiced by every one of us, in the humblest and meanest affairs of life. A detective policeman discovers a burglar from the marks made by his shoe, by a mental process identical with that by which Cuvier restored the extinct animals of Montmartre from fragments of their bones.

*Collected Essays* (Volume 3)

*Science and Education*

On the Educational Value of the National History Sciences (p. 45)

Macmillan & Company Ltd. London, England. 1904

Books are the money of Literature, but only the counters of Science.

*Collected Essays* (Volume 3)

*Science and Education*

Universities: Actual and Ideal (p. 213)

Macmillan & Company Ltd. London, England. 1904

Anybody who knows his business in science can make anything subservient to that purpose. You know it was said of Dean Swift that he could write an admirable poem upon a broomstick, and the man who has a real knowledge of science can make the commonest object in the world subservient to an introduction to the principles and greater truths of natural knowledge.

*Collected Essays* (Volume 3)

*Science and Education*

Address on Behalf of the National Association for the Promotion of Technical Education (p. 432)

Macmillan & Company Ltd. London, England. 1904

In science, as in art, and, as I believe, in every other sphere of human activity, there may be wisdom in a multitude of counselors, but it is only [obvious] in one or two of them.

*Collected Essays* (Volume 1)

*Method and Result*

The Progress of Science (p. 57)

Macmillan & Company Ltd. London, England. 1904

...the man of science, who, forgetting the limits of philosophical inquiry, slides from these formulae and symbols into what is commonly understood by materialism, seems to me to place himself on a level with the mathematician, who should mistake the x's and y's with which he works his problems for real entities — and with this further disadvantage, as compared with the mathematician, that the blunders of the latter are of no practical consequence, while the errors of systematic materialism may paralyse the energies and destroy the beauty of a life.

*Collected Essays* (Volume 1)

*Method and Result*

On the Physical Basis of Life (p. 165)

Macmillan & Company Ltd. London, England. 1904



... whatever evil voices may rage, Science, secure among the powers that are eternal, will do her work and be blessed.

*Collected Essays* (Volume 1)

*Method and Result*

Descartes' Discourse on Method (p. 198)

Macmillan & Company Ltd. London, England. 1904

Addressing myself to you, as teachers, I would say, mere book learning in physical science is a sham and a delusion — what you teach, unless you wish to be impostors, that you must first know; and real knowledge in science means personal acquaintance with the facts, be they few or many.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 227)

Macmillan & Company Ltd. London, England. 1904

**Ingersoll, Robert G.** 1833–99

American orator and lawyer

Reason, Observation, and Experience — the Holy Trinity of Science.

*On the Gods and Other Essays*

The Gods (p. 54)

Prometheus Books. Buffalo, New York, USA. 1990

**Jacks, L. P.** 1860–1955

English educator, philosopher, and Unitarian minister

Science is never static, never stagnant, never content with the boundary it has reached. It is always dynamic, always breaking bounds. ... Science...abhors a limitation. ...

Is There a Foolproof Science?

*The Atlantic Monthly*, February 1924 (p. 231)

Science is the pursuer, life is the pursued....

Is There a Foolproof Science?

*The Atlantic Monthly*, February 1924 (p. 238)

**Jacob, François** 1920–

French biologist

Science advances metaphorically. It does not proceed in an orthogenic fashion moving inexorably forward in a straight line. It does not radiate along many branches like a growing tree. It moves from one view to another by a large leap, preceded by a radical shift in the scientist's mode of thought.

Translated by Betty E. Spillmann

*The Logic of Life: A History of Heredity*

Pantheon Books. New York, New York, USA. 1974

For science, there are many possible worlds; but the interesting one is the world that exists and has already shown itself to be at work for a long time. Science attempts to confront the possible with the actual.

*The Possible and the Actual*

Myth and Science (p. 12)

Pantheon Books. New York, New York, USA. 1982

**Jacobi, Karl Gustav Jacob** 1804–51

German mathematician

... Monsieur Fourier was of the opinion that the principal aim of Mathematics is to serve mankind and to explain natural phenomena; but a philosopher such as he ought to have known that the sole aim of science is the fulfillment of the human spirit, and that, accordingly, a question about numbers has as much significance as a question about the workings of the world.

*Gesammelte Werke* (Volume 1)

Letter to Legendre

July 2, 1830 (p. 454)

Publisher undetermined

**James, William** 1842–1910

American philosopher and psychologist

The aim of "science" is to attain conceptions so adequate and exact that we shall never need to change them.

*The Principles of Psychology*

The Perception of Things (p. 109)

Dover Publications, Inc. New York, New York, USA. 1950

Science herself consults her heart when she lays it down that the infinite ascertainment of fact and correction of false belief are the supreme goods for man.

*The Will to Believe and Other Essays in Popular Philosophy*

The Will to Believe

Section IX (p. 22)

Dover Publications, Inc. New York, New York, USA. 1956

Science as such assuredly has no authority, for she can only say what is, not what is not.

*The Will to Believe and Other Essays in Popular Philosophy*

Is Life Worth Living? (p. 56)

Dover Publications, Inc. New York, New York, USA. 1956

Science like life feeds on its own decay. New facts burst old rules; then newly developed concepts bind old and new together into a reconciling law.

*The Will to Believe and Other Essays in Popular Philosophy*

Psychical Research (p. 320)

Dover Publications, Inc. New York, New York, USA. 1956

**Jastrow, Joseph** 1863–1944

Polish-born psychologist

Theories rise and fall as better, truer theories replace them; yet it is unwarranted to conclude that science is truth for a day.

In Joseph Jastrow (ed.)

*The Story of Human Error*

Introduction (p. 34)

D. Appleton-Century Company, Inc. New York, New York, USA. 1936

Science, unlike the Bible, has no explanation for the occurrence of that extraordinary event. The universe, and everything that has happened in it since the beginning of time, are a grand effect without a known cause.

*Until the Sun Dies*

Chapter 2 (p. 21)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

To this present-day science adds that, at the farthest point she has so far reached, much, and possibly all, that was not mental has disappeared, and nothing new has come in that is not mental. Yet who shall say what we may find awaiting us round the next corner?

*The New Background of Science*

Chapter VIII (p. 307)

The University of Michigan Press. Ann Arbor, Michigan, USA. 1959

The infinitely great is never very far from the infinitely small in science...

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

The Wider Aspect of Cosmogony (p. 170)

Government Printing Office. Washington, D.C. 1929

**Jeffers, Robinson** 1887–1962

American poet

Science is not to serve but to know. Science is for itself its own value, it is not for man...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 291)

Stanford University Press. Stanford, California, USA. 1988

Science is an adoration; a kind of worship.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 292)

Stanford University Press. Stanford, California, USA. 1988

**Jefferson, Thomas** 1743–18263<sup>rd</sup> president of the United States

The main objects of all science, the freedom and happiness of man...[are] the sole objects of all legitimate government.

In Andrew A. Lipscomb (ed.)

*The Writings of Thomas Jefferson* (Volume 12) (p. 369)

G. Putnam's Sons. New York, New York, USA. 1892–99

**Jevons, William Stanley** 1835–82

English economist and logician

Science arises from the discovery of Identity amidst Diversity.

*The Principles of Science: A Treatise on Logic and Scientific Method*

Book I, Chapter I (p. 1)

Macmillan &amp; Company. London, England. 1887

**Joad, Cyril Edwin Mitchinson** 1891–1953

English philosopher and broadcasting personality

Man by the light of science can see his hands, and can catch a glimpse of himself, his past, and the patch upon which he stands; but around him in place of that known comfort and beauty he had anticipated, and in the first few moments falsely thought that he saw, is darkness still.

*Philosophical Aspects of Modern Science*

Chapter XI (p. 342)

George Allen &amp; Unwin Ltd. London, England. 1939

**Joffe, A. F.**

No biographical data available

Science with its strict analysis of the facts, its persevering search for new, more consummate truths, and its relentless struggle against discovered mistakes and prejudices — science must saturate all or technics, our culture, and everyday life.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

The Sciences having long seen their votaries labouring for the benefit of mankind without reward, put up their petitions to Jupiter for a more equitable distribution of riches and honor... A synod of the celestials was therefore convened, in which it was resolved that Patronage should descend to the assistance of the Sciences.

*The Rambler* (Volume 2)

No. 91, January 29, 1751 (p. 231)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

In science, which, being fixed and limited, admits of no other variety than such as arises from new methods of distribution, or new arts of illustration, the necessity of following the traces of our predecessors is indisputably evident; but there appears no reason why imagination should be subject to the same restraint... The roads of science are narrow, so that they who travel them, must either follow or meet one another; but in the boundless regions of possibility, which fiction claims for her dominion, there are surely a thousand recesses unexplored, a thousand flowers unplucked, a thousand fountains unexhausted, combinations of imagery yet unobserved, and races of ideal inhabitants not hitherto described.

*The Rambler* (Volume 3)

No. 121, May 14, 1751 (pp. 89–90)

Edward Earle. Philadelphia, Pennsylvania, USA. 1812

**Jones, Rufus M.** 1863–1948

American writer and journal editor

Science has not closed, and will never close the soul's east window of divine surprise.

*A Preface to Christian Faith in a New Age*

Chapter II, Section IV (pp. 55–56)

The Macmillan Company. New York, New York, USA. 1932

**Jones, Steve**

No biographical data available

This is the essence of science. Even though I do not understand quantum mechanics or the nerve cell membrane, I trust those who do. Most scientists are quite ignorant about most sciences but all use a shared grammar that allows them to recognize their craft when they see it. The motto of the Royal Society of London is “*Nul-lius in verba*”: trust not in words.

Review of *How the Mind Works* by Steve Pinker  
*The New York Review of Books*, November 6, 1997 (p. 13)

**Jordan, David Starr** 1851–1931  
American scientist and educator

Science must stop where the facts stop, or thereabout, the limit of “thereabout” covering all legitimate diversions and excursions of philosophy.

In Frances Mason  
*Creation by Evolution*  
Evolution — Its Meaning (p. 4)  
The Macmillan Company. New York, New York, USA. 1928

**Jung, Carl G.** 1875–1961  
Swiss psychiatrist and founder of analytical psychology

Science is the tool of the Western mind... It is part and parcel of our understanding, and it obscures our insight only when it claims that the understanding it conveys is the only kind there is.

Translated by R.F.C. Hull  
*Alchemical Studies*  
Difficulties Encountered by a European in Trying to Understand the East (pp. 6–7)  
Princeton University Press. Princeton, New Jersey, USA. 1967

Science is not indeed a perfect instrument, but it is a superb and invaluable tool that works harm only when it is taken as an end in itself.

Translated by R.F.C. Hull  
*Alchemical Studies*  
Difficulties Encountered by a European in Trying to Understand the East (p. 6)  
Princeton University Press. Princeton, New Jersey, USA. 1967

**Kaczynski, Theodore** 1942–  
American anarchist

Science marches on blindly...without regard to the real welfare of the human race or to any other standard, obedient only to the psychological needs of the scientists and of the government officials and corporate executives who provide the funds for research.

In Anne Eisenberg  
The Unabomber and the Bland Decade  
*Scientific American*, Volume 274, Number 4, April, 1998 (p. 35)

**Kafka, Franz** 1883–1924  
German-language novelist

All science is methodology with regard to the Absolute. Therefore, there need be no fear of the unequivocally methodological. It is a husk, but not more than everything except the One.

*Dearest Father: Stories and Other Writings*  
The Blue Octavo Notebooks  
The Third Notebook  
October 18, 1917

**Kapitza, Pyetr Leonidovich** 1894–1984  
Russian physicist

The year that Rutherford died there disappeared for ever the happy days of free scientific work which gave us such delight in our youth. Science has lost her freedom. Science has become a productive force. She has become rich but she has become enslaved and part of her is veiled in secrecy.

Address to the Royal Society in Honour of Lord Rutherford  
*Nature*, Volume 210, Number 5038, 17 May 1966 (p. 783)

**Keller, Evelyn Fox** 1936–  
American scientist

To know the history of science is to recognize the mortality of any claim to universal truth.

*Reflections on Gender and Science*  
Epilogue (pp. 178–179)  
Yale University Press. New Haven, Connecticut, USA. 1985

A healthy science is one that allows for the productive survival of diverse conceptions of mind and nature and correspondingly diverse strategies.

*Reflections on Gender and Science*  
Epilogue (p. 178)  
Yale University Press. New Haven, Connecticut, USA. 1985

**Keller, Helen** 1880–1968  
American author and lecturer

Science may have found a cure for most evils; but it has found no remedy for the worst of them all — the apathy of human beings.

*My Religion*  
Part 1, Chapter 6  
Swedenborg & Foundation, Inc. New York, New York, USA. 1927

**Kellogg, Vernon L.** 1867–1937  
American zoologist

Science does not assume that it knows — despite the great deal that it does know — more than a very small part of the order of nature.

Some Things Science Doesn't Know  
*The World's Work*, March 1926 (p. 528)

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Science is bound by the everlasting law of honour, to face fearlessly every problem which can fairly be presented to it. If a probable solution, consistent with the ordinary course of nature, can be found, we must not involve the abnormal act of Creative Power.

*Popular Lectures and Addresses* (Volume 2)

Presidential Address to the British Association, Edinburgh, 1871  
(pp. 199–200)  
Macmillan & Company Ltd. London, England. 1894

**Kennedy, John F.** 1917–63  
35<sup>th</sup> president of the United States

Science contributes to our culture in many ways, as a creative intellectual activity in its own right, as the light which has served to illuminate man's place in the universe, and as the source of understanding of man's own nature.

Address to the National Academy of Sciences  
Washington, D.C., 22 October, 1963

Let both sides seek to invoke the wonders of science instead of its terrors. Together let us explore the stars, conquer the deserts, eradicate disease, tap the ocean depths and encourage the arts and commerce.  
Inaugural Address, January 20, 1961

In the years since man unlocked the power stored up within the atom, the world has made progress, halting but effective, toward bringing that power under human control. The challenge may be our salvation. As we begin to master the destructive potentialities of modern science, we move toward a new era in which science can fulfill its creative promise and help bring into existence the happiest society the world has ever known.

Address  
National Academy of Sciences  
Washington, D.C., October 22, 1963

**Kettering, Charles Franklin** 1876–1958  
American engineer and inventor

So that we might kill one another more expertly, science found wonderful ways to live more comfortably, richly, to communicate more rapidly. So that we might exterminate one another more successfully, science showed us how we might all live longer and stronger...

In Paul de Kruif  
America Comes Through a Crisis  
*Saturday Evening Post*, 13 May 1933 (p. 3)

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

Science is destined to appear as the child and the parent of freedom blessing the earth without design. Not in the ground of need, not in bent and painful toil, but in the deep-centered play-instinct of the world, in the joyous mood of the eternal Being, her spirit, which is always young, Science has her origin and root; and her spirit, which is the spirit of genius in moments of elevation, is but a sublimated form of play, the austere and lofty analogue of the kitten playing with the entangled skein...

*Mathematics* (p. 44)  
Columbia University Press. New York, New York, USA. 1907

**King, Jr., Martin Luther** 1929–68  
American civil rights leader and clergyman

We have genuflected before the god of science only to find that it has given us the atomic bomb, producing fears and anxieties that science can never mitigate.

*Strength to Love*  
Chapter XIII (p. 106)  
Harper & Row, Publishers. New York, New York, USA. 1963

**Kingsley, Charles** 1819–75  
English clergyman and author

For science is, I verily believe, like virtue, its own exceeding great reward.

*Health and Education*  
Science (p. 289)  
W. Isbister & Company. London, England. 1874

For from blind fear of the unknown, science does certainly deliver man. She does by man as he does by an unbroken colt. The colt sees by the road side some quite new object — a cast-away boot, an old kettle, or what not. What a fearful monster! What unknown terrific powers may it not possess! And the colt shies across the road, runs up the bank, rears on end; putting itself thereby, as many a man does, in real danger. What cure is there? But one, experience. So science takes us, as we should take the colt, gently by the halter; and makes us simply smell at the new monster; till after a few trembling sniffs, we discover, like the colt, that it is not a monster, but a kettle.

*Health and Education*  
Science (p. 284)  
W. Isbister & Company London, England. 1874

...it is the childlike, simple, patient, reverent heart, which science at once demands and cultivates. To prejudice or haste, to self-conceit or ambition, she proudly shuts her treasuries — to open them to men of humble heart, whom this world thinks simple dreamers — her Newtons, and Owens, and Faradays.

*Alton Locke, Taylor and Poet*  
Chapter XVIII (p. 141)  
Macmillan & Company Ltd. London, England. 1911

...Science was the child of Courage, and Courage the child of Knowledge.

*Health and Education*  
Science (p. 259)  
W. Isbister & Company London, England. 1874

**Kipling, Rudyard** 1865–1936  
British writer and poet

There are times when Science does not satisfy.

*With the Night Mail* (p. 24)  
Doubleday, Page & Company. New York, New York, USA. 1909

**Kirby, William** 1759–1850  
Clergyman and entomologist

Mankind in general, not excepting even philosophers, are prone to magnify, often beyond its just merit, the science or pursuit to which they have addicted themselves, and to depreciate any that seems to stand in competition with their favorite: like the redoubted champions of romance, each thinks himself bound to take the field against every one that will not subscribe to the peerless beauty and accomplishments of his own Dulcinea.

*An Introduction to Entomology; or, Elements of the Natural History of Insects*

Letter I (p. 1)

Longman, Green, Longman & Roberts. London, England. 1860

### **Kirkpatrick, Clifford** 1898–1970

American sociologist

Science recognizes no personal powers in the universe responsive to the prayers and needs of men.

*Religion in Human Affairs*

Chapter XVI (p. 470)

John Wiley & Sons, Inc. New York, New York, USA. 1929

### **Kline, Morris** 1908–92

American mathematics professor and writer

Theoretical Science is a game of mathematical make-believe.

*Mathematics: The Loss of Certainty*

Chapter XIV (p. 325)

Oxford University Press, Inc. New York, New York, USA. 1980

### **Kliuchevsky, V. O.** 1841–1911

Russian historian

Science is often identified with knowledge. This is a gross misunderstanding. Science is not merely knowledge, but also consciousness, that is, the skill of properly using knowledge.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

### **Knight, David**

No biographical data available

Most science is a very ordinary human activity not so very far removed from painting by numbers.

*Ideas in Chemistry: A History of the Science*

Introduction (p. 6)

Athlone. London, England. 1992

### **Knuth, Donald E.** 1938–

Creator of TeX

Science is what we understand well enough to explain to a computer, Art is all the rest.

In Marko Petkovsek, Herbert S. Wilf and Doron Zeilberger

*A=B*

Foreword

A.K. Peters. Wellesley, Massachusetts, USA. 1996

### **Kofahl, R. E.**

No biographical data available

Science is human experience systematically extended (by intent, methodology and instrumentation) for the purpose of learning more about the natural world and for the critical empirical testing and possible falsification of all ideas about the natural world. Scientific hypotheses may incorporate only elements of the natural empirical world, and thus may contain no element of the supernatural.

Correctly Redefining Distorted Science: A Most Essential Task

*Creation Research Society Quarterly*, Volume 23, 1986 (p. 112)

### **Köhler, Wolfgang** 1887–1967

American psychologist

It would be interesting to inquire how many times essential advances in science have first been made possible by the fact that the boundaries of special disciplines are not respected. ...at the present time it is of course quite customary for physicists to trespass on chemical ground, for mathematicians to do excellent work in physics, and for physicists to develop new mathematical procedures...trespassing is one of the most successful techniques in science.

*Dynamics in Psychology*

Retention and Recall (pp. 115–116)

Liveright Publishing Corporation. New York, New York, USA. 1940

### **Kolb, Edward W. (Rocky)** 1951–

American cosmologist

Science does not proceed like a cookbook recipe in the making of a hypothesis, comparing its prediction with observations and either accepting or rejecting the hypothesis. There is always confusion at the leading edge of research, and there are always a few discrepant and contradictory pieces of information that can't be explained.

*Blind Watchers of the Sky*

Chapter Seven (pp. 193–194)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

The process of science involves heroic ideas as well as its share of stupidity.

*Blind Watchers of the Sky*

Preface (p. x)

Addison-Wesley Publishing Company. Reading, Massachusetts,

USA. 1996

More often than not, the way science goes from point A to point B is by a random lurch through points X, Y, and Z. Even when great leaps of progress do occur, they only rarely come “out of the blue.” Advances are nearly always preceded by years, decades, or even centuries of patient accumulation of facts and data and ideas.

*Blind Watchers of the Sky*

Chapter Two (p. 25)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Koshland, Jr., Daniel E.** 1920–  
American biochemist

Science is not impressed with a conglomeration of data. It likes carefully constructed analysis of each problem.

Editorial

*Science*, Volume 263, Number 5144, 14 January 1994 (p. 155)

**Krauss, Lawrence M.** 1954–  
American theoretical physicist

There are times, such as when the state school board in Kansas in 1999 removed evolution from its science curriculum, when I am reminded of Lavoisier, and shudder at the damage that can be done by ignorance combined with power. Even the magnificent modern edifice called science, built up over half a millennium of small increments toward the truth, is not safe from the vicissitudes of the political world. If, as Carl Sagan claimed, science is a “candle in the dark,” banishing demons that haunted the benighted eras of mankind, it burns tenuously at best. One generation of ignorance, steeped in myth and mysticism, is all that may be needed to snuff it out.

*Atom: An Odyssey from the Big Bang to Life on Earth...and Beyond*  
Chapter 13 (p. 172)

Little, Brown & Company. Boston, Massachusetts, USA. 2001

Science is based on limits: It proceeds by progressively finding out what is not possible, through experiment and theory, in order to determine how the universe might really function. It is worth recalling Sherlock Holmes’s adage that when you have eliminated all other possibilities, whatever remains, no matter how improbable, is the truth. Because of this, the universe is a pretty remarkable place even without all the extras. The greatest gift science has bestowed upon humanity, in my opinion, is the knowledge that whether we like it or not, the universe is the way it is.

*Beyond Star Trek: Physics from Alien Invasions to the End of Time*  
Epilogue (p. 173)

Basic Books, Inc. New York, New York, USA. 1997

**Kroeber, Alfred Louis** 1876–1960  
American anthropologist

...it appears that the total work of science must be done on a series of levels which the experience of science gradually discovers.

*The Nature of Culture* (p. 121)

The University of Chicago Press. Chicago, Illinois, USA. 1952

Science has always promised two things not necessarily related — an increase first in our powers, second in our happiness or wisdom, and we have come to realize that it is the first and less important of the two promises which it has kept most abundantly.

*The Modern Temper*

Chapter Three (p. 43)

Harcourt, Brace & Company. New York, New York, USA. 1929

...the most important part of our lives — our sensations, emotions, desires, and aspirations — takes place in a universe of illusions which science can attenuate or destroy, but which it is powerless to enrich.

*The Modern Temper*

Chapter Three (p. 50)

Harcourt, Brace & Company. New York, New York, USA. 1929

**Kubie, L. S.**  
No biographical data available

The primary achievement of science is the humility and honesty with which it constantly corrects its own errors. It is this that makes science the greatest of the humanities.

*The Fostering of Creative Scientific Productivity*

*Daedalus*, Volume 91, 1962 (p. 305)

**Kuhn, Thomas S.** 1922–96  
American historian of science

To understand why science develops as it does, one need not unravel the details of biography and personality that lead each individual to a particular choice, though that topic has vast fascination. What one must understand, however, is the manner in which a particular set of shared values interacts with the particular experiences shared by a community of specialists to ensure that most members of the group will ultimately find one set of arguments rather than another decisive.

*The Structure of Scientific Revolutions*

Postscript–1969 (p. 200)

The University of Chicago Press. Chicago, Illinois, USA. 1970

Normal science...is predicated on the assumption that the scientific community knows what the world is like. Much of the success of the enterprise derives from the community’s willingness to defend that assumption, if necessary at considerable cost.

*The Structure of Scientific Revolutions*

Chapter I (p. 5)

The University of Chicago Press. Chicago, Illinois, USA. 1970

The practice of normal science depends on the ability, acquired from exemplars, to group objects and situations into similarity sets which are primitive in the sense that the grouping is done without an answer to the question, “similar with respect to what?”

*The Structure of Scientific Revolutions*

Postscript–1969 (p. 200)

The University of Chicago Press. Chicago, Illinois, USA. 1970

...science...often suppresses fundamental novelties because they are necessarily subversive of its basic commitments.

*The Structure of Scientific Revolutions*

Chapter I (p. 5)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Kusch, Polykarp** 1911–93  
German-American physicist

Science is the greatest creative impulse of our time. It dominates the intellectual scene and forms our lives, not only in the material things which it has given us, but also in that it guides our spirit. Science shows us truth and beauty and fills each day with a fresh wonder of the exquisite order which governs our world.

Address to University Students  
December 10, 1955

**Lamb, Charles** 1775–1834

English essayist and critic

Science has succeeded to poetry, no less in the little walks of children than with men. Is there no possibility of averting this sore evil?

In Thoas Noon Talfourd

*The Works of Charles Lamb: To which are Prefixed His Letters, and a Sketch of His Life* (Volume 1)

Letter to S.T. Coleridge, October 23, 1802 (p. 118)

Harper & Brothers, Publishers. New York, New York, USA. 1838

Can we unlearn the arts that pretend to civilize, and then burn the world? There is a march of science; but who shall beat the drums for its retreat?

In Thoas Noon Talfourd

*The Works of Charles Lamb: To which are Prefixed His Letters, and a Sketch of His Life* (Volume 1)

Letter to George Dyer, December 20, 1830 (p. 292)

Harper & Brothers, Publishers. New York, New York, USA. 1838

In everything that relates to science, I am a whole Encyclopaedia behind the rest of the world.

*Essays of Elia*

The Old and the New Schoolmaster (p. 88)

Little, Brown & Company. Boston, Massachusetts. USA. 1896

**Landsberg, Peter Theodore** 1922–

No biographical data available

Everybody who takes up science has the ambition to become a successful scientist and make some discoveries. Most of us are disappointed because we do not make the really big and interesting discoveries. Or, if we do make them, we do not realize they are interesting, because other discoveries seem more important.

*Mathematics Today*, October 1902 (p. 135)

**Lang, Andrew** 1844–1912

Scottish scholar and man of letters

But science, like the spear of Achilles, can cure the wounds which herself inflicts.

*The Disentanglers*

Adventure of the Canadian Heiress (p. 399)

Longmans, Green Publishers. New York, New York, USA. 1902

**Lapp, Ralph E.** 1917–2004

American nuclear physicist

No one — not even the most brilliant scientist alive today — really knows where science is taking us. We are aboard a train which is gathering speed, racing down

a track on which are an unknown number of switches leading to unknown destinations. No single scientist is in the cab, and there may be demons at the switch. Most of society is in the caboose looking backward. Some passengers, fearful that they have boarded an express train to hell, want to jump off before it is too late

*The New Priesthood: The Scientific Elite and the Uses of Power*

Chapter 2 (p. 29)

Harper & Row, Publishers. New York, New York, USA. 1965

**Larrabee, Eric** 1922–90

Historian

Science is a — what? a method, a faith, a body of facts, a structure of theories, an institution, a way of life, a finite number of duly qualified individuals, an infinity of relevance and possibility. For a large number of scientists, science is indescribable, but indisputably a thing: it is knowable, palpable, reliable, usable. They live with it and by it; it is simply and unequivocally there.

Commentary

*Science and the Common Reader*, June 1966 (p. 43)

**Laudan, Larry** 1945–

American philosopher of science

The aim of science is merely to secure theories with a high problem-solving effectiveness.

*New Scientist*, 1 August 1892 (p. 26)

**Lavoisier, Antoine Laurent** 1743–94

French chemist

When we begin the study of any science, we are in a situation, respecting that science, similar to that of children; and the course by which we have to advance is precisely the same which nature follow in the formation of their ideas.

In *Great Books of the Western World* (Volume 45)

*Elements of Chemistry*

Preface (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Science still has many chasms, which interrupt the series of facts and often render it extremely difficult to reconcile them with each other...

In *Great Books of the Western World* (Volume 45)

*Elements of Chemistry*

Preface (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Le Guin, Ursula K.** 1929–

American writer of science fiction and fantasy

...it is only when science asks why, instead of simply describing how, that it becomes more than technology. When it asks why, it discovers Relativity. When it only shows how, it invents the atomic bomb and then puts its hands over its eyes and says, My God what have I done?...

*Language of the Night*

The Stalin in the Soul (p. 219)  
Putnam. New York, New York, USA. 1979

**Leary, Timothy** 1920–96  
American psychologist and educator

Science is all metaphor.  
*Contemporary Authors*, Volume 107

**Lebowitz, Fran** 1951–  
American comedian

Science is not a pretty thing. It is unpleasantly proportioned, outlandishly attired and often over-eager. What then is the appeal of science? What accounts for its popularity? And who gives it its start?

*Metropolitan Life*  
Science (p. 104)  
Fawcett Crest. New York, New York, USA. 1978

...modern science was largely conceived of as an answer to the servant problem and...is generally practiced by those who lack the flair for conversation.

*Metropolitan Life*  
Science (p. 104)  
Fawcett Crest. New York, New York, USA. 1978

**Leclerc, Georges-Louis, Comte de Buffon** 1707–88  
French naturalist

The only good science is the knowledge of facts, and mathematical truths are only truths of definition, and completely arbitrary, quite unlike physical truths.

In L. Ducros  
*Les Encyclopedistes* (p. 326)  
Publisher undetermined

**Lerner, Max** 1902–92  
American educator and author

It is not science that has destroyed the world, despite all the gloomy forebodings of the earlier prophets. It is man who has destroyed man.

*Actions and Passions: Notes on the Multiple Revolution of Our Time*  
The Human Heart and Human Will (p. 3)  
Simon & Schuster. New York, New York, USA. 1949

**Lewis, Gilbert Newton** 1875–1946  
American chemist

The strength of science lies in its naiveté.  
*The Anatomy of Science*  
Chapter I (p. 1)  
Yale University Press. New Haven, Connecticut, USA. 1926

**Lewis, Wyndham** 1882–1957  
English author and painter

When we say “science” we can either mean any manipulation of the inventive and organizing power of the human intellect: or we can mean such an extremely

different thing as the religion of science, the vulgarized derivative from this pure activity manipulated by a sort of priestcraft into a great religious and political weapon.

*The Art of Being Ruled*  
Revolution and Progress, Chapter 1 (pp. 3–4)  
Chatto & Windus. London, England. 1926

The puritanic potentialities of science have never been forecast. If it evolves a body of organized rites, and is established as a religion, hierarchically organized, things more than anything else will be done in the name of “decency.” The coarse fumes of tobacco and liquors, the consequent tainting of the breath and staining of white fingers and teeth, which is so offensive to many women, will be the first things attended to.

*The Art of Being Ruled*  
Chapter 7 (p. 210)  
Chatto & Windus. London, England. 1926

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

There is no greater impediment to progress in the sciences than the desire to see it take place too quickly.

Translated by R.J. Hollingdale  
*Aphorisms*  
Notebook K, Aphorism 72  
Penguin Classics. New York, New York, USA. 1990

The most heated defenders of a science, who can not endure the slightest sneer at it, are commonly those who have not made very much progress in it and are secretly aware of this defect.

Translated by R.J. Hollingdale  
*Aphorisms*  
Notebook F, aphorism 8  
Penguin Classics. New York, New York, USA. 1990

**Lindley, David** 1956–  
English astrophysicist and author

When scientists begin to wonder...how science is possible at all, which is ultimately what their questioning of the mathematical basis of science is about, they are searching for reassurance, for some proof that there really is a fundamental theory out there in the dark waiting to be hunted down.

*The End of Physics: The Myth of a Unified Theory*  
Prologue (p. 4)  
Basic Books, Inc. New York, New York, USA. 1993

**Locke, John** 1632–1704  
English philosopher and political theorist

Nobody is under an obligation to know every thing. Knowledge and science in general is the business only of those who are at ease and leisure.

*An Essay Concerning Human Understanding and a Treatise on the Conduct of the Understanding*  
A Treatise on the Conduct of the Understanding



Section 7 (p. 494)

James Kay, June & Company. Philadelphia, Pennsylvania, USA. ca.1850

**Lorenz, Konrad** 1903–89  
Austrian zoologist

Truth, in science, can be defined as the working hypothesis best fitted to open the way to the next better one.

Translated by Marjorie Kerr Wilson

*On Aggression*

Chapter Fourteen (p. 288)

Harcourt, Brace & World, Inc. New York, New York, USA. 1963

**Lowell, Percival** 1855–1916  
American astronomer

Now in science there exists two classes of workers. There are men who spend their days in amassing material, in gathering facts. They are the collectors of specimens in natural history, the industrious takers of routine measurements in physics and astronomy or the mechanical accumulators of photographic plates. Very valuable such collections are. They may not require much brains to get, but they enable other brains to get a great deal out of them later.... The rarer they are the better. For the less mind enters into them the more they are worth. When destitute altogether of informing intelligence, they become priceless, as they then convey nature's meaning unmeddled of man.... The second class of scientists are the architects of the profession. They are the men to whom the building up of science is due. In their hands, the acquired facts are put together to that synthesizing of knowledge from which new conceptions spring.... Though the gathering of material is good, without the informing mind to combine the facts they had forever remained barren of fruit.

In William Graves Hoyt

*Lowell and Mars*

Chapter 2 (p. 22)

University of Arizona Press. Tucson, Arizona, USA. 1976

**Lubbock, Sir John** 1834–1913  
English banker, author, and scientist

Science, our Fairy Godmother, will, unless we perversely reject her help, and refuse her gifts, so richly endow us, that fewer hours of labour will serve to supply us with the material necessities of life, leaving us more time to ourselves, more leisure to enjoy all that makes life best worth living.

*The Beauties of Nature and the Wonders of the World We Live In*

Introduction (p. 37)

Macmillan & Company New York, New York, USA. 1893

**Lundberg, G. A.**  
No biographical data available

...no science tells us what to do with the knowledge that constitutes the science. Science only provides a car and a chauffeur for us. It does not directly, as science, tell us where to drive. The car and the chauffeur will take us into the ditch,

over the precipice, against a stone wall, or into the highlands of age-long human aspirations with equal efficiency. If we agree as to where we want to go and tell the driver our goal, he should be able to take us there by one of a number of possible routes the costs and conditions of each of which the scientist should be able to explain to us.

*Can Science Save Us?*

Social Problems (p. 31)

Longmans, Green & Company New York, New York, USA. 1947

**Lynch, Gary**  
No biographical data available

What you really need to do the best science is a tremendous tolerance for ambiguity. You have to be able to tolerate ambiguity. Because we as creatures are set up for some reason to see cause-and-effect. And what you really wind up doing is tolerating the fact that you have all these assumptions and all these uncertainties, and living with them. And when you really go into a novel area, what do you have to guide you? The more novel it is, the fewer the constraints. For a human being that is a very uncomfortable feeling.

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*

Mucking Around in the Wetware (pp. 91–92)

Alfred A. Knopf. New York, New York, USA. 1991

**Lysaght, Sidney R.** 1860–1941  
Irish writer

Science is the lamp which man has himself kindled. It has built him lighthouses on the dark shores of the unknown; but his dreams, his quests for truth, lead him beyond the waters which his little lamp of knowledge illuminates.

*A Reading of Life*

Chapter II (p. 54)

Macmillan & Company Ltd. London, England. 1936

**Lyttleton, R. A.**  
English astronomer

...many very serious-minded, solid, and knowledgeable people work hard in science all their lives and produce nothing of the smallest importance, while others, few by comparison and perhaps seemingly carefree and not highly erudite, exhibit a serendipity of mind that enables them to have valuable ideas in any subject they may choose to take up.

In R. Duncan and M. Weston-Smith (eds.)

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know*

*About the Unknown*

The Nature of Knowledge (p. 10)

Pergamon Press. Oxford, England. 1977

**MacArthur, Robert H.** 1930–72  
American ecologist

[N]ot all naturalists want to do science; many take refuge in nature's complexity as a justification to oppose any

search for patterns... Doing science is not such a barrier to feeling or such a dehumanizing influence as is often made out. It does not take the beauty from nature.

*Geographical Ecology*

Introduction (p. 1)

Harper & Row, Publishers, New York, New York, USA. 1972

**Macfie, Ronald Campbell** 1867–1931

Poet and physician

The God of Science speaks in the thunder and smiles in the sunshine. He is so great that the stars eddy round his feet not ankle-high, yet so loving that He makes roses and sunsets for the human heart.

*Science, Matter and Immortality*

Chapter XVII (p. 207)

William & Norgate. London, England. 1909

Conceived aright, science must always lead to belief in the unseen and to hope of immortality; but Science must learn to recognize her own limitations — must learn to recognize that her logic is not conclusive when her postulates are dubious — and that she can only become a ruler of men's souls and a brightener of men's lives if she takes Poetry and Philosophy by the hand, and dwells with them in the temple of Beauty and Reverence.

*Science, Matter and Immortality*

Chapter XXIII (p. 300)

William & Norgate. London, England. 1909

It is time that men knew that Science does not write with the cold finger of a starfish; it is time that men realized that true science is not a mere compilation of dead facts; it is time that men understood that Science is flamboyant and alive.

*Science, Matter and Immortality*

Chapter XXIII (p. 297)

William & Norgate. London, England. 1909

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

All science has its origin in the needs of life.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter V, Part II, Section 1 (p. 610)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Every one who busies himself with science recognizes how unsettled and indefinite the notions are which he has brought with him from common life, and how, on a minute examination of things, old differences are effaced and new ones introduced.

*Popular Scientific Lectures*

The Forms of Liquids (pp. 1–2)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

...the entire course of the development of science will, as a matter of course, judge more freely and more correctly of the significance of any present scientific movement than they who, limited in their views to the age in which their own lives have been spent, contemplate merely the

momentary trend that the course of intellectual events takes at the present moment.

*The Science of Mechanics* (5<sup>th</sup> edition)

Introduction (p. 8)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

The great results achieved by physical science in modern times — results not restricted to its own sphere but embracing that of other sciences which employ its help — have brought it about that physical ways of thinking and physical modes of procedure enjoy on all hands unwonted prominence, and that the greatest expectations are associated with their application.

*The Analysis of Sensations and the Relation of the Physical to the Psychological*

Chapter I (p. 1)

The Open Court Publishing Company. Chicago, Illinois, USA. 1914

The function of science, as we take it, is to replace experience. Thus, on the one hand, science must remain in the province of experience, but, on the other, must hasten beyond it, constantly expecting confirmation, constantly expecting the reverse. Where neither confirmation nor refutation is possible, science is not concerned...

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter IV, Part IV, Section 7 (p. 587)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Physical science does not pretend to be a complete view of the world; it simply claims that it is working toward such a complete view in the future.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter IV, Part II, Section 9 (p. 560)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Science always has its origin in the adaptation of thought to some definite field of experience.

*The Analysis of Sensations and the Relation of the Physical to the Psychological*

Chapter I (p. 31)

The Open Court Publishing Company. Chicago, Illinois, USA. 1914

Science throws her treasures, not like a capricious fairy into the laps of a favored few, but into the laps of all humanity, with a lavish extravagance that no legend ever dreamt of!

*Popular Scientific Lectures*

The Economical Nature of Physical Inquiry (p. 189)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

Economy of communication and of apprehension is of the very essence of science. Herein lies its pacificatory, its enlightening, its refining element.

*The Science of Mechanics* (5<sup>th</sup> edition)

Introduction (p. 7)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Is science itself anything more than — a business? Is not its task to acquire with the least possible work, in the least possible time, with the least possible thoughts, the greatest possible part of eternal truth?

*Popular Scientific Lectures*

The Forms of Liquids (p. 16)

The Open Court Publishing Company, Chicago, Illinois, USA. 1898

**Maffei, Paolo** 1926–  
Italian astronomer

We are now moving beyond those concepts and the knowledge familiar to us in the first half of this century, and we are entering a world in which science and fantasy intertwine...

Translated by D.J.K. O'Connell

*Beyond the Moon*

Chapter 10 (p. 301)

The MIT Press, Cambridge, Massachusetts, USA. 1978

**Magendie, Francois** 1783–1855  
French physiologist

I am a mere street scavenger of science. With hook in hand and basket on my back, I go about the streets of science collecting whatever I find.

In Rene Dubos

*Louis Pasteur: Free Lance of Science*

Chapter XIII (p. 363)

Little, Brown &amp; Company, Boston, Massachusetts, USA. 1950

**Mandelbrot, Benoit** 1924–  
French mathematician

I started looking in the trash cans of science...because I suspected that what I was observing was...perhaps very widespread. I attended lectures and looked in unfashionable periodicals...once in a while finding some interesting things. In a way it was a naturalist's approach, not a theoretician's approach. But my gamble paid off.

In James Gleick

*Chaos: Making a New Science*

A Geometry of Nature (p. 110)

The Viking Press, New York, New York, USA. 1987

**Mara Corday**  
Fictional character

Science is science, but a girl must get her hair done.

*Tarantula*

Film (1955)

**March, Robert H.** 1937–  
American professor of physics

Science is more than a mere attempt to describe nature as accurately as possible. Frequently the real message is well hidden, and a law that gives a poor approximation to nature has more significance than one which works fairly well but is poisoned at the root.

*Physics for Poets*

Chapter I (p. 17)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1996

**Margenau, Henry** 1901–97  
American physicist

It is in fact obvious that science should be pressed to say all it can about any problem which is at all susceptible to scientific treatment.

*The Nature of Physical Reality: A Philosophy of Modern Physics*

Chapter 2 (p. 12)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Margulis, Lynn** 1938–  
American cell biologist and evolutionist**Sagan, Dorion** 1959–

American science writer

Science has become a social method of inquiring into natural phenomena, making intuitive and systematic explorations of laws which are formulated by observing nature, and then rigorously testing their accuracy in the form of predictions. The results are then stored as written or mathematical records which are copied and disseminated to others, both within and beyond any given generation. As a sort of synergetic, rigorously regulated group perception, the collective enterprise of science far transcends the activity within an individual brain.

*Microcosmos*

Chapter 12 (p. 233)

Summit Books, New York, New York, USA. 1986

**Maritain, Jacques** 1882–1973  
French philosopher

Since science's competence extends to observable and measurable phenomena, not to the inner being of things, and to the means, not to the ends of human life, it would be nonsense to expect that the progress of science will provide men with a new type of metaphysics, ethics, or religion.

Science and Ontology

*Bulletin of the Atomic Scientists*, 1944, Volume 5 (p. 200)**Marshall, Alfred** 1842–1924  
English economist

...the mathematico-physical group of sciences...have this point in common, that their subject-matter is constant and unchanged in all countries and in all ages. ...if the subject-matter of a science passes through different stages of development, the laws which apply to one stage will seldom apply without modification to others; the laws of science must have a development corresponding to that of the things of which they treat.

In A.C. Pigou (ed.)

*Memorials of Alfred Marshall*

Chapter VI (p. 154)

Macmillan &amp; Company Ltd. London, England. 1925

**Mason, James** 1909–84  
English actor

Don't you see what's at stake here? The ultimate aim of all science — to penetrate the unknown. Do you realize we know less about the earth we live on than about

the stars and the galaxies of outer space? The greatest mystery is right here, right under our feet.

*A Journey to the Center of the Earth*  
Film (1959)

**Matsen, F. Albert**

No biographical data available

Science is defined as a set of observations and theories about observations.

The Role of Theory in Chemistry  
*Journal of Chemical Education*, Volume 62, Number 5, May 1985  
(p. 365)

**Maxwell, James Clerk** 1831–79

Scottish physicist

It was a great step in science when men became convinced that, in order to understand the nature of things, they must begin by asking, not whether a thing is good or bad, noxious or beneficial, but of what kind it is? and how much is there of it? Quality and Quantity were then first recognized as the primary features to be observed in scientific inquiry.

In William H. George  
*The Scientist in Action: A Scientific Study of His Methods*  
British Association Address, 1870 (p. 15)  
Williams & Norgate Ltd. London, England. 1936

**McCarthy, Mary** 1912–89

American writer

Modern neurosis began with the discoveries of Copernicus. Science made man feel small by showing him that the earth was not the center of the universe.

*On the Contrary*  
Tyranny of the Orgasm (p. 168)  
Farrar, Straus & Cudahy, New York, New York, USA, 1961

**McLuhan, Marshall** 1911–80

Canadian educator, philosopher, and scholar

Current illusion is that science has abolished all natural laws.

In Mattie Molinaro, Corinne McLuhan, and William Toye (eds.)  
*Letters of Marshall McLuhan*  
Letter to Ezra Pound  
January 1951  
Oxford University Press, Inc. New York, New York, USA. 1987

**Mead, Margaret** 1901–78

American anthropologist

...the negative cautions of science are never popular. If the experimentalist would not commit himself, the social philosopher, the preacher and the pedagogue tried the harder to give a short-cut answer.

*Coming of Age in Samoa*  
Chapter 1 (p. 3)  
The Modern Library. New York, New York, USA. 1953

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Science is no more a classified inventory of factual information than history a chronology of dates. The equation of science with facts and of the humane arts with ideas is one of the shabby genteelisms that bolster up the humanist's self-esteem.

Two Conceptions of Science  
*Encounter*, 143, August 1965

Science can only proceed on a basis of confidence, so that scientists do not suspect each other of dishonesty or sharp practice, and believe each other unless there is very good reason to do otherwise.

*The Limits of Science*  
An Essay on Scians [Science] (p. 6)  
Harper & Row, Publishers. New York, New York, USA. 1984

Science will persevere just as long as we retain a faculty we show no signs of losing: the ability to conceive — in no matter how imperfect or rudimentary a form — what the truth might be and retain also the inclination to ascertain whether our imaginings correspond to real life or not.

*The Limits of Science*  
Chapter 4 (pp. 86–87)  
Harper & Row, Publishers. New York, New York, USA. 1984

It is a layman's illusion that in science we caper from pinnacle to pinnacle of achievement and that we exercise a Method which preserves us from error. Indeed we do not; our way of going about things takes it for granted that we guess less often right than wrong, but at the same time ensures that we need not persist in error if we earnestly and honestly endeavor not to do so.

*The Limits of Science*  
Notes, 3 (p. 101)  
Harper & Row, Publishers. New York, New York, USA. 1984

...science is a great and glorious enterprise — the most successful, I argue, that human beings have ever engaged in. To reproach it for its inability to answer all the questions we should like to put to it is no more sensible than to reproach a railway locomotive for not flying or, in general, not performing any other operation for which it was not designed.

*The Limits of Science*  
Preface (p. xiii)  
Harper & Row, Publishers. New York, New York, USA. 1984

If we accept, as I fear we must, that science cannot answer questions about first and last things or about purposes, there is yet no known or conceivable limit to its power to answer questions of the kind science can answer... Science will dry up only if scientists lose or fail to exercise the power or incentive to imagine what the truth might be.

*Advice to a Young Scientist*  
Chapter 11 (p. 90)  
Basic Books, Inc. New York, New York, USA. 1979

...the factual burden of a science varies inversely with its degree of maturity. As a science advances, particular

facts are comprehended within, and therefore in a sense annihilated by, general statements of steadily increasing explanatory powers and compass. In all sciences we are being progressively relieved of the burden of singular instances, the tyranny of the particular. We need no longer record the fall of every apple.

*The Art of the Soluble*

Two Conceptions of Science (p. 114)

Methuen & Company Ltd. London, England. 1967

...nowadays we all give too much thought to the material blessings or evils that science has brought with it, and too little to its power to liberate us from the confinements of ignorance and superstition. The greatest liberation of thought achieved by the scientific revolution was to have given human beings a sense of future in this world.

*The Art of the Soluble*

Introduction (p. 15)

Methuen & Company Ltd. London, England. 1967

One can envisage an end of science no more readily than one can envisage an end of imaginative literature or the fine arts.

*Advice to a Young Scientist*

Chapter 11 (p. 90)

Basic Books, Inc. New York, New York, USA. 1979

### **Melville, Herman** 1819–91

American novelist

...however baby man may brag of his science and skill, and however much, in a flattering future, that science and skill may augment; yet for ever and for ever, to the crack of doom, the sea will insult and murder him, and pulverize the stateliest, stiffest frigate he can make; nevertheless, by the continual repetition of these very impressions, man has lost that sense of the full awfulness of the sea which aboriginally belongs to it.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 58 (p. 204)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

After science comes sentiment.

*Typee, Omoo, Mardi*

Mardi

Chapter 38 (p. 785)

The Library of America. New York, New York, USA. 1982

### **Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

There is, in fact, no reason to believe that any given natural phenomenon, however marvelous it may seem today, will remain forever inexplicable. Soon or late the laws governing the production of life itself will be discovered in the laboratory, and man may set up business as a creator on his own account. The thing, indeed, is not only conceivable; it is even highly probable.

*Treatise on the Gods*

Chapter 5 (p. 241)

Vintage Books. New York, New York, USA. 1963

The notion that science does not concern itself with first causes — that it leaves the field to theology or metaphysics, and confines itself to mere effects — this notion has no support in the plain facts. If it could, science would explain the origin of life on earth at once — and there is every reason to believe that it will do so on some not too remote tomorrow. To argue that gaps in knowledge which will confront the seeker must be filled, not by patient inquiry, but by intuition or revelation, is simply to give ignorance a gratuitous and preposterous dignity.

*Treatise on the Gods*

Chapter 5 (p. 239)

Vintage Books. New York, New York, USA. 1963

### **Mendeleev, Dmitry** 1834–1907

Russian chemist

What has been sown for the field of science will grow up for the people's welfare.

Translated by George Kamensky

*Principles of Chemistry* (Volume 1)

Introduction

Longmans, Green & Company. London, England. 1891

While science is pursuing a steady onward movement, it is convenient from time to time to cast a glance back on the route already traversed, and especially to consider the new conceptions which aim at discovering the general meaning of the stock of facts accumulated from day to day in our laboratories.

The Periodic Law of the Chemical Elements

*Journal of the Chemical Society*, Volume 55, 1889 (p. 634)

The edifice of science not only requires material but also a plan, and necessitates the work of preparing the materials, putting them together, working out the plans and the symmetrical proportions of the various parts. To conceive, understand, and grasp the whole symmetry of the scientific edifice, including its unfinished portions, is equivalent to tasting that enjoyment only conveyed by the highest forms of beauty and truth.

*Principles of Chemistry* (Volume 1)

Preface (p. ix, fn 1)

Longmans, Green & Company. London, England. 1891

Science plays an auxiliary part in our lives, for it is merely a means to the attainment of wellbeing.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneiersson

Progress Publishers. Moscow, Russia. 1979

Knowing how contented, free and joyful is life in the realms of science, one fervently wishes that many would enter their portals.

*Principles of Chemistry* (Volume 1)

Preface (p. ix, fn 1)

Longmans, Green & Company. London, England. 1891

**Meredith, George** 1828–1909  
English novelist and poet

Science is notoriously of slow movement.

*The Ordeal of Richard Feverel*  
Chapter XLIV (p. 518)  
The Modern Library. New York, New York, USA. 1927

**Meyer, Agnes** 1887–1970  
American author and journalist

From the nineteenth century view of science as a god, the twentieth century has begun to see it as a devil. It behooves us now to understand that science is neither the one nor the other.

*Education for a New Morality*  
Chapter 2 (p. 11)  
The Macmillan Company. New York, New York, USA. 1957

**Mill, John Stuart** 1806–73  
English political philosopher and economist

It is a common notion, or at least it is implied in many common modes of speech, that thoughts, feelings, and actions of sentient beings are not a subject of science.... This notion seems to involve some confusion of ideas, which it is necessary to begin by clearing up. Any facts are fitted, in themselves, to be a subject of science, which follows one another according to constant laws; although those laws may not have been discovered, nor even to be discoverable by our existing resources.

*A System of Logic, Rationative and Inductive* (Volume 2)  
Book VI, Chapter 3, Section 1 (p. 426)  
Longmans, Green, Reader & Dyer. London, England. 1868

**Millikan, Robert Andrews** 1868–1953  
American physicist

We need science in education, and much more of it than we now have, not primarily to train technicians for the industries, which demand them, though that may be important, but much more to give everybody a little glimpse of the scientific mode of approach to life's problems, to give everyone some familiarity with at least one field in which the distinction between right and wrong is not always blurred and uncertain, to let him see that it is not true that "one opinion is as good as another"...

The Relationship of Science to Industry  
*Science*, Volume 69, Number 1776, January 11, 1929 (p. 30)

The distinguishing feature of modern scientific thought lies in the fact that it begins by discarding all a priori conceptions about the nature of reality — or about the ultimate nature of the universe — such as had characterized practically all Greek philosophy and all medieval thinking as well, and takes instead, as its starting point, well-authenticated, carefully tested experimental facts, no matter whether these facts seen at the moment to fit into any general philosophical scheme or not — that is, no matter whether they seem at the moment to be reasonable or not.

Professor Einstein at the California Institute of Technology  
*Science*, Volume 73, Number 1893, April 10, 1931 (p. 376)

It is to lighten man's understanding, to illuminate his path through life, and not merely to make it easy, that science exists.

In Frederick Houk Law  
*Science in Literature*  
Modern Physics (p. 318)  
Harper & Brothers. New York, New York, USA. 1929

...Science walks forward on two feet, namely theory and experiment... Sometimes it is one foot which is put forward first, sometimes the other, but continuous progress is only made by the use of both — by theorizing and then testing, or by finding new relations in the process of experimenting and then bringing the theoretical foot up and pushing it beyond, and so on in unending alternation.

*Nobel Lectures, Physics 1922–1941*  
Nobel lecture for award received in 1923  
The Electron and the Light-Quant from the Experimental Point of View (p. 55)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1965

**Milne, Edward Arthur** 1896–1950  
English astrophysicist and cosmologist

The Christmas message — which is also the Christian message — is "*Gloria in excelsis Deo*"... Glory to God in the highest and on earth peace among men of goodwill.... This is not a bad definition of the aim of all true science: the aim of rejoicing in the splendid mysteries of the world and universe we live in, and of attempting so to understand those mysteries that we can improve our command over nature, improve our conditions of life and so ensure peace...

*Modern Cosmology and the Christian Idea of God*  
Chapter I (p. 1)  
At The Clarendon Press. Oxford, England. 1952

**Mitchell, Maria** 1818–89  
American astronomer and educator

The phrase "popular science" has in itself a touch of absurdity. That knowledge which is popular is not scientific.

In Phebe Mitchell Kendall  
*Maria Mitchell: Life, Letters, and Journals*  
Chapter VII (p. 138)  
Lee & Shepard. Boston, Massachusetts, USA. 1896

**Monod, Jacques** 1910–76  
French biochemist

In science, self-satisfaction is death. Personal self-satisfaction is the death of the scientist. Collective self-satisfaction is the death of the research. It is restlessness, anxiety, dissatisfaction, agony of mind that nourish science.

Obituary  
*News Science*, Volume 109, June 5, 1976 (p. 359)

**Montagu, Ashley** 1905–99  
English-born American anthropologist

As the god of contemporary man's idolatry, science is a two-handed engine, and as such science is too important a human activity to leave to the scientist.

Advertisement of Jacques Barzun's "Science: The Glorious Entertainment"

*New York Times Book Review*, April 26, 1964

**More, Louis Trenchard** 1870–1944

English physicist and biographer of Isaac Newton

Science has so many dazzling achievements to its credit; we have done so many things which seemed to be impossible, that the popular mind is apt to conclude that, if an explanation is given in the name of science, it must be true whether it be understood or not.

*The Dogma of Evolution*

Chapter Seven (p. 241)

Princeton University Press. Princeton, New Jersey, USA. 1925

**Morgan, Lloyd** 1852–1936

English psychologist

Science...deals exclusively with changes of configuration, and traces the accelerations which are observed to occur, leaving to metaphysics to deal with the underlying agency, if it exists.

*The Interpretation of Nature*

Chapter V (p. 62)

The Knickerbocher Press. New York, New York, USA. 1906

**Morrow, James** 1947–

American novelist

Everybody thinks he's being oh-so-deep when he says science doesn't have all the answers.... Science *does* have all the answers.... The problem is that we don't have all the science.

*Only Begotten Daughter* (p. 90)

Harcourt Incorporated. Orlando, Florida, USA. 1990

**Moscovici, S.** 1925–

Romanian-born French psychologist

Science has become involved in this adventure, our adventure, in order to renew everything it touches and warm all that it penetrates — the earth on which we live and the truths which enable us to live. At each turn it is not the echo of a demise, a bell tolling for a passing away that is heard, but the voice of rebirth and beginning, ever afresh, of mankind and materiality, fixed for an instant in their ephemeral permanence. That is why the great discoveries are not revealed on a deathbed like that of Copernicus, but offered like Kepler's on the road of dreams and passion.

*Social Influence and Social Change* (pp. 297–298)

Academic Press. London, England. 1980

**Motto**

Science Finds — Industry Applies — Man Conforms  
Chicago World's Fair, 1933

**Muller, Herbert J.** 1905–80

American historian and educator

Although science is no doubt the Jehovah of the modern world, there is considerable doubt about the glory of its handiwork.

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*  
Chapter III (p. 59)

G. Braziller. New York, New York, USA. 1943

...men of science, men given to "realism," are likely to make a clean sweep of old interests and sentiments as so much rubbish. They regard religion as superstition, metaphysics as moonshine, art as primitive pastime, and all ritual as monkey-business.

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*

Chapter I (p. 6)

G. Braziller. New York, New York, USA. 1943

**Mumford, Lewis** 1895–1990

American social philosopher

...however far modern science and technics have fallen short of their inherent possibilities, they have taught mankind at least one lesson: Nothing is impossible.

*Technics and Civilization*

Chapter VIII, Section 13 (p. 435)

Routledge & Kegan Paul Ltd. London, England, 1934

**Munger, Theodore** 1830–1910

American clergyman

Science cannot determine origin, and so cannot determine destiny. As it presents only a sectional view of creation, it gives only a sectional view of everything in creation.

In Jefferson Hane Weaver

*The World of Physics* (Volume 3)

U.1 (p. 212)

Simon & Schuster. New York, New York, USA. 1987

**Needham, Joseph** 1900–95

English biochemist and sinologist

...our proper conclusion seems to me to be that the conceptual framework of Chinese associative or coordinative thinking was essentially something different from that of European causal and "legal" or nomothetic thinking. That it did not give rise to 17<sup>th</sup>-century theoretical science is no justification for calling it primitive.

*Science and Civilisation in China* (Volume 2) (p. 286)

At The University Press. Cambridge, England. 1954

**Nekrasov, Nikolai** 1821–78

Russian poet

There is no science for the sake of science, no art for the sake of art — they exist for the sake of society, for the ennoblement and exaltation of man, to enrich his knowledge and provide his material comforts.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson  
Progress Publishers. Moscow, Russia. 1979

### Newell, A.

No biographical data available

Scientific fields emerge as the concerns of scientists congeal around various phenomena. Sciences are not defined, they are recognized.

In R.C. Shank and K.M. Colby (eds.)  
*Computer Models of Thought and Language*  
Artificial Intelligence and the Concept of Mind (p. 1)  
W.H. Freeman. San Francisco, California, USA. 1973

### Newton, Roger G.

Physics professor and author

Science is not holy scripture, nor do its practitioners consider themselves priests protecting a glittering grail, forever unchanging and pure. What drives scientists on is the thirst to understand more and to use nature, to build rather than to exploit a comprehensible universe.

*What Makes Nature Tick?*  
Epilogue (p. 234)  
Harvard University Press. Cambridge, Massachusetts, USA. 1993

Science is, in fact, an intricate edifice erected from complex, imaginative designs in which esthetics is a more powerful incentive than utility. Beauty, finally, comprises its greatest intellectual appeal.

*What Makes Nature Tick?*  
Epilogue (p. 236)  
Harvard University Press. Cambridge, Massachusetts, USA. 1993

### Nietzsche, Friedrich 1844–1900

German philosopher

To the man who works and searches in it, science gives much pleasure; to the man who learns its results, very little.

Translated by Marion Faber  
*Human, All Too Human: A Book for Free Spirits*  
Section Five, Number 251  
Aphorism 205 (p. 153)  
University of Nebraska Press. Lincoln, Nebraska, USA. 1984

Oh, how much is today hidden by science! Oh, how much it is expected to hide!

Translated by William A. Haussmann  
*The Genealogy of Morals*  
What Do Ascetic Ideals Mean?  
Aphorism 23  
Macmillan Publishing Company. New York, New York, USA. 1907

Science offends the modesty of all real women. It makes them feel as though it were an attempt to peek under their skin — or, worse yet, under their dress and ornamentation!

*Beyond Good and Evil*  
Chapter IV, 127 (p. 83)  
The Modern Library. New York, New York, USA. 1917

Science rushes headlong, without selectivity, without “taste,” at whatever is knowable, in the blind desire to know all at any cost.

Translated by Marianne Cowan  
*Philosophy in the Tragic Age of the Greeks*  
Section 3 (p. 43)  
A Gateway Edition. Chicago, Illinois, USA. 1962

The old God was seized by mortal terror. Man himself had been his greatest blunder; he had created a rival to himself; science makes men godlike — it is all up with priests and gods when man becomes scientific — Moral: science is the forbidden per se; it alone is forbidden. Science is the first of sins, the germ of all sins, the original sin. This is all there is of morality. — “Thou shalt not know”: the rest follows from that.

Translated by H.L. Mencken  
*The Anti-Christ*  
Aphorism 48  
Macmillan Publishing Company. New York, New York, USA. 1911

### Nobel Prize Medal

*Inventas vitam iuvat excoluisse per artes.*  
Let us improve life through science and art.  
*Inscribed on Nobel Prize Medal*

### Oberth, Hermann 1894–1989

German mathematician and physicist

The present state of science and of technological knowledge permits the building of machines that can rise beyond the limits of the atmosphere of the earth. After further development these machines will be capable of attaining such velocities that they — left undisturbed in the void of ether space — will not fall back to earth; furthermore, they will even be able to leave the zone of terrestrial attraction.

*The Rocket to the Interplanetary Spaces*  
Publisher undetermined

### O’Neill, Eugene 1888–1953

American playwright

DARRELL: Happiness hates the timid! So does Science!

*Strange Interlude*  
Act Four (p. 152)  
Boni & Liveright. New York, New York, USA. 1928

### Oppenheimer, J. Robert 1904–67

American theoretical physicist

We live today in a world in which poets and historians and men of affairs are proud that they wouldn’t even begin to consider thinking about learning anything of science, regarding it as the far end of a tunnel too long for any wise man to put his head into.

*The Open Mind*  
Chapter VII (p. 128)  
Simon & Schuster. New York, New York, USA. 1955

A subject is much harder to understand when no one understands it. The world is really an open place, but we start with such crude and limited experience, and our minds



are so determined by that experience, that when science carries us into new domains we are not always prepared for what we encounter, and we are floored by it.

In Edward Lueders

*Writing on Life: Sixteen Close-Ups*

Physicist Oppenheimer (p. 358)

William Sloane Associates, Publishers. New York, New York, USA. 1951

**O'Rourke, P. J.** 1947–

American political satirist

...to mistrust science and deny the validity of the scientific method is to resign your job as a human. You'd better go look for work as a plant or wild animal.

*Parliament of Whores: A Lone Humorist Attempts to Explain the Entire U.S. Government*

Dirt of the Earth (p. 1 97)

Vintage Books. New York, New York, USA. 1992

**Orr, Louis**

American Medical Association president

Science will never be able to reduce the value of a sunset to arithmetic. Nor can it reduce friendship or statesmanship to a formula. Laughter and love, pain and loneliness, the challenge of accomplishment in living, and the depth of insight into beauty and truth; these will always surpass the scientific mastery of nature.

Commencement Address, Emory University, June 6, 1960

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

To the physician particularly, a scientific discipline is an incalculable gift, which leavens his whole life, giving exactness to habits of thought and tempering the mind with that judicious faculty of distrust which can alone, amid the uncertainties of practice, make him wise unto salvation. For perdition inevitably awaits the mind of the practitioner who has never had the full inoculation with the leaven, who has never grasped clearly the relations of science to his art, and who knows nothing and perhaps cares less, for the limitations of either.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (p. 92)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The future belongs to science. More and more she will control the destinies of the nations. Already she has them in her crucible and on her balances.

In Harvey Cushing

*The Life of Sir William Osler* (Volume 2) (p. 262)

Clarendon Press. Oxford, England. 1925

**Ostwald, Friedrich Wilhelm** 1853–1932

Latvian-born German chemist

The more perfect the theoretical evolution of the sciences becomes, the greater will be the scope of their

explanations and at the same time the greater their practical importance.

On Chemical Energy

*The Journal of the American Chemical Society*, Volume 15, Number 8, August 1893 (p. 430)

**Pagels, Heinz R.** 1939–88

American physicist and science writer

This sense of the unfathomable beautiful ocean of existence drew me into science. I am awed by the universe, puzzled by it and sometimes angry at a natural order that brings such pain and suffering, Yet an emotion or feeling I have toward the cosmos seems to be reciprocated by neither benevolence nor hostility but just by silence. The universe appears to be a perfectly neutral screen unto which I can project any passion or attitude, and it supports them all.

*Perfect Symmetry: The Search for the Beginning of Time*

Part Four, Chapter 2 (p. 370)

Simon & Schuster. New York, New York, USA. 1985

Science is not the enemy of humanity but one of the deepest expressions of the human desire to realize that vision of infinite knowledge.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part III, Chapter 2 (p. 348)

Simon & Schuster. New York, New York, USA. 1982

**Paglia, Camille** 1947–

American social critic, intellectual, and writer

Modern bodybuilding is ritual, religion, sport, art, and science, awash in Western chemistry and mathematics. Defying nature, it surpasses it.

*Sex, Art, and American Culture*

Alice in Muscle Land (p. 82)

Vintage Books. New York, New York, USA. 1992

**Pallister, William Hales** 1877–1946

Canadian physician

You are the sum of what we know,

You are our might and main;

You are the whole of what is so,

The little we retain:

Our fond beliefs all come and go,

And you alone remain.

*Poems of Science*

Science (p. 39)

Playford Press. New York, New York, USA. 1931

Science works by the slow method of the classification of data, arranging the detail patiently in a periodic system into groups of facts, in series like the strata of the rocks. For each series there must be a vocabulary of special words which do not always make good sense when used in another series. But the laws of periodicity seem to hold throughout, among the elements and in every sphere of thought, and we must learn to co-ordinate the whole through our new conception of the reign of relativity.

*Poems of Science*

Men and the Stars (p. 88)  
Playford Press. New York, New York, USA. 1931

**Panunzio, Constantine** 1884–1964  
Italian sociologist

Science...involves active, purposeful search; it discovers, accumulates, sifts, orders, and tests data; it is a slow, painstaking, laborious activity; it is a search after bodies of knowledge sufficiently comprehensive to lead to the discovery of uniformities, sequential orders or so-called "laws"; it may be carried on by an individual, but it gains relevance only as it produces data which can be added to and tested by the findings of others.

*Major Social Institutions*  
Chapter 20 (p. 322)  
The Macmillan Company. New York, New York, USA. 1945

If science is to subserve human needs, it will continue to discover and catalogue "all the islands of the universe 300,000,000 or more light years distant," but it will not fiddle while Rome burns...

*Major Social Institutions*  
Chapter 21 (p. 338)  
The Macmillan Company. New York, New York, USA. 1945

**Parin, V. V.**  
No biographical data available

Science breathes but one air — the oxygen of facts. New methods of research are the trees that clear its atmosphere of the carbon dioxide of inaccurate conclusions and saturate it with the oxygen of first discovered, seen and apprehended phenomena.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneiereson  
Progress Publishers. Moscow, Russia. 1979

**Pasteur, Louis** 1822–95  
French chemist

You bring me the deepest joy that can be felt by a man whose invincible belief is that Science and Peace will triumph over Ignorance and War, that nations will unite, not to destroy, but to build, and that the future will belong to those who will have done most for suffering humanity.

In Rene Vallery-Radot  
*The Life of Pasteur*  
Chapter XIV (pp. 450–451)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1928

I am imbued with two deep impressions; the first, that science knows no country; the second, which seems to contradict the first, although it is in reality a direct consequence of it, that science is the highest personification of the nation. Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of the nation

because that nation will remain the first which carries the furthest the works of thought and intelligence.

In Rene Dubos  
*Pasteur and Modern Science*  
Chapter 15. A Dedicated Life (p. 146)  
Science Tech Publishers. Madison, Wisconsin, USA. 1988

I could never work for money, but I would always work for science.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter I (p. 6)  
Macmillan & Company Ltd. London, England. 1918

**Pavlov, Ivan Petrovich** 1849–1936  
Russian physiologist

Only science, exact science about human nature itself, and the most sincere approach to it by the aid of the omnipotent scientific method, will deliver man from his present gloom, and will purge him from his contemporary shame in the sphere of interhuman relations.

Translated by Stephen G. Brush  
*Lectures on Conditioned Reflexes*  
Preface to the First Russian Edition (p. 41)  
University of California Press. Berkeley, California, USA. 1964

Science moves in fits and starts, depending on the progress in methods of research. Every step forward in method takes us a step higher, affording a broader view of the horizon and of objects that were invisible before.

Compiled by V.V. Vorontsov  
*Words of the Wise: A Book of Russian Quotations*  
Translated by Vic Schneiereson  
Progress Publishers. Moscow, Russia. 1979

Remember that science demands from a man all his life. If you had two lives that would be not enough for you. Be passionate in your work and your searchings.

Bequest of Pavlov to the Academic Youth of his Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Learn the ABC of science before you try to ascend to its summit. Never begin the subsequent without mastering the preceding. Never attempt to screen an insufficiency of knowledge even by the most audacious surmise and hypothesis.

Bequest of Pavlov to the Academic Youth of His Country  
*Science*, Volume 83, Number 2155, April 17, 1936 (p. 369)

Here I now simply uphold and assert the absolute and incontestable right of natural science to operate wherever and whenever it is able to display its power. And who knows the limits to this!

*Experimental Psychology and Other Essays*  
Natural Science and the Brain (p. 218)  
Philosophical Library. New York, New York, USA. 1957

**Peacock, Thomas Love** 1785–1866  
English writer

Science is one thing and wisdom is another. Science is an edged tool with which men play like children and cut

their own fingers. If you look at the results which science has brought in its train, you will find them to consist almost wholly in elements of mischief... The day would fail if I should attempt to enumerate the evils which science has inflicted on mankind. *Gryll Grange*

Chapter 19 (p. 127)

Penguin Books. Harmondsworth, England. 1949

I almost think it is the ultimate destiny of science to exterminate the human race.

*Gryll Grange*

Chapter 19 (p. 127)

Penguin Books. Harmondsworth, England. 1949

**Pearson, Karl** 1857–1936

English mathematician

When every fact, every present or past phenomenon of that universe, every phase or present or past life therein, has been examined, classified, and co-ordinated with the rest, then the mission of science will be completed. What is this but saying that the task of science can never end till man ceases to be, till history is no longer made, and development itself ceases?

*The Grammar of Science*

Introductory, Section 5 (p. 15)

Charles Scribner's Sons. London, England. 1892

Science for the past is a description, for the future a belief...

*The Grammar of Science*

Chapter IV, Section 1 (p. 136)

Charles Scribner's Sons. London, England. 1892

Every great advance of science opens our eyes to facts which we have failed before to observe, and makes new demands on our powers of interpretation. This extension of the material of science into regions where our great-grandfathers could see nothing at all, or where they would have declared human knowledge impossible, is one of the most remarkable features of modern progress. Where they interpreted the motion of the planets of our own system, we discuss the chemical constitution of stars, many of which did not exist for them, for the telescopes could not reach them. Where they discovered the circulation of the blood, we see the physical conflict of living poisons within the blood, whose battles would have been absurdities for them.

*The Grammar of Science*

Introductory, Section 5 (p. 17)

Charles Scribner's Sons. London, England. 1892

Does science leave no mystery? On the contrary it proclaims mystery where others profess knowledge. There is mystery enough in the universe of sensation and in its capacity for containing those little corners of consciousness which project their own products, or order and law and reason, into an unknown and unknowable world. There is mystery enough here, only let us clearly distinguish it from ignorance within the field of possible knowledge. The one is impenetrable, the other we are daily subduing.

*The Grammar of Science*

Chapter III, Conclusion (p. 134)

Charles Scribner's Sons. London, England. 1892

Modern Science, as training the mind to an exact and impartial analysis of facts, is an education specifically fitted to promote sound citizenship.

*The Grammar of Science*

Introductory, Section 3 (p. 11)

Charles Scribner's Sons. London, England. 1892

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

Of our windows on the universe, science is set with the clearest pane; it is not warped or waved to make the images appear to support any dogma; the glass is not rose-tinted, neither is it leaded with a picture that shuts out the sun and, coming between the light of day and you, enforces the credence of the past upon the young present.

*Flowering Earth*

Chapter 18 (p. 244)

G.P. Putnam's Sons. New York, New York, USA. 1939

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

Science, when it comes to understand itself, regards facts as merely the vehicle of eternal truth, while for Practice they remain the obstacles which it has to turn, the enemy of which it is determined to get the better.

*The Essential Peirce: Selected Philosophical Writings* (Volume 2)

The First Rule of Logic (p. 55)

Indiana University Press. Bloomington, Indiana, USA. 1998

It is a common observation that a science first begins to be exact when it is quantitatively treated. What are called the exact sciences are no other than the mathematical ones.

*Chance, Love and Logic: Philosophical Essays*

The Doctrine of Chances (p. 61)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1923

**Perl, Martin** 1927–

American physicist

I was following an old idea in science: "If you can't understand a phenomenon, look for more examples of that phenomenon..."

Electron, Muon, and Tau Heavy Lepton — Are These the Truly Elementary Particles?

*The Science Teacher*, Volume 47, Number 9, December 1980 (pp. 18–19)

**Perutz, Max F.** 1914–2002

Austrian-born English biochemist

It seems to me that, just as the Church did in former times, science offers a safe niche where you can spend a quiet life classifying spiders, away from what E.M. Forster called the world of telegrams and anger.

*Is Science Necessary?*

How to Become a Scientist (p. 193)

E.P. Dutton & Company. New York, New York, USA. 1989

**Pirsig, Robert M.** 1928–  
American writer

Science values static patterns.

*Lila: An Inquiry Into Morals*

Chapter 11 (p. 142)

Bantam Books. New York, New York, USA. 1991

**Planck, Max** 1858–1947  
German physicist

That we do not construct the external world to suit our own ends in the pursuit of science, but that vice versa the external world forces itself upon our recognition with its own elemental power, is a point which ought to be categorically asserted again and again in these positivistic times. From the fact that in studying the happenings of nature we strive to eliminate the contingent and accidental and to come finally to what is essential and necessary, it is clear that we always look for the basic thing behind the dependent thing, for what is absolute behind what is relative, for the reality behind the appearance and for what abides behind what is transitory. In my opinion, this is characteristic not only of physical science but all of science.

*Where Is Science Going?*

Chapter VI (pp. 198–199)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

Science...means unrelenting endeavor and continually progressing development toward an aim which the poetic intuition may apprehend but which the intellect can never fully grasp.

*Continuum*, Volume 20, Number 5, February 1980 (p. 42)

Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of nature and therefore part of the mystery that we are trying to solve.

*Where Is Science Going?*

Epilogue (p. 217)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

Science does not mean an idle resting upon a body of certain knowledge; it means unrelenting endeavor and continually progressing development towards an aim, which the poetic intuition may apprehend, but which the intellect can never fully grasp.

Translated by W. H. Johnston

*The Philosophy of Physics*

Chapter II (p. 83)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

Exact science — what wealth of connotation these two words have! They conjure up a vision of a lofty structure, of imperishable slabs of stone firmly joined together, treasure-house of all wisdom, symbol and promise of the coveted goal for a human race thirsting for knowledge, longing for the final revelation of truth.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science (p. 80)

Philosophical Library. New York, New York, USA. 1949

The roots of exact science feed in the soil of human life.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part IV (p. 112)

Philosophical Library. New York, New York, USA. 1949

...I had always looked upon the search for the absolute as the noblest and most worthwhile task of science.

*Scientific Autobiography and Other Papers*

A Scientific Autobiography (p. 46)

Philosophical Library. New York, New York, USA. 1949

...science is not contemplative repose amidst knowledge already gained, but is indefatigable work and an ever progressive development.

*Scientific Autobiography and Other Papers*

The Concept of Causality in Physics (p. 150)

Philosophical Library. New York, New York, USA. 1949

**Plato** 428 BCE–347 BCE  
Greek philosopher

As being is to becoming, so is pure intellect to opinion. And as intellect is to opinion, so is science to belief...

In *Great Books of the Western World* (Volume 7)

*The Republic*

Book VII, Section 534 (p. 398)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Podolsky, Boris** 1896–1966  
American physicist

In recent years the power of Science has received such popular recognition that the adjective scientific attached to merchandise or statement is known to give to such merchandise or to a statement prestige having definite advertising value. As a consequence the words science and scientific are frequently abused by those who find it profitable to borrow reputation instead of earning it.

What Is Science?

*The Physics Teacher*, Volume 3, Number 2, February 1965 (p. 71)

**Poe, Edgar Allan** 1809–49  
American short story writer

Science! true daughter of old Time thou art  
Who alterest all things with thy peering eyes!  
Why prey'st thou thus upon the poet's heart,  
Vulture! whose wings are dull realities!

*The Raven and Other Poems*

Sonnet — To Science

Columbia University Press. New York, New York, USA. 1942

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

The advance of science is not comparable to the changes of a city, where old edifices are pitilessly torn down to give place to new, but to the continuous evolution of zoologic types which develop ceaselessly and end by becoming

unrecognizable to the common sight, but where an expert eye finds always traces of the prior work of the past centuries.

*The Foundations of Science*

The Value of Science, Introduction (p. 208)

The Science Press. New York, New York, USA. 1913

Man, then, can not be happy through science, but to-day he can be much less be happy without it.

*The Foundations of Science*

The Value of Science, Introduction (p. 206)

The Science Press. New York, New York, USA. 1913

There is no science other than disinterested science.

In Stefan Amsterdamski

*Between History and Method*

Chapter V Crisis of the Modern Ideal (p. 94)

Kluwer Academic Publishers. Dordrecht, Netherlands. 1992

As science progress, it becomes more and more difficult to fit in the new facts when they will not fit in spontaneously. The older theories depend upon the coincidences of so many numerical results which can not be attributed to chance. We should not separate what has been joined together.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1912*

The Ether and Matter (pp. 209–210)

Government Printing Office. Washington, D.C. 1913

...science is a rule of action which is successful...

*The Foundations of Science*

The Value of Science, Part III, Chapter X (p. 324)

The Science Press. New York, New York, USA. 1913

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

This coherence of valuation throughout the whole range of science underlies the unity of science. It means that any statement recognized as valid in one part of science can, in general, be considered as underwritten by all scientists. It also results in a general homogeneity of and a mutual respect between all kinds of scientists, by virtue of which science forms an organic unity.

*Science, Faith and Society*

Authority and Conscience (p. 49)

The University of Chicago Press. Chicago, Illinois. 1964

The morsels of science which [the young scientist] picks up — even though often dry or else speciously varnished — instill in him the intimation of intellectual treasures and creative joys far beyond his ken. His intuitive realization of a great system of valid thought and of an endless path of discovery sustain him in laboriously accumulating knowledge and urge him on to penetrate into intricate brain-racking theories. Sometimes he will also find a master whose work he admires and whose manner and outlook he accepts for his guidance. Thus his mind will become assimilated to the premise of science. The scientific institution of reality henceforth shapes his perception. He learns the methods of scientific investigation and accepts the standards of scientific value.

*Science, Faith and Society*

Authority and Conscience (p. 44)

The University of Chicago Press. Chicago, Illinois. 1964

**Pope, Alexander** 1688–1744

English poet

Trace Science then, with Modesty thy guide;

First strip off all her equipage of Pride.

*The Complete Poetical Works* (Volume 2)

An Essay on Man

Epistle II, l. 43–44

Houghton Mifflin Company. New York, New York, USA. 1903

One science only will one genius fit,

So vast is art, so narrow human wit...

*The Complete Poetical Works* (Volume 2)

Essay on Criticism, Part I, l. 60–61

Houghton Mifflin Company. New York, New York, USA. 1903

Far eastward cast thine eye, from whence the Sun

And orient Science their brite course begun.

*The Complete Poetical Works* (Volume 4)

Duncaid, Book III, l. 73–74

Houghton Mifflin Company. New York, New York, USA. 1903

How Index-learning turns no student pale,

Yet holds the eel of science by the tail...

*The Complete Poetical Works* (Volume 4)

Duncaid, Book I, l. 279–80

Houghton Mifflin Company. New York, New York, USA. 1903

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The empirical basis of objective science has thus nothing “absolute” about it. Science does not rest upon solid bed-rock. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or “given” base; and when we cease our attempts to drive our piles into a deeper layer, it is not because we have reached firm ground. We simply stop when we are satisfied that they are firm enough to carry the structure, at least for the time being.

*The Logic of Scientific Discovery*

Part II, Chapter V, Section 30 (p. 111)

Basic Books, Inc. New York, New York, USA. 1959

Science is not a system of certain, or well-established statements, nor is it a system which steadily advances towards a state of finality... Like Bacon we might describe our own contemporary science...as consisting of “anticipations, rash and premature,” and as “prejudices.”

*The Logic of Scientific Discovery*

Part II, Chapter X, Section 85 (p. 278)

Basic Books, Inc. New York, New York, USA. 1959

Science may be described as the art of systematic oversimplification.

*The Observer; London*, 1 August 1982

Science does not aim, primarily, at high probabilities. It aims at a high informative content, well backed by

experience. But a hypothesis may be very probable simply because it tells us nothing, or very little.

*The Logic of Scientific Discovery*

Appendix ix (p. 399)

Basic Books, Inc. New York, New York, USA. 1959

...science is most significant as one of the greatest spiritual adventures that man has yet known...

*The Poverty of Historicism*

Chapter III, Section 19 (p. 56)

The Beacon Press. Boston, Massachusetts, USA. 1957

...it is the aim of science to find satisfactory explanations, of whatever strikes us as being in need of explanation.

*Objective Knowledge: An Evolutionary Approach*

Chapter 5 (p. 191)

Clarendon Press. Oxford, England. 1972

### Porterfield, Austin L.

No biographical data available

Science, in the broadest sense, is the entire body of the most accurately tested, critically established, systematized knowledge available about that part of the universe which has come under human observation. For the most part this knowledge concerns the forces impinging upon human beings in the serious business of living and thus affecting man's adjustment to and of the physical and the social world.... Pure science is more interested in understanding, and applied science is more interested in control...

*Creative Factors in Scientific Research*

Chapter II (p. 11)

Duke University Press. Durham, North Carolina, USA. 1941

### Poteat, William Louis 1856–1938

American educator

Science confers power, not purpose. It is a blessing, therefore, if the purpose which it serves is good; it is a curse, if the purpose is bad.

*Can a Man Be a Christian Today?*

Part I, Section 2 (p. 27)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1925

### Powers, Richard 1957–

American novelist

Science is not about control. It is about cultivating a perpetual condition of wonder in the face of something that forever grows one step richer and subtler than our latest theory about it. It is about reverence, not mastery.

*The Gold Bug Variations*

Dialog

William Morrow & Company, Inc. New York, New York, USA. 1991

### Praed, Winthrop 1802–39

English poet

Of science and logic he chatters,  
As fine and as fast as he can;

Though I am no judge of such matters,  
I'm sure he's a talented man.

*The Poems of Winthrop Mackworth Praed*

The Talented Man

Houghton Mifflin Company. Boston, Massachusetts, USA. 1909

### Pratt, C. C.

No biographical data available

Science is a vast and impressive tautology.

*The Logic of Modern Psychology*

Chapter VI (p. 154)

The Macmillan Company. New York, New York, USA. 1939

### Prescott, William Hickling 1796–1859

American historian

It is the characteristic of true science, to discern the impassable, but not very obvious, limits which divide the province of reason from that of speculation. Such knowledge comes tardily. How many ages have rolled away in which powers, that, rightly directed, might have revealed the great laws of nature, have been wasted in brilliant, but barren reveries on alchemy and astrology.

*History of the Conquest of Mexico* (Volume 1)

Book I, Chapter IV (p. 102)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1891

### Pribram, Karl 1919–

Austrian neurosurgeon

For the first time in three hundred years science is admitting spiritual values into its explorations.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Holographic Brain (p. 133)

Ticknor & Fields. New York, New York, USA. 1984

### Priestley, Joseph 1733–1804

English theologian and scientist

A successful pursuit of science makes a man the benefactor of all mankind and of every age.

*Experiments and Observations on Different Kinds of Air* (Volume 1)

The Preface (p. xxvii)

Thomas Pearson. Birmingham, England. 1790

### Prigogine, Ilya 1917–2003

Russian-born Belgian physical chemist

### Stengers, I. 1949–

Belgian philosopher

Science is part of the Darwinian struggle for life. It helps us to organize our experience. It leads us to economy of thought. Mathematical laws are nothing more than conventions useful for summarizing the results of possible experiments.

*Order Out of Chaos*

Chapter III 5. Ignoramus, Ignoramibus (p. 97)

Bantam Books. New York, New York, USA. 1984

**Prior, Matthew** 1664–1721  
English poet and diplomat

Forc'd by reflective Reason I confess,  
That human Science is uncertain guess.

In John Aikin

*Select Works of the British Poets*

Solomon, Book 1, l. 740

Longman, Hurst, Reese, Orme & Brown. London, England. 1820

**Pritchett, V. S.** 1900–97  
English writer

A touch of science, even bogus science, gives an edge to  
the superstitious tale.

*The Living Novel and Later Appreciations*

An Irish Ghost (p. 123)

Random House, Inc. New York, New York, USA. 1964

**Prout, Curtis**

No biographical data available

The study of science suggests the need for humility.

*Demand and Get the Best Health Care for You: An Eminent Doctor's  
Practical Advice* (p. 148)

Faber & Faber. Boston, Massachusetts, USA. 1997

**Quetelet, Adolphe** 1794–1874

Belgian mathematician, astronomer, and statistician

The more progress physical sciences makes, the more  
they tend to enter the domain of mathematics, which is a  
kind of center to which they all converge. We may even  
judge of the degree of perfection to which a science has  
arrived by the facility with which it may be submitted to  
calculation.

In E. Mailly

*Annual Report of the Board of Regents of the Smithsonian Institution,  
1874*

Eulogy of Quetelet (p. 173)

Government Printing Office. Washington, D.C. 1875

**Quine, Willard Van Orman** 1908–2000

American logician and philosopher

Science is like a boat, which we rebuild plank by plank  
while staying afloat in it. The philosopher and the scien-  
tist are in the same boat.

In George Johnson

*In the Palaces of Memory: How We Build the World Inside Our Heads*

The End of Philosophy (p. 222)

Alfred A. Knopf. New York, New York, USA. 1991

**Quinet, Edgar** 1803–75

French historian

Science is Christian, not when it condemns itself to the  
letter of things, but when, in the infinitely little, it discov-  
ers as many mysteries and as much depth and power as  
in the infinitely great.

*Ultramontanism, or the Roman Church and Modern Society*

The Roman Church and Science-Galileo

Lecture, May 7, 1844

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

Science is a great game. It is inspiring and refreshing.  
The playing field is the universe itself.

*New York Times*, October 28, 1964 (p. 38)

**Ramsay, Sir William** 1852–1916

English chemist

No process is so perfect that there is not plenty of room  
for improvement. There is no finality in science. And  
that which today is a scientific toy may be to-morrow the  
essential part of an important industry.

*Essays Biological and Chemical*

The Great London Chemists

Section I (p. 19)

Archibald Constable & Company Ltd. London, England. 1908

**Randall, J. H.**

No biographical data available

[Science] swept man out of his proud position as the cen-  
tral figure and end of the universe, and made him a tiny  
speck on a third-rate planet revolving about a tenth-rate  
sun drifting in an endless cosmic ocean.

*The Making of the Modern Mind: A Survey of the Intellectual Back-  
ground of the Present Age*

Chapter X (p. 226)

The Riverside Press. Cambridge, Massachusetts, USA. 1940

**Randi, James** 1928–

Canadian magician and scientific skeptic

I believe that science is best defined as a careful, dis-  
ciplined, logical search for knowledge about any and  
all aspects of the universe, obtained by examination of  
the best available evidence and always subject to cor-  
rection and improvement upon the discovery of better  
evidence.

What's left is magic, and it doesn't work.

*The Mask of Nostradamus*

Chapter Five (p. 66)

Prometheus Books. Buffalo, New York, USA. 1993

**Ravetz, J. R.**

No biographical data available

The obsolescence of the conception of science as the pur-  
suit of truth results from several changes in the social  
activity of science. First, the heavy warfare with "theol-  
ogy and metaphysics" is over. Although a few sharp skir-  
mishes still occur, the attacks on the freedom of science  
from this quarter are no longer significant. This is not so  
much because of the undoubted victory of science over  
its ancient contenders as for the deeper reason that the  
conclusions of natural science are no longer ideologically  
sensitive. What people, either the masses or the educated,  
believe about the inanimate universe or the biological

aspects of humanity is not relevant to the stability of society as it was once thought to be.

*Scientific Knowledge and Its Social Problems*  
Chapter I (pp. 200–201)  
Clarendon Press. Oxford, England. 1971

**Raymo, Chet** 1936–

American physicist and science writer

Science cannot be a repository of ultimate faith: It is a fulcrum upon which we can hope to balance the treasure of our knowledge against the claims of ignorance.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 21 (p. 199)  
The Viking Press. New York, New York, USA. 1991

...science is a spider's web. Confidence in any one strand of the web is maintained by the tension and resiliency of the entire web.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 16 (p. 144)  
The Viking Press. New York, New York, USA. 1991

Science, like the play of children, satisfies a deep-seated need for escape from the boredom of fixity and the trauma of chaos.

Focal Point  
*Sky and Telescope*, Volume 81, Number 5, May 1991 (p. 460)

**Renan, Ernest** 1823–92

French philosopher and Orientalist

The lofty serenity of science becomes possible only on the condition of impartial criticism, which without regard for the beliefs of a certain portion of humanity, handles its imperturbable instrument with the inflexibility of the geometrician, without anger and without pity. The critic never insults.

*The Future of Science*  
Chapter XV (p. 257)  
Roberts Brothers. Boston, Massachusetts, USA. 1893

...science is a religion, science alone will henceforth make the creeds, science alone can solve for men the eternal problems, the solutions of which his nature imperatively demands.

*The Future of Science*  
Chapter V (p. 97)  
Roberts Brothers. Boston, Massachusetts, USA. 1893

...science must pursue its road without minding with whom it comes in collision. Let the others get out of the way. If it appears to raise objections against received dogmas, it is not for science but the received dogmas to be on the defensive and to reply to the objections. Science should behave as if the world were free from preconceived opinions, and not heed the difficulties it starts.

*The Future of Science*  
Chapter V (p. 83)  
Roberts Brothers. Boston, Massachusetts, USA. 1893

A little true science is better than a great deal of bad science. One is less liable to error by confessing one's ignorance than by fancying that one knows a great many things one does not.

*The Future of Science*  
Preface (p. xix)  
Roberts Brothers. Boston, Massachusetts, USA. 1893

**Reynolds, William C.** 1933–2004

American mechanical engineer

**Perkins, Harry C.**

No biographical data available

Concepts form the basis for any science. These are ideas, usually somewhat vague (especially when first encountered), which often defy really adequate definition. The meaning of a new concept can seldom be grasped from reading a one-paragraph discussion. There must be time to become accustomed to the concept, to investigate it with prior knowledge, and to associate it with personal experience. Inability to work with details of a new subject can often be traced to inadequate understanding of its basic concepts.

*Engineering Thermodynamics*  
Chapter 1 (p. 4)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1977

**Richards, Ivor Armstrong** 1893–1979

English literary critic

For science, which is simply our most elaborate way of pointing to things systematically, tells us and can tell us nothing about the nature of things in any ultimate sense. It can never answer any question of the form: What is so and so? [I]t can only tell us how so and so behaves. And it does not attempt to do more than this.

*Science and Poetry*  
Chapter V (pp. 52–53)  
Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1926

**Richards, Theodore William** 1868–1928

American chemist

Every student of Science, even if he cannot start his journey where his predecessors left off, can at least travel their beaten track more quickly than they could while they were clearing the way: and so before his race is run he comes to virgin forest and becomes himself a pioneer.

*Nobel Lectures, Chemistry 1901–1921*  
Nobel lecture for award received in 1914  
Atomic Weights (p. 280)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1966

**Richardson, Samuel** 1689–1761

English novelist

Vast is the field of Science. The more a man knows, the more he will find he has to know.

*Sir Charles Grandison* (Volume 1)



Letter 11

Oxford University Press, Inc. Oxford, England. 1972

**Richet, Charles** 1850–1935

French physiologist

To neglect science is to exclude fair hope, to condemn ourselves to live in a uniform monotonous existence.

*The Natural History of a Savant*

Chapter XIII (p. 147)

J.M. Dent &amp; Sons Ltd. London, England. 1927

The future and the happiness of humanity depend on science.

*The Natural History of a Savant*

Chapter XIII (p. 155)

J.M. Dent &amp; Sons Ltd. London, England. 1927

No one has the right to encumber science with premature assertions.

*The Natural History of a Savant*

Chapter X (p. 122)

J.M. Dent &amp; Sons Ltd. London, England. 1927

All...believe in the sovereignty of science; which like the grammar of Martine, rules even over kings, and imperiously subjects them to its laws.

*The Natural History of a Savant*

Chapter II (p. 13)

J.M. Dent &amp; Sons Ltd. London, England. 1927

**Ridley, Matt** 1958–

English science writer

The fuel on which science runs is ignorance. Science is like a hungry furnace that must be fed logs from the forests of ignorance that surround us. In the process, the clearing we call knowledge expands, but the more it expands, the longer its perimeter and the more ignorance comes into view.... A true scientist is bored by knowledge; it is the assault on ignorance that motivates him — the mysteries that previous discoveries have revealed.

The forest is more interesting than the clearing.

*Genome: The Autobiography of a Species in 23 Chapters*

Chapter 20 (p. 271)

HarperCollins Publishers. New York, New York, USA. 2000

**Robinson, Sir Robert** 1886–1975

English chemist

Science cannot be based on dogma or authority of any kind, nor on any institution or revelation, unless indeed it be of the Book of Nature that lies open before our eyes. We need not dwell on the processes of acquiring knowledge by observation, experiment, and inductive and deductive reasoning. The study of scientific method both in theory and practice is of great importance. It is inherent in the philosophy that the record may be imperfect and the conceptions erroneous; the potential fallibility of our science is not only acknowledged but also insisted upon.

Science and the Scientist

*Nature*, Volume 176, Number 4479, September 3, 1955 (p. 434)**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

Pure science has no part in politics.

*Encyclopedia of Thoughts*

Aphorisms 1281

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Religions offer unbounded faith; science, logical preciseness; and the arts, creative imagination.

*Encyclopedia of Thoughts*

Aphorisms 1471

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Science and technology may lead to self-destruction; humanities to sensible social recovery.

*Encyclopedia of Thoughts*

Aphorisms 2937

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Science is advanced by husbands, but wives are often behind them.

*Encyclopedia of Thoughts*

Aphorisms 91

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Dedication to pure science or fine arts often is incompatible with a desire for economic gain.

*Encyclopedia of Thoughts*

Aphorism 1457

Ithaca Heritage Books. Ithaca, New York, USA. 1975

Into the life of a cultured man enter science, art, and poetic philosophy.

*Encyclopedia of Thoughts*

Aphorisms 1220

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Ross, Sir Ronald** 1857–1932

English bacteriologist

We must not accept any speculations merely because they now appear pleasant, flattering, or ennobling to us. We must be content to creep upwards step by step, planting each foot on the firmest finding of the moment, using the compass and such other instruments as we many have, observing without either despair or contempt the clouds and precipices above and beneath us. Especially our duty at present is to better our present foothold; to investigate; to comprehend the forces of nature, to set our State rationally in order; to stamp down disease in body, mind, and government; to lighten the monstrous misery of our fellows, not by windy dogmas, but by calm science.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VIII (p. 233)

Macmillan &amp; Company Ltd. London, England. 1918

**Roszak, Theodore** 1933–

American social critic

Science *uses* the senses but does not *enjoy* them; finally buries them under theory, abstraction, mathematical generalization

*Where the Wasteland Ends*

Chapter 9 (p. 280)

Doubleday & Company. Garden City, New York, USA. 1973

**Rothman, Tony** 1953–

American cosmologist

Principle of Literary Oversight: Textbooks may be straightforward and succinct, but the path of science is crooked and tortuous.

*Instant Physics: From Aristotle to Einstein, and Beyond*

Introduction (p. xi)

Ballentine Books. New York, New York, USA. 1995

**Roux, Joseph** 1725–93

French hydrographer

Science is for those who learn; poetry, for those who know.

*Meditations of a Parish Priest*

Part I, Number 71 (p. 43)

Thomas Y. Crowell & Company New York, New York, USA. 1886

**Rubin, Harry**

No biographical data available

...one of the great pitfalls of science is the fallacy of misplaced concreteness. Scientists seem to prefer questionable explanations to no explanation at all.

Does Somatic Mutation Cause Most Cancers?

*Journal of the National Cancer Institute*, Volume 64, Number 5. May 1980 (p. 999)

**Ruse, Michael** 1940–

English historian and philosopher of science

Science, like most human cultural phenomena, has evolved. What was allowable in the early nineteenth century is not necessarily allowable in the late twentieth century. Specifically, science today does not break with law. And this is what counts for us. We want criteria of science for today, not for yesterday.

Response to the Commentary: Pro Justice

*Science, Technology and Human Values*, Volume 7, Number 41, Fall 1982 (p. 21)

**Ruskin, John** 1819–1900

English writer, art critic, and social reformer

Science does its duty, not in telling us the causes of spots in the sun, but in explaining to us the laws of our own life, and the consequences of their violation.

In Henry Attwell

*Thoughts from Ruskin*

33 (p. 29)

Longmans, Green & Company, New York, New York, USA; 1901

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Science, ever since the time of the Arabs, has had two functions: (1) to enable us to know things, and (2) to enable us to do things.

*The Impact of Science on Society*

Chapter II (p. 18)

Simon & Schuster. New York, New York, USA. 1938

Science has always prided itself on being empirical and believing only what could be verified.

In Robert E. Egner and Lester E. Denonn (eds.)

*The Basic Writings of Bertrand Russell*

Limitations on the Scientific Method (p. 623–24)

Simon & Schuster. New York, New York, USA. 1961

Even if the open windows of science at first make us shiver after the cozy indoor warmth of traditional humanizing myths, in the end the fresh air brings vigor, and the great spaces have a splendor of their own.

*What I Believe*

Chapter I (p. 14)

E.P. Dutton & Company. New York, New York, USA. 1925

In science men have discovered an activity of the very highest value in which they are no longer, as in art, dependent for progress upon the appearance of continually greater genius, for in science the successors stand upon the shoulders of their predecessors; where one man of supreme genius has invented a method, a thousand lesser men can apply it.

*A Free Man's Worship and Other Essays*

Chapter 3 (first published as "The Free Man's Worship" in December 1903)

George Allen & Unwin Ltd. London, England. 1917

A life devoted to science is therefore a happy life, and its happiness is derived from the very best sources that are open to dwellers on this troubled and passionate planet.

*Mysticism and Logic and Other Essays*

Chapter II, Section II (p. 45)

Longmans, Green & Company London, England. 1925

**Sagan, Carl** 1934–96

American astronomer and author

There is no other species on Earth that does science. It is, so far, entirely a human invention, evolved by natural selection in the cerebral cortex for one simple reason: it works. It is not perfect. It can be misused. It is only a tool. But it is by far the best tool we have, self-correcting, ongoing, applicable to everything.

*Cosmos*

Chapter XIII (p. 333)

Random House, Inc. New York, New York, USA. 1980

One of the great commandments of science is, "Mistrust arguments from authority."

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 28)

Random House, Inc. New York, New York, USA. 1995

Science is an attempt, largely successful, to understand the world, to get a grip on things, to get hold of ourselves,

to steer a safe course. Microbiology and meteorology now explain what only a few centuries ago was considered sufficient cause to burn women to death.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 2 (p. 26)

Random House, Inc. New York, New York, USA. 1995

Science involves a seemingly self-contradictory mix of attitudes: On the one hand, it requires an almost complete openness to all ideas, no matter how bizarre and weird they sound, a propensity to wonder... But at the same time, science requires the most vigorous and uncompromising skepticism, because the vast majority of ideas are simply wrong, and the only way you can distinguish the right from the wrong, the wheat from the chaff, is by critical experiment and analysis.

Wonder and Skepticism

*Skeptical Inquirer*, Jan/Feb 1995 (p. 24)

[Science is not popular] is...the fault of the educational system. We do not teach how to think. This is a very serious failure that may even, in a world rigged with 60,000 nuclear weapons, compromise the human future.

The Burden of Skepticism

*Skeptical Inquirer*, Fall 1987

Science demands a tolerance for ambiguity. Where we are ignorant, we withhold belief. Whatever annoyance the uncertainty engenders serves a higher purpose: It drives us to accumulate better data. This attitude is the difference between science and so much else. Science offers little in the way of cheap thrills. The standards of evidence are strict. But when followed they allow us to see far, illuminating even a great darkness.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 20 (p. 365)

Random House, Inc. New York, New York, USA. 1994

Reasoned disputation is the lifeblood of science — as is, sadly, infrequently the case in the intellectually more anemic arena of politics.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Preface (p. ix)

Dell Publishing, Inc. New York, New York, USA. 1975

Science — pure science, science not for any practical application but for its own sake — is a deeply emotional matter for those who practice it, as well as for those non-scientists who every now and then dip in to see what's been discovered lately.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 19 (p. 330)

Random House, Inc. New York, New York, USA. 1995

Cutting off fundamental, curiosity-driven science is like eating the seed corn. We may have a little more to eat next winter, but what will we plant so we and our children will have enough to get through the winters to come?

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 23 (p. 400)

Random House, Inc. New York, New York, USA. 1995

It is a supreme challenge for the popularizer of science to make clear the actual, tortuous history of its great discoveries and the misapprehensions and occasional stubborn refusal by its practitioners to change course.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 1 (p. 22)

Random House, Inc. New York, New York, USA. 1995

Science is far from a perfect instrument of knowledge. It's just the best we have.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 2 (p. 27)

Random House, Inc. New York, New York, USA. 1995

### **Sandage, Allan** 1926–

American astronomer

Science is the only self-correcting human institution, but it also is a process that progresses only by showing itself to be wrong.

In Alan Lightman and Roberta Brawer

*Origins: The Lives and Worlds of Modern Cosmologists*  
Allan Sandage (p. 82)

Harvard University Press. Cambridge, Massachusetts, USA. 1990

### **Santayana, George (Jorge Augustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

Science is a half-way house between private sensation and universal vision.

*The Life of Reason; or The Phases of Human Progress*

Part V, Chapter I (p. 385)

Charles Scribner's Sons. New York, New York, USA. 1953

### **Sarnoff, David** 1891–1971

Russian-born American broadcasting executive

At their best, at their most creative, science and engineering are attributes of liberty — noble expressions of man's God-given right to investigate and explore the universe without fear of social or political or religious reprisals.

In Emily Davie (ed.)

*Profile of America: An Autobiography of the U.S.A.*

Electronics — Today and Tomorrow

Crowell. New York, New York, USA. 1954

### **Scatchard, George** 1892–1973

American physical chemist

Since science progresses by building block upon block, it is important to examine the structure from time to time to make sure that there are no badly fitted blocks, none which are being made to carry more than their proper capacity and none which might be made more useful.

Equilibrium Thermodynamics and Biological Chemistry

*Science*, Volume 95, Number 2454, January 9, 1942 (p. 27)

### **Schiebinger, Londa** 1952–

Science historian

Only recently have we begun to appreciate that who does science affects the kind of science that gets done. How, then, has our knowledge of nature been influenced by struggles determining who is included in science and who is excluded, which projects are pursued and which ignored, whose experiences are validated and whose are not, and who stands to gain in terms of wealth or well-being and who does not?

*Nature's Body: Gender in the Making of Modern Science*

Introduction (p. 3)

Beacon Press. Boston, Massachusetts, USA. 1993

**Schiller, Ferdinand Canning Scott** 1864–1937

English philosopher

To Archimedes once came a youth, who for knowledge was thirsting,

Saying, "Initiate me into the science divine,  
Which for my country has borne forth fruit of such wonderful value,

And which the walls of the town 'gainst the Sambuca protects.

"Calls't thou the science divine? It is so," the wise man responded;

"But it was so, my son, ere it avail'd for the town.

Wouldst thou have fruit from her only, e'en mortals wit that can provide thee;

Wouldst thou the goddess obtain, seek not the woman in Her!"

In Edgar Alfred Bower

*The Poems of Schiller*

Archimedes and the Student (p. 262)

John W. Parker & Son. London, England. 1851

Science: To one, she is the exalted and heavenly Goddess; to another she is a capable cow which keeps him supplied with butter.

In Folke Doving

*Knowledge and Ignorance: Essays on Lights and Shadows*

Chapter Ten (p. 141)

Praeger. Westport, Connecticut, USA. 1998

**Schneer, Cecil J.** 1923–

American science historian and mineralogist

The primary importance of science and the characteristic that distinguished it from other philosophies and arts is its usefulness. The remarkable thing about science is the extent to which nature and the world appear to adhere to the rules and constructions of science.

*The Evolution of Physical Science*

Grove Press, Inc. New York, New York, USA. 1960

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

...there is a tendency to forget that all science is bound up with human culture in general, and that scientific findings, even those which at the moment appear the most advanced and esoteric and difficult to grasp, are meaningless outside their cultural context.

Are There Quantum Jumps?

*The British Journal for the Philosophy of Science*, Volume 3, 1952 (p. 109)

A theoretical science unaware that those of its constructs considered relevant and momentous are destined eventually to be framed in concepts and words that have a grip on the educated community and become part and parcel of the general world picture — a theoretical science, I say, where this is forgotten, and where the initiated continue musing to each other in terms that are, at best, understood by a small group of close fellow travelers, will necessarily be cut off from the rest of cultural mankind; in the long run it is bound to atrophy and ossify however virulently esoteric chat may continue within its joyfully isolated groups of experts.

Are There Quantum Jumps?

*The British Journal for the Philosophy of Science*, Volume 3, 1952 (p. 110)

...the scientific picture of the real world around me is very deficient. It gives a lot of factual information, puts all our experience in a magnificently consistent order, but it is ghastly silent about all and sundry that is really near to our heart, that really matters to us. It cannot tell us a word about red and blue, bitter and sweet, physical pain and physical delight; it knows nothing of beautiful and ugly, good or bad, God and eternity. Science sometimes pretends to answer questions in these domains, but the answers are very often so silly that we are not inclined to take them seriously.

*Nature and the Greeks*

Chapter VII (p. 93)

At The University Press. Cambridge, England. 1954

**Schwartz, John** 1941–

American theoretical physicist

Science is a long movie, and the news media generally take mere snapshots.

If You Seek the Truth, Don't Trash the Science

*Washington Post*, 21 February, 1999 (p. B-1)

**Seifriz, William**

No biographical data available

Let me give full credit to the young and enthusiastic research workers, full of high-energy phosphate bonds. What I deplore is their attitude of mind. Science has become tough and students learn to accept it that way.

A New University

*Science*, Volume 120, Number 3107, 16 July 1954 (p. 89)

**Shapiro, Harry L.** 1902–90

American physical anthropologist

Science, like organic life, has ramified by expanding into unoccupied areas and then adapting itself to the special requirements encountered there.

Symposium on the History of Anthropology, the History and Development of Physical Anthropology

*American Anthropologist*, Volume 61, Number 3, 1959 (p. 371)

...as the diversified forms of animals, plants, and insects make evident by their morphology and their function the characteristics of ecological niches whose very existence might otherwise escape notice, so the diversity of techniques and concepts of scientific specialties by their very formulation reveal aspects of nature we would not have suspected. Anthropology, like other branches of science, has also embodied in its structure whole new worlds rich in insights into the development and nature of man.

Symposium on the History of Anthropology, the History and Development of Physical Anthropology  
*American Anthropologist*, Volume 61, Number 3, 1959 (p. 371)

**Shapiro, Robert** 1935–

American DNA researcher and author

Science is not a given set of answers but a system for obtaining answers. The method by which the search is conducted is more important than the nature of the solution. Questions need not be answered at all, or answers may be provided and then changed. It does not matter how often or how profoundly our view of the universe alters, as long as these changes take place in a way appropriate to science. For the practice of science, like the game of baseball, is covered by definite rules.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*  
Chapter One (p. 33)  
Summit Books. New York, New York, USA. 1986

Science is not the place for those who want certainty, who wish the truths they learned in childhood to reassure them in their old age. Surprises occur, and alter our perception of reality — for example, the discovery of radioactivity or the genetic role of DNA.... When we treat each new observation and theory with skepticism, retaining our doubt until it has passed the test of experience, and then place it alongside our other acquisitions with the care of a collector who has acquired a valued object after a long search, then we can experience the joy of science. It is this joy, rather than an insistence on an immediate answer, that is likely to be our reward as we continue to search for the origin of life. But even in this conclusion, let us exercise some caution. We may be closer to the answer than we think.

*Origins: A Skeptic's Guide to the Creation of Life on Earth*  
Chapter Thirteen (p. 312)  
Summit Books. New York, New York, USA. 1986

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Science becomes dangerous only when it imagines that it has reached its goal.

*The Doctor's Dilemma*

Preface on Doctors

The Latest Theories (p. xc)

Brentano's. New York, New York, USA. 1920

Science is always simple and always profound. It is only the half-truths that are dangerous.

*The Doctor's Dilemma*

Act I (p. 24)

Brentano's. New York, New York, USA. 1920

**Shelley, Mary** 1797–1851

English Romantic writer

You seek for knowledge and wisdom, as I once did; and I ardently hope that the gratification of your wishes may not be a serpent to sting you, as mine has been.

*Frankenstein*

Letter 4 (p. 27)

Running Press. Philadelphia, Pennsylvania, USA. 1990

The ambition of the enquirer seemed to limit itself to the annihilation of those visions on which my interest in science was chiefly founded. I was required to exchange chimeras of boundless grandeur for realities of little worth.

*Frankenstein*

Chapter 3 (p. 38)

Running Press. Philadelphia, Pennsylvania, USA. 1990

Life and death appeared to me ideal bounds, which I should first break through, and pour a torrent of light into our dark world.

*Frankenstein*

Chapter 4 (p. 43)

Running Press. Philadelphia, Pennsylvania, USA. 1990

“Man,” I cried, “how ignorant art thou in thy pride of wisdom!”

*Frankenstein*

Chapter 23 (p. 141)

Running Press. Philadelphia, Pennsylvania, USA. 1990

**Shelley, Percy Bysshe** 1792–1822

English poet

The cultivation of those sciences which have enlarged the limits of the empire of man over the external world, has, for want of the poetical faculty, proportionally circumscribed those of the internal world; and man, having enslaved the elements, remains himself a slave.

In Fanny Delisle

*A Study of Shelley's "A Defence of Poetry"* (Volume 1)

Line 1223 (p. 138)

Institute für Englische Sprache und Literatur. Salzburg, Austria. 1974

**Shermer, Michael** 1954–

American science writer

What separates science from all other human activities (and morality has never been successfully placed on a scientific basis) is its commitment to the tentative nature of all its conclusions. There are no final answers in science, only varying degrees of probability. Even scientific “facts” are just conclusions confirmed to such an extent that it would be reasonable to offer temporary agreement, but that assent is never final.

*Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time*

Part 2, Chapter 8 (p. 124)

Henry H. Holt. New York, New York, USA. 2002

Science is not the affirmation of a set of beliefs but a process of inquiry aimed at building a testable body of knowledge constantly open to rejection or confirmation. In science, knowledge is fluid and certainty fleeting. That is at the heart of its limitations. It is also its greatest strength.

*Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time*

Part 2, Chapter 8 (p. 124)

Henry H. Holt. New York, New York, USA. 2002

### **Shu, Frank H.**

American theoretical astrophysicist

Science has a beauty and uplifting spirit which rivals any of the other cultural attainments of humanity. This aesthetic response arose in a recent congressional hearing. When asked how particle physics contributes to the defense of our country, Robert Wilson replied that it makes the country worth defending.

*The Physical Universe: An Introduction to Astronomy* (p. 101)

University Science Books. Mill Valley, California, USA. 1982

### **Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

Science comes from the knowing that you want to know.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #298 (p. 68)

Definition Press. New York, New York, USA. 1972

### **Silver, Brian L.**

Israeli professor of physical chemistry

One point is incontestable: the “truth” of science must always remain open to critical scrutiny and will sometimes have the status of a beauty queen: looks good today, but next year she’ll be dethroned. That is because the real test of a scientific theory is not whether it is “true.” The real test is whether it works.

*The Ascent of Science*

Part I, Chapter 2 (p. 24)

Solomon Press Book. New York, New York, USA. 1998

Science is not a harmless intellectual pastime. In the last two centuries we have moved from being simply observers of nature to being, in a modest but growing way, its controller. Concomitantly, we have occasionally disturbed the balance of nature in ways that we did not always understand. Science has to be watched. The layman can no longer afford to stand to one side, ignorant of the meaning of advances that will determine the kind of world that his children will inhabit—and the kind of children that he will have. Science has become part of the human race’s way of conceiving of and manipulating its future. The manipulation of the future is not a question to be left to philosophers. The answers can affect the

national budget, the health of your next child, and the long-term prospects for life on this planet.

*The Ascent of Science*

Preface (p. xiv)

Solomon Press Book. New York, New York, USA. 1998

Science, man’s greatest intellectual adventure, has rocked his faith and engendered dreams of a material Utopia. At its most abstract, science shades into philosophy; at its most practical, it cures disease. It has eased our lives and threatened our existence. It aspires, but in some very basic ways fails, to understand the ant and the Creation, the infinitesimal atom and the mind-bludgeoning immensity of the cosmos. It has laid its hand on the shoulders of poets and politicians, philosophers and charlatans. Its beauty is often apparent only to the initiated, its perils are generally misunderstood, its importance has been both over- and underestimated, and its fallibility, and that of those who create it, is often glossed over or malevolently exaggerated.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

...the history of science may be a trail littered with broken theories and discarded concepts, science is also a triumph of reason, luck, and above all imagination. There are few more successful, exciting, or strange journeys.

*The Ascent of Science*

Preface (p. xiv)

Solomon Press Book. New York, New York, USA. 1998

### **Simon, Herbert Alexander** 1916–2001

American social scientist

The central task of a natural science is to make the wonderful commonplace: to show that complexity, correctly viewed, is only a mask for simplicity; to find pattern hidden in apparent chaos.

*The Sciences of the Artificial*

Chapter I (p. 1)

The MIT Press. Cambridge, Massachusetts, USA. 1969

### **Simpson, George Gaylord** 1902–84

American paleontologist

The important distinction between science and those other systematizations [*i.e.*, art, philosophy, and theology] is that science is self-testing and self-correcting. Here the essential point of science is respect for objective fact. What is correctly observed must be believed...the competent scientist does quite the opposite of the popular stereotype of setting out to prove a theory; he seeks to disprove it.

*Notes on the Nature of Science*

Notes on the Nature of Science by a Biologist (p. 9)

Harcourt, Brace & World, Inc. New York, New York, USA. 1962

As for the scope of science, it includes everything known to exist or to happen in the material universe. Since the

arts, philosophy, and theology do exist in the material universe, they too are within the scope of science and can properly be studied as psychological, anthropological, and biological phenomena.

*Notes on the Nature of Science*

Notes on the Nature of Science by a Biologist (pp. 11–12)

Harcourt, Brace & World, Inc. New York, New York, USA. 1962

### **Singer, Charles** 1876–1960

Historian of science and medicine

To succeed in science it is necessary to receive the tradition of those who have gone before us. In science, more perhaps than in any other study, the dead and the living are one.

In Lloyd William Taylor

*Physics: the Pioneer Science* (Volume 1)

Chapter 15 (p. 182)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

### **Slosson, Edwin E.** 1865–1929

American chemist and journalist

Science consists in learning from nature how to surpass nature.

Spun Logs

*The Scientific Monthly*, December 1925

Most people think of science as a serious and solemn thing, a strain upon the strongest intellect.

So it is for the pioneers of scientific progress, but not for those who merely follow along behind.

*Chats on Science*

Introduction (p. 1)

G. Bell & Sons Ltd. London, England. 1924

### **Smith, Adam** 1723–1790

Scottish moral philosopher and founder of modern economic theory

Science is the great antidote to the poison of enthusiasm and superstition.

*An Inquiry into the Nature and Causes of the Wealth of Nations*

Book V, Chapter I, part III, Section III (p. 748)

The Modern Library. New York, New York, USA. 1937

### **Smith, Henry Preserved** 1847–1927

American Biblical scholar

More and more, science has become not only increasingly necessary as a foundation for professional skill, but has come to be regarded as the most valuable instrument of culture.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 28 (p. 395)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

...whether as the new salvation or the new superstition, science has modeled the whole life of the modern world.... All modern production of wealth, all contemporary life, depend on the knowledge of nature acquired by science. But more than that, religion, politics,

philosophy, art and literature have capitulated to science, or at least receded before her. There is no department of human activity today untouched with the spirit of experiment and of mathematics.

*A History of Modern Culture* (Volume 1)

Epilogue (p. 606)

Peter Smith. Gloucester, Massachusetts, USA. 1957

### **Smith, Sydney** 1771–1845

English clergyman, writer, and wit

Science is his forte, and omniscience his foible.

In Isaac Todhunter

*William Whewell* (Volume 1)

Conclusion (p. 410)

Macmillan & Company Ltd. London, England. 1876

### **Smolin, Lee** 1955–

American theoretical physicist

Science is, above everything else, a search for an understanding of our relationship with the rest of the universe.

*The Life of the Cosmos*

Part One, Chapter One (p. 23)

Oxford University Press, Inc. New York, New York, USA. 1997

### **Smyth, Nathan A.**

No biographical data available

To recognize with science that beyond our horizon lies impenetrable mystery will serve but to increase our reverence for the glory of the whole.

*Through Science to God*

Chapter I (p. 5)

The Macmillan Company. New York, New York, USA. 1936

### **Snow, Charles Percy** 1905–80

English novelist and scientist

But after the idyllic years of science, we passed into a tempest of history; and by an unfortunate coincidence, we passed into a technological tempest, too.

In Paul C. Opler and Herman A. Estrin (eds.)

*The New Scientist: Essays on the Methods and Value of Modern Science*

The Moral Un-Neutrality of Science (p. 135)

### **Soddy, Frederick** 1877–1956

English chemist

As science advances and most of the more accessible fields of knowledge have been gleaned of their harvest, the need for more and more powerful and elaborate appliances and more and more costly materials ever grows.

*Science and Life*

Science and the State (p. 60)

E.P. Dutton & Company, Inc. New York, New York, USA. 1920

### **Somerville, Mary** 1780–1872

English mathematician

Science, regarded as the pursuit of truth, which can only be attained by patient and unprejudiced investigation,

wherein nothing is too great to be attempted, nothing so minute as to be justly disregarded, must ever afford occupation of consummate interest and subject of elevated meditation.

*On the Connexion of the Physical Sciences*  
Section I (p. 2)  
John Murray. London, England. 1834

**Sorokin, Pitirim A.** 1889–1968  
Russian-born American sociologist

Any science, at any moment of its historical existence, contains not only truth but also much that is half-truth, sham-truth, and plain error.

*Fads and Foibles in Modern Sociology*  
Preface (p. v)  
Henry Regnery. Chicago, Illinois, USA. 1956

**Spark, Muriel** 1918–2006  
Scottish novelist

Art and religion first; then philosophy; lastly science. That is the order of the great subjects of life, that's their order of importance.

*The Prime of Miss Jean Brodie*  
Chapter 2 (p. 39)  
Macmillan & Company Ltd. London, England. 1961

**Spencer, Herbert** 1820–1903  
English social philosopher

What knowledge is of most worth? — the uniform reply is — Science. This is the verdict on all counts.

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 84)  
A.L. Fowle. New York, New York, USA. 1860

For direct self-preservation, or the maintenance of life and health, the all-important knowledge is — Science. For the indirect self-preservation which we call gaining a livelihood, the knowledge of greatest value is — Science. For that interpretation of national life, past and present, without which the citizen cannot rightly regulate his conduct, the indispensable key is — Science. Alike for the most perfect production and highest enjoyment of art in all its forms, the needful preparation is still — Science. And for the purposes of discipline — intellectual, moral, religious — the most efficient study is, once more — Science.

*Education: Intellectual, Moral, and Physical*  
Chapter I (pp. 84–85)  
A.L. Fowle. New York, New York, USA. 1860

Only when Genius is married to Science, can the highest results be produced.

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 70)  
A.L. Fowle. New York, New York, USA. 1860

Devotion to science is a tacit worship — a tacit recognition of worth in the things one studies; and by implication

in their cause. It is not a mere lip-homage, but a homage expressed in actions — not a mere professed respect, but a respect proved by the sacrifice of time, thought, and labour.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter III (p. 41)  
Macmillan & Company Ltd. London, England. 1918

**Spencer-Brown, George** 1923–  
English mathematician and polymath

Left to itself, the world of science slowly diminishes as each result classed as scientific has to be reclassified as anecdotal or historical... Science is a continuous living process; it is made up of activities rather than records; and if the activities cease it dies.

*Probability and Scientific Inference*  
Chapter XV (p. 107)  
Longmans, Green & Company. London, England. 1957

**Stanislaus, Leszczynski (Stanislaus I)** 1677–1766  
King of Poland

Science when well digested is nothing but good sense and reason.

*Maxims*  
No. 43  
Publisher undetermined

**Stansfield, William D.** 1930–  
American biologist

Most scientific theories, however, are ephemeral. Exceptions will likely be found that invalidate a theory in one or more of its tenets. These can then stimulate a new round of research leading either to a more comprehensive theory or perhaps to a more restrictive (*i.e.*, more precisely defined) theory. Nothing is ever completely finished in science; the search for better theories is endless. The interpretation of a scientific experiment should not be extended beyond the limits of the available data. In the building of theories, however, scientists propose general principles by extrapolation beyond available data. When former theories have been shown to be inadequate, scientists should be prepared to relinquish the old and embrace the new in their never-ending search for better solutions. It is unscientific, therefore, to claim to have “proof of the truth” when all that scientific methodology can provide is evidence in support of a theory.

*The Science of Evolution*  
Introduction (p. 8)  
Macmillan Publishing Company. New York, New York, USA. 1977

**Stenger, Victor J.** 1935–  
American physicist

No one ever said science was easy, and nobody, scientist or not, should be expected to fall over and play dead when a challenge to existing knowledge is made. If a new



idea has sufficient merit, it should ultimately overcome any resistance, no matter how strong.... Resistance to new ideas is part of the process of science. A worthy new idea must overcome barriers of doubt and skepticism, and even occasional irrational objections. But if an idea has merit, it will eventually climb over these barriers.

*Physics and Psychics: The Search for a World Beyond the Senses*  
Chapter 3 (p. 65)

Prometheus Books. Buffalo, New York, USA. 1990

### **Sterne, Laurence** 1713–68

English novelist and humorist

Sciences may be learned by rote, but Wisdom not.

*The Life and Opinions of Tristram Shandy, Gentleman and A Sentimental Journey Through France and Italy* (Volume 1)

Book V, Chapter XXXII (p. 356)

Macmillan & Company Ltd. London, England. 1900

### **Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

Science writes of the world as if with the cold finger of a starfish; it is all true; but what is it when compared to the reality of which it discourses, where hearts beat high in April, and death strikes, and hills totter in the earthquake, and there is a glamour over all the objects of sight, and a thrill in all noises for the ear, and Romance herself has made her dwelling among men? So we come back to the old myth, and hear the goat-footed piper making the music which is itself the charm and terror of things; and when a glen invites our visiting footsteps, fancy that Pan leads us thither with a gracious tremolo; or when our hearts quail at the thunder of the cataract, tell ourselves that he has stamped his hoof in the nigh thicket.

*Virginibus Puerisque and Familiar Studies of Men and Books*

Pan's Pipe (p. 108)

J.M. Dent & Sons Ltd. London, England. No date

### **Steward, J. H.**

No biographical data available

It is the unhappy lot of science that it must clear the ground of flimsy and fanciful structures built upon false premises and errors of fact before it can build anew.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1936*

Petroglyphs of the United States (p. 407)

Government Printing Office. Washington, D.C. 1937

### **Stewart, Ian** 1945–

English mathematician and science writer

Science is a collective activity, and the actions of each individual resonate and interact with those of the others in a pattern so gigantic that we can no more comprehend the whole than a blood cell can comprehend how its host feels when it mashes a finger in a car door.

*The Problems of Mathematics*

Chapter 20 (p. 234)

Oxford University Press, Inc. Oxford, England. 1987

### **Stoker, Bram** 1847–1912

English writer

There are mysteries which men can only guess at, which age by age they may solve only in part.

*Dracula*

Chapter XV (p. 217)

Ameron House. Mattituck, New York, USA. No date

### **Strutt, John William (Lord Rayleigh)** 1842–1919

English physicist

There are some great men of science whose charm consists in having said the first word on a subject, in having introduced some new idea which has proved fruitful; there are others whose charm consists perhaps in having said the last word on the subject, and who have reduced the subject to logical consistency and clearness.

*Life of John William Strutt: Third Baron Rayleigh*

Chapter XVII (p. 310)

University of Wisconsin Press. Madison, Wisconsin, USA. 1968

### **Sullivan, John William Navin** 1886–1937

Irish mathematician

Science, like everything else that man has created, exists, of course, to gratify certain human needs and desires. The fact that it has been steadily pursued for so many centuries, that it has attracted an ever-wider extent of attention, and that it is now the dominant intellectual interest of mankind, shows that it appeals to a very powerful and persistent group of appetites.

*The Limitations of Science*

Introduction (p. 7)

New American Library. New York, New York, USA. 1956

...science deals with but a partial aspect of reality, and there is no faintest reason for supposing that everything science ignores is less real than what it accepts... Why is it that science forms a closed system? Why is it that the elements of reality it ignores never come in to disturb it? The reason is that all the terms of physics are defined in terms of one another. The abstractions with which physics begins are all it ever has to do with.

*The Limitations of Science*

Chapter 6, Section IV (p. 147)

New American Library. New York, New York, USA. 1956

### **Swann, William Francis Gray** 1884–1962

Anglo-American physicist

The forerunners in the march of science do not often come heralded by much ceremony suggestive of the power that lies behind them. Often in apparent trivialities do they reveal themselves — trivialities so void of spectacular content that but few can be found who deem it worth while to listen to their story.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

Three Centuries of Natural Philosophy (p. 237)

Government Printing Office. Washington, D.C. 1929

**Swenson, Jr., Lloyd S.**

No biographical data available

The interplay of thought and action, theory and experiment, individuals and institutions in science is both comic and tragic, despite the actors' common belief that their lines are delivered as if for a triumphal pageant rather than a tragicomic play.

*Genesis of Relativity: Einstein in Context*

Preface (p. xiii)

Burt Franklin & Company, Inc. New York, New York, USA. 1979

**Tatishchev, Vasili Nikitich** 1686–1750

Russian historian and geographer

Freedom is not an essential and basic condition for the growth of science; the care and diligence of government authorities are the most important conditions for this development.

USA

*OMNI Magazine*, Volume 3, Number 1, October 1980 (p. 41)

**Teall, J. J. Harris** 1849–1924

British geologist

The chief glory of science is, not that it produces an amelioration of the conditions under which we live, but that it continually enlarges our view, introduces new ideas, new ways of looking at things, and thus contributes in no small degree to the intellectual development of the human race.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

The Evolution of Petrological Ideas (p. 288)

Government Printing Office. Washington, D.C. 1903

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

Science introduces consistency and simplicity into a world that without them appears confused and random.

*Better a Shield than a Sword: Perspectives in Defense and Technology*

Chapter 29 (p. 215)

The Free Press. New York, New York, USA. 1987

Science, like music or art, is not something that can or should be practiced by everybody. But we want all children to be able to enjoy music, to be able to tell good music from poor music, so we teach them to appreciate music in a discriminating manner. That should be the aim in science education for the nonscientist.

*Better a Shield than a Sword: Perspectives in Defense and Technology*

Chapter 28 (p. 208)

The Free Press. New York, New York, USA. 1987

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

**Teller, Wendy**

No biographical data available

If there ever was a misnomer, it is "exact science." Science has always been full of mistakes. The present day is

no exception. And our mistakes are good mistakes; they require a genius to correct them. Of course, we do not see our own mistakes.

*Conversations on the Dark Secrets of Physics*

Chapter 3 (p. 37)

Plenum Press. New York, New York, USA. 1991

**Temple, Frederick** 1821–1902

Anglican prelate and archbishop of Canterbury

The regularity of nature is the first postulate of Science; but it requires the very slightest observation to show us that, along with this regularity, there exists a vast irregularity which Science can only deal with by exclusion from its province.

*The Relations Between Religion and Science* (p. 99)

Macmillan & Company. New York, New York, USA. 1884

**Temple, G.**

No biographical data available

...any serious examination of the basic concepts of any science is far more difficult than the elaboration of their ultimate consequences.

*Turning Points in Physics: A Series of Lectures Given at Oxford*

*University in Trinity Term, 1958* (p. 68)

Interscience Publishers. New York, New York, USA. 1959

**Tennyson, Alfred (Lord)** 1809–92

English poet

Science moves, but slowly, slowly, creeping on from point to point.

*Alfred Tennyson's Poetical Works*

Locksey Hall, Stanza 60

Oxford University Press, Inc. London, England. 1953

...nourishing a youth sublime

With the fairy tales of science, and the long result of time.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 6

Oxford University Press, Inc. London, England. 1953

**Thom, René** 1923–2002

French mathematician

If we admit a priori that science is just acquisition of knowledge, that is, building an inventory of all observable phenomena in a given disciplinary domain — then, obviously, any science is empirical.

In J. Casti and A. Karlqvist (eds.)

*Newton to Aristotle: Toward a Theory of Models for Living Systems*

Causality and Finality in Theoretical Biology

**Thomas, Lewis** 1913–93

American physician and biologist

You either have science or you don't, and if you have it you are obliged to accept the surprising and disturbing pieces of information, even the overwhelming and upheaving ones, along with the neat and promptly useful bits. It is like that.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
The Hazard of Science (p. 73)  
The Viking Press. New York, New York, USA. 1979

The central task of science is to arrive, stage by stage, at a clearer comprehension of nature, but this does not mean, as it is sometimes claimed to mean, a search for mastery over nature.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*  
Humanities and Science (p. 153)  
Viking Press. New York, New York, USA. 1983

The essential wildness of science as a manifestation of human behavior is not generally perceived. As we extract new things of value from it, we also keep discovering parts of the activity that seem in need of better control, more efficiency, less unpredictability.

*The Lives of a Cell: Notes of a Biology Watcher*  
Natural Science (p. 100)  
The Viking Press. New York, New York, USA. 1974

Science began by fumbling. It works because the people involved in it work, and work together. They become excited and exasperated, they exchange their bits of information at a full shout, and, the most wonderful thing of all, they keep at one another.

*Late Night Thoughts on Listening to Mahler's Ninth Symphony*  
Alchemy  
The Viking Press. New York, New York, USA. 1983

### Thompson, A. R.

No biographical data available

...science has not only helped to destroy popular traditions that might have nourished a modern spirit of admiration, but has fostered a wintry skepticism, making man appear not an imperfect angel, but a super-educated monkey.

In R. Foerster (ed.)  
*Humanism and America: Essays on the Outlook of Modern Civilization*  
The Dilemma of Modern Tragedy (p. 129)  
Farrar & Rinehart Inc. New York, New York, USA. 1930

### Thomson, J. Arthur 1861–1933

Scottish biologist

When science makes minor mysteries disappear, greater mysteries stand confessed. For one object of delight whose emotional value science has inevitably lessened — as Newton damaged the rainbow for Keats — science gives back double.

*The Outline of Science* (Volume 4)  
Chapter XXXVIII (p. 1176)  
G.P. Putnam's Sons. New York, New York, USA. 1937

To the grand primary impression of the world power, the immensities, the pervading order, and the universal flux, with which the man of feeling has been nurtured from the old, modern science has added thrilling impressions of manifoldedness, intricacy, uniformity, inter-relatedness, and evolution. Science widens and clears the emotional

window. There are great vistas to which science alone can lead, and they make for elevation of mind.

*The Outline of Science* (Volume 4)  
Chapter XXXVIII (pp. 1176–1177)  
G.P. Putnam's Sons. New York, New York, USA. 1937

The opposition between science and feeling is largely a misunderstanding. As one of our philosophers has remarked, Science is in a true sense “one of the humanities.”

*The Outline of Science* (Volume 4)  
Chapter XXXVIII (p. 1177)  
G.P. Putnam's Sons. New York, New York, USA. 1937

Science expresses a quite specific endeavor to get phenomena under intellectual control, so that we can think of them economically and clearly in relation to the rest of our science, and so that we can use them as a basis for secure prediction and effective action.

*The System of Animate Nature* (Volume 1)  
Lecture I (p. 8)  
William & Norgate. London, England. 1920

Science as science never asks the question Why? That is to say, it never inquires into the meaning, or significance, or purpose of this manifold Being, Becoming, and Having Been.... Thus science does not pretend to be a bedrock of truth.

In Bertrand Russell  
*Religion and Science*  
Mysticism (p. 175)  
Henry Holt & Company. New York, New York, USA. 1935

Science makes so many permanent discoveries, which are never contradicted though often transcended, that she acquires an assured confidence which has only been equaled by that of Theology.

*The System of Animate Nature* (Volume 1)  
Lecture I (p. 13)  
William & Norgate. London, England. 1920

Science is one of the pathways toward the truth, but there are other pathways.

The New World of Science  
*The Atlantic Monthly*, June 1930

Science is not wrapped up with any particular body of facts; it is characterized as an intellectual attitude. It is not tied down to any peculiar methods of inquiry; it is simply sincere critical thought, which admits conclusions only when these are based on evidence.

*Introduction to Science*  
Chapter I (p. 27)  
Williams & Norgate Ltd. London, England. 1916

Science is always setting forth on Columbus voyages, discovering new worlds and conquering them by understanding.

*The Outline of Science* (Volume 1)  
Introduction (p. 3)  
G.P. Putnam's Sons. New York, New York, USA. 1937

Science is frankly empirical in method and aim; it seeks to discover the laws of concrete being and becoming,

and to formulate these in the simplest terms, which are either immediate data of experience or verifiably derived therefrom.

*The System of Animate Nature* (Volume 1)  
Lecture I (p. 39)  
William & Norgate. London, England. 1920

Science is a particular way of looking at the world, but it is not the only way.

The New World of Science  
*The Atlantic Monthly*, June 1930

Great stores of wealth are awaiting the scientific “Open Sesame”; a great heightening of the standard of health will be attainable in a few generation if men of good-will take science as their torch.

*The Outline of Science* (Volume 4 )  
Chapter XXXVIII (p. 1180)  
G.P. Putnam’s Sons. New York, New York, USA. 1937

Is it science that satisfies man’s soul, or is it the attendant feeling and imagining which the study of Nature evokes?

*The System of Animate Nature* (Volume 1)  
Lecture I (p. 27)  
William & Norgate. London, England. 1920

...science gives Man from time to time a greatly increased mastery over Nature; science, with its analytical triumphs, ever tends to diminish, in the shallowminded, the saving grace of wonder; and science is ever dispelling the darkness that oppresses the mind.

*The System of Animate Nature* (Volume 1)  
Lecture I (pp. 41–42)  
William & Norgate. London, England. 1920

...science aims at description in terms of the lowest common denominators available; while religion and philosophy aim at interpretation in terms of the greatest common measure.

The New World of Science  
*The Atlantic Monthly*, June 1930

**Thomson, Sir George** 1892–1975  
English physicist

The influence of science on men’s lives comes in two rather different ways — one through the ideas themselves, and the other through their material consequences.

The New Industrial Revolution  
*Bulletin of the Atomic Scientists*, Volume 13, Number 1, January 1957 (p. 9)

[The method of science is] a collection of pieces of advice, some general, some rather special, which may help to guide the explorer in his passage through the jungle of apparently arbitrary facts.... In fact, the sciences differ so greatly that it is not easy to find any sort of rule which applies to all without exception.

*The Inspiration of Science*  
Chapter II (p. 7)  
Oxford University Press, Inc. London, England. 1961

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

There is a chasm between knowledge and ignorance which the arches of science can never span.

*The Writings of Henry David Thoreau* (Volume 1)  
A Week on the Concord and Merrimack Rivers  
Sunday (p. 125)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

What an admirable training is science for the more active warfare of life! Indeed, the unchallenged bravery which these studies imply, is far more impressive than the trumpeted valor of the warrior.

*The Writings of Henry David Thoreau* (Volume 9)  
Natural History of Massachusetts (p. 131)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Science with its retorts would have put me to sleep; it was the opportunity to be ignorant that I improved. It suggested to me that there was something to be seen if one had eyes. It made a believer of me more than before. I believed that the woods were not tenantless, but choke-full of honest spirits as good as myself any day, — not an empty chamber, in which chemistry was left to work alone, but an inhabited house, — and for a few moments I enjoyed fellowship with them.

*The Writings of Henry David Thoreau* (Volume 3)  
The Maine Woods, the Allegash and East Branch (pp. 247–248)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Let us consider under what disadvantages Science has hitherto labored before we pronounce thus confidently on her progress.

*The Writings of Henry David Thoreau* (Volume 4 )  
Paradise (to Be) Regained (p. 301)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

Already nature is serving all those uses which science slowly derives on a much higher and grander scale to him that will be served by her. When the sunshine falls on the path of the poet, he enjoys all those pure benefits and pleasures which the arts slowly and partially realize from age to age. The winds which fan his cheek waft him the sum of that profit and happiness which their lagging inventions supply.

*The Writings of Henry David Thoreau* (Volume 4 )  
Paradise (to Be) Regained (p. 302)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Thorne, Kip S.** 1940–  
American theoretical physicist

Science is a community enterprise. The insights that shape our view of the Universe come not from a single person or a small handful, but from the combined efforts of many.

*Black Holes and Time Warps: Einstein’s Outrageous Legacy*  
Preface (p. 18)  
W.W. Norton & Company, Inc. New York, New York, USA. 1994

**Thurber, James** 1894–1961  
American writer and cartoonist

Science has zipped the atom open in a dozen places, it can read the scrawling on the Rosetta stone as glibly as a literary critic explains Hart Crane, but it doesn't know anything about playwrights.

*Collecting Himself: James Thurber on Writing and Writers, Humor and Himself*

Roaming in the Gloaming (p. 194)

Harper & Row, Publishers. New York, New York, USA. 1989

**Tolstoy, Leo** 1828–1910  
Russian writer

What is called science today consists of a haphazard heap of information, united by nothing, often utterly unnecessary, and not only failing to present one unquestionable truth, but as often as not containing the grossest errors, today put forward as truths, and tomorrow overthrown.

*What Is Religion?*

Chapter I (p. 3)

T.Y. Crowell. New York, New York, USA. 1899

The highest wisdom has but one science — the science of the whole — the science explaining the whole creation and man's place in it.

*In Great Books of the Western World* (Volume 51)

*War and Peace*

Book Five, Chapter II (p. 197)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Toynbee, Arnold J.** 1852–83  
English historian

There have been many definitions of the word "science." Perhaps the most generally accepted one is that science is a form of study in which there can be an exact knowledge of the present and the past and, through this, an infallible prediction of the future. If this is what science means, then no study made by a human mind can be completely scientific.

*Occasional Paper, The Institute for the Study of Science in Human Affairs*

Science in Human Affairs: An Historian's View

**Tucker, Wilson** 1914–2006  
American mystery and science fiction writer

...Science tends to frighten those who are infrequently exposed to it, while the practitioners of science are often the most misunderstood people in the world....

*The Year of the Quiet Sun* (p. 78)

Ace. New York, New York, USA. 1970

**Tudge, Colin** 1943–  
English science writer

The true role of science is not to change the universe but more fully to appreciate it.

*The Engineer in the Garden: Genes and Genetics* (p. 361)

Hill & Wang. New York, New York, USA. 1993

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

Science is as sorry as you are that this year's science is no more like last year's science than last year's was like the science of twenty years gone by. But science cannot help it. Science is full of change. Science is progressive and eternal. The scientists of twenty years ago laughed at the ignorant men who had groped in the intellectual darkness of twenty years before. We derive pleasure from laughing at them.

*Collected Tales, Sketches, Speeches, and Essays 1852–1890* (Volume 1)

A Brace of Brief Lectures on Science (p. 538)

The Library of America. New York, New York, USA. 1992

[W]hat we most admire is the vast capacity of that intellect which, without effort, takes in at once all the domains of science — all the past, the present and the future, all the errors of two thousand years, all the encouraging signs of the passing times, all the bright hopes of the coming age.

*Is Shakespeare Dead?*

Chapter X (p. 124)

Oxford University Press, Inc. London, England. 1996

## Union Carbide and Carbon

More Jobs Through Science  
Advertising slogan

**Urey, Harold Clayton** 1893–1981  
American chemist

To those of us who spend our lives working on scientific problems, science is a great intellectual adventure of such interest that nothing else we ever do can compare with it. We are attempting to understand the order of a physical universe, vast in extent in space and time, and most complicated and beautiful in its details.

In Shirley Thomas

*Men of Space. Profiles of the Scientists Who Probe for Life in Space* (Volume 6)

Harold C. Urey (p. 212)

Chilton Books. Philadelphia, Pennsylvania, USA. 1963

**Valéry, Paul** 1871–1945  
French poet and critic

Science is feasible when the variables are few and can be enumerated; when their combinations are distinct and clear. We are tending toward the condition of science and aspiring to do it. The artist works out his own formulas; the interests of science lies in the art of making science.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

Analects (p. 191)

Princeton University Press. Princeton, New Jersey, USA. 1971

Science means simply the aggregate of all the recipes that are always successful. All the rest is literature.

In J. Matthews (ed.)

*Collected Works* (Volume 14)

Analects

Princeton University Press. Princeton, New Jersey, USA. 1971

## Vash

Fictional character

Well, when it comes to choosing between science and profit, I'll choose profit every time.

*Star Trek: Deep Space Nine*

Q-Less

Television program

Season 1, 1993

## Vernadskii, Vladimir Ivanovich 1863–1945

Russian mineralogist

Science is alone and the routes to its achievement are alone. They are independent from the ideas of man, from his aspirations and wishes, from the social tenor of his life, from his philosophical, social, and religious theories. They are independent from his will and from his world outlook — they are primordial.

In Loren R. Graham

*The Soviet Academy of Sciences and the Communist Party, 1927–1932*

Chapter III (p. 80)

Princeton University Press. Princeton, New Jersey, USA. 1967

## Verne, Jules 1828–1905

French novelist

[I]n the cause of science men are expected to suffer.

*A Journey to the Center of the Earth*

Chapter 6 (p. 33)

The Limited Editions Club. New York, New York, USA. 1966

When science has sent forth her fiat — it is only to hear and obey.

*A Journey to the Center of the Earth*

Chapter 11 (p. 73)

The Limited Editions Club. New York, New York, USA. 1966

Science, great, mighty and in the end unerring...science has fallen into many errors — errors which have been fortunate and useful rather than otherwise, for they have been the stepping stones to truth.

*A Journey to the Center of the Earth*

Chapter 28 (p. 182)

The Limited Editions Club. New York, New York, USA. 1966

We may brave human laws, but we cannot resist natural ones.

Translated by Mercier Lewis

*Twenty Thousand Leagues Under the Sea*

Part Two, Chapter 15 (p. 249)

Nelson Doubleday, Inc. Garden City, New York, USA. 1900

## Virchow, Rudolf Ludwig Karl 1821–1902

German pathologist and archaeologist

Science in itself is nothing, for it exists only in the human beings who are its bearers.

Translated by Lelland J. Rather

*Disease, Life, and Man, Selected Essays*

Standpoints in Scientific Medicine (1847) (pp. 29–30)

Stanford University Press. Stanford, California, USA. 1958

Has not science the noble privilege of carrying on its controversies without personal quarrels.

In F.H. Garrison

*Bulletin of the New York Academy of Medicine*, Volume 4, 1928 (p. 995)

## Voltaire (François-Marie Arouet) 1694–1778

French writer

True science necessarily carries tolerance with it.

Letter to Madame d'Épinay

*Correspondance de Voltaire*, 1881 edition, Volume 12, July 6, 1766 (p. 329)

## von Baer, Carl Ernst 1792–1876

Prussian-Estonian biologist

Science...is, in its source, eternal; in its operation, not limited by time and space; in its scope, immeasurable; in its problem, endless; in its goal, unattainable.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 53)

Macmillan & Company Ltd. London, England. 1918

## von Frisch, Karl 1886–1982

Austrian ethnologist

Science advances but slowly, with halting steps. But does not therein lie her eternal fascination? And would we not soon tire of her if she were to reveal her ultimate truths too easily?

*A Biologist Remembers*

To Munich for the Fifth Time (p. 178)

Pergamon Press. Oxford, England. 1967

## von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

Sciences destroy themselves in two ways: by the breadth they reach and by the depth they plumb.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 305)

Suhrkamp. New York, New York, USA. 1988

Four epochs of science:

childlike,

poetic, superstitious;

empirical,

searching, curious;

dogmatic,

didactic, pedantic;

ideal,

methodical, mystical.

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 304–305)

Suhrkamp. New York, New York, USA. 1988

Germans — and they are not alone in this — have a knack of making the sciences unapproachable.

*Scientific Studies* (Volume 12)

Chapter VIII (p. 306)  
Suhrkamp. New York, New York, USA. 1988

In general the sciences put some distance between themselves and life, and make their way back to it only by a roundabout path.

*Scientific Studies* (Volume 12)  
Chapter VIII (p. 306)  
Suhrkamp. New York, New York, USA. 1988

A crisis must necessarily arise when a field of knowledge matures enough to become a science, for those who focus on details and treat them as separate will be set against those who have their eye on the universal and try to fit the particular into it.

*Scientific Studies* (Volume 12)  
Chapter VIII (p. 305)  
Suhrkamp. New York, New York, USA. 1988

**von Humboldt, Alexander** 1769–1859  
German naturalist and explorer

Science is the labor of mind applied to nature...

*Cosmos: A Sketch of a Physical Description of the Universe* (Volume 1)  
Introduction (p. 76)  
Harper & Brothers. New York, New York, USA. 1869

**Waddington, Conrad Hal** 1905–75  
British biologist and paleontologist

Science is the organized attempt of mankind to discover how things work as causal systems.

*The Scientific Attitude*  
Forward (p. 9)  
Penguin Books. Middlesex, England. 1941

Science as a whole certainly cannot allow its judgment about facts to be distorted by ideas of what ought to be true, or what one may hope to be true.

*The Scientific Attitude*  
Science Is Not Neutral (p. 25)  
Penguin Books, Middlesex, England. 1941

...science, if given its head, is not just cold efficiency; its attitude is tolerant, friendly and humane. It has already become the dominant inspiration of human culture, so that modern poetry, painting and architecture derive their most constructive ideas from scientific thought.

*The Scientific Attitude*  
The Scientific Attitude (p. 1)  
Penguin Books, Middlesex, England. 1941

**Wald, George** 1906–97  
American biologist and biochemist

Science goes from question to question; big questions, and little, tentative answers. The questions as they age grow ever broader, the answers are seen to be more limited.

*Les Prix Nobel. the Nobel Prizes in 1967*  
Nobel banquet speech for award received in 1967  
Nobel Foundation. Stockholm, Sweden. 1968

The trouble with most of the things that people want is that they get them. No scientist needs to worry on that score. For him there is always the further horizon. Science goes from question to question; big questions, and little, tentative answers. The questions as they age grow ever broader, the answers are seen to be more limited.

*Les Prix Nobel. the Nobel Prizes in 1967*  
Nobel banquet speech for award received in 1967  
Nobel Foundation. Stockholm, Sweden. 1968

**Waterman, Alan T.** 1892–1967  
American physicist

Science, in its pure form, is not concerned with where discoveries may lead; its disciples are interested only in discovering the truth.

*Imagination of Science and Society*  
*American Behavioral Scientist*, Volume VI, Number 4, December 1962 (p. 3)

**Watson, David Lindsay** 1901–73  
No biographical data available

The main vehicle of science is not the published formulations of laws and experiments in books and periodicals. This vehicle is, first and foremost, men who are worthy of them, who can understand and use the laws. But more than this: the vehicle is also the pattern of the society that can produce such men.

*Scientists Are Human*  
Chapter I (p. 3)  
Watts. London, England. 1938

Science sprawls over all the horizons of the modern mind like some vast cloudbank. The outlook and method of science penetrate relentlessly the strata of daily custom into the caverns of the unconscious mind itself. Science is by far the most powerful intellectual phenomenon of modern times, inexorably laying down the law in regions far from the laboratory, and subtly governing, by its techniques and devices, our modes of life and ways of thinking.

*Scientists Are Human*  
Chapter I (p. 1)  
Watts. London, England. 1938

**Watson, James D.** 1928–  
American geneticist and biophysicist

...good science as a way of life is sometimes difficult. It often is hard to have confidence that you really know where the future lies. We must thus believe strongly in our ideas, often to point where they may seem tiresome and bothersome and even arrogant to our colleagues.

*Les Prix Nobel. The Nobel Prizes in 1962*  
Nobel banquet speech for award received in 1962  
Nobel Foundation. Stockholm, Sweden. 1963

**Weaver, Warren** 1894–1978  
American mathematician

The desirable adjuncts of modern living, although in many instances made possible by science, certainly do not constitute science.

*Science and Imagination: Selected Papers*

Chapter 1

Basic Books, Inc. New York, New York, USA. 1967

Science is not technology, it is not gadgetry, it is not some mysterious cult, it is not a great mechanical monster! Science is an adventure of the human spirit. It is essentially an artistic enterprise, stimulated largely by the universe, served largely by disciplined imagination, and based largely on faith in the reasonableness, order, and beauty of the universe of which man is part.

In Walter Orr Robek

Science, a Well Spring of our Discontent

*American Scientist*, Volume 55, Number 1, March 1957 (p. 3)

It is hardly necessary to argue, these days, that science is essential to the public. It is becoming equally true, as the support of science moves more and more to state and national sources, that the public is essential to science. The lack of general comprehension of science is thus dangerous both to science and the public, these being interlocked aspects of the common danger that scientists will not be given the freedom, the understanding, and the support that are necessary for vigorous and imaginative development.

In Hilary J. Deason

*A Guide to Science Reading*

Science and People (p. 38)

The New American Library. New York, New York, USA. 1966

### **Weber, Max** 1864–1920

German founder of modern sociology and economic thinker

Science today is a “vocation” organized in special disciplines in the service of self-clarification and knowledge of interrelated facts. It is not the gift of grace of seers and prophets dispensing sacred values and revelations, nor does it partake of the contemplation of sages and philosophers about the meaning of the Universe.

In H.H. Gerth and C. Wright Mills (eds.)

*From Max Weber: Essays in Sociology*

Science as a Vocation (p. 152)

Oxford University Press, Inc. New York, New York, USA. 1970

### **Weil, Simone** 1909–43

French philosopher and mystic

To us, men of the West, a very strange thing happened at the turn of the century; without noticing it, we lost science, or at least the thing that had been called by that name for the last four centuries. What we now have in place of it is something different, radically different, and we don't know what it is. Nobody knows what it is.

Translated by Richard Rees

*On Science, Necessity, and the Love of God*

Classical Science and After, Chapter I (p. 3)

Oxford University Press, Inc. London, England. 1968

Science is voiceless; it is the scientist who talks.

*On Science, Necessity, and the Love of God*

Reflections on Quantum Theory (p. 57)

Oxford University Press, Inc. London, England. 1968

Science today will either have to seek a source of inspiration higher than itself or perish.

*Gravity and Grace*

Intelligence and Grace (p. 119)

Routledge & Kegan Paul. London, England. 1952

Science only offers three kinds of interest: 1. Technical applications. 2. A game of chess. 3. A road to God. (Attractions are added to the game of chess in the shape of competitions, prizes, and medals.)

*Gravity and Grace*

Intelligence and Grace (p. 119)

Routledge & Kegan Paul. London, England. 1952

Science is today regarded by some as a mere catalogue of technical recipes, and others as a body of pure intellectual speculations which are sufficient unto themselves; the former set too little value on the intellect, the latter on the world.

Translated by Arthur Wills and John Petrie

*Oppression and Liberty*

Theoretical Picture of a Free Society (pp. 104–105)

Routledge & Kegan Paul Ltd. London, England. 1958

### **Weinberg, Steven** 1933–

American nuclear physicist

...there is an essential element in science that is cold, objective, and nonhuman...the laws of nature are as impersonal and free of human values as the rules of arithmetic.... Nowhere do we see human value or human meaning.

Reflections of a Working Scientist

*Daedalus*, Volume 103, 1974 (p. 3)

### **Weiss, Paul A.** 1898–1985

Chemist

Science, to some, is Lady Bountiful, to others is the Villain of the Century. Some years ago, a book called it our “Sacred Cow,” and certainly to many it has at least the glitter of the “Golden Calf.” Glorification at one extreme, vituperation at the other...

*Within the Gates of Science and Beyond*

Science Looks at Itself (p. 25)

Hafner Publishing Company. New York, New York, USA. 1971

### **Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

Science cannot develop unless it is pursued for the sake of pure knowledge and insight. It will not survive unless it is used intensely and wisely for the betterment of humanity and not as an instrument of domination by one group over another.

*Physics in the Twentieth Century: Selected Essays*



The Significance of Science (p. 364)  
The MIT Press. Cambridge, Massachusetts, USA. 1972

Science is curiosity, discovering things and asking why.

*The Privilege of Being a Physicist*

Chapter 4 (p. 31)

W.H. Freeman & Company. New York, New York, USA. 1989

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

The science hangs like a gathering fog in a valley, a fog which begins nowhere and goes nowhere, an incidental, unmeaning inconvenience to passers-by.

*The Works of H.G. Wells* (Volume 9)

A Modern Utopia

Chapter 3, Section 3

Charles Scribner's Sons. London, England. 1924–27

Science is a match that man has just got alight. He thought he was in a room — in moments of devotion, a temple — and that his light would be reflected from and display walls inscribed with wonderful secrets and pillars carved with philosophical systems wrought into harmony. It is a curious sensation, now that the preliminary splutter is over and the flame burns up clear, to see his hands and just a glimpse of himself and the patch he stands on visible, and around him, in place of all that human comfort and beauty he anticipated — darkness still.

The Rediscovery of the Unique

*The Fortnightly Review*, New Series 50, July 1891

**Weyl, Hermann** 1885–1955  
German mathematician

Modern science, insofar as I am familiar with it through my own scientific work, mathematics and physics make the world appear more and more an open one.... Science finds itself compelled, at once by the epistemological, the physical and the constructive-mathematical aspect of its own methods and results, to recognize this situation. It remains to be added that science can do no more than show us this open horizon; we must not by including the transcendental sphere attempt to establish anew a closed (though more comprehensive) world.

*The Open World: Three Lectures in the Metaphysical Implications of Science*

Preface (p. v)

Yale University Press. New Haven, Connecticut, USA. 1932

We must await the further development of science, perhaps for centuries, before we can design a true and detailed picture of the interwoven texture of Matter, Life and Soul. But the old classical determinism of Hobbes, and Laplace need not oppress us any longer.

*The Open World: Three Lectures in the Metaphysical Implications of Science*

Lecture II (p. 55)

Yale University Press. New Haven, Connecticut, USA. 1932

Modern science in so far as I am familiar with it through my own scientific work, mathematics and physics, make the world appear more and more as an open one, as a world not closed but pointing beyond itself...science finds itself compelled, at once by the epistemological, the physical and the constructive-mathematical aspect of its own methods and results, to recognize this situation. It remains to be added that science can do no more than show us this open horizon; we must not by including the transcendental sphere attempt to establish anew a closed (though more comprehensive) world.

In A.S. Eddington

*New Pathways in Science*

Chapter XIV (p. 309)

...science would perish without the continuous interplay between its facts and constructions on the one hand and the imagery of ideas on the other.

*Philosophy of Mathematics and Natural Science*

Preface (p. vi)

Princeton University Press. Princeton, New Jersey, USA. 1949

**Wheeler, John Archibald** 1911–  
American physicist and educator

...the pursuit of science is more than the pursuit of understanding. It is driven by the creative urge, the urge to construct a vision, a map, a picture of the world that gives the world a little more beauty and coherence than it had before.

*Geons, Black Holes, and Quantum Foam: A Life in Physics*

Chapter 3 (p. 84)

W.W. Norton & Company, Inc. New York, New York, USA. 1998

...the human activity that we call science is not science unless it is the uncovering or discovery of something new.

*At Home in the Universe*

Be the Best to Give the Most (p. 76)

The American Institute of Physics. Woodbury, New York, USA. 1994

**Whetham, Sir William Cecil Dampier** 1867–1952  
English scientific writer

But beyond the bright searchlights of science,

Out of sight of the windows of sense,

Old riddles still bid us defiance,

Old questions of Why and of Whence.

*Recent Development of Physical Science* (p. 10)

John Murray. London, England. 1927

**Whewell, William** 1794–1866  
English philosopher and historian

Science begins with common observation of facts; but even at this stage, requires that the observations be precise. Hence the sciences which depend upon space and number were the earliest formed. After common observation, comes Scientific Observation and Experiment.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 2)

Aphorisms, Aphorisms Concerning Science, VII (p. 467)  
John W. Parker. London, England. 1847

The tendency of the sciences has long been an increasing proclivity of separation and dismemberment. The mathematician turns away from the chemist; the chemist from the naturalist; between the mathematician and the chemist is to be interpolated a “physician” (we have no English name for him), who studies heat, moisture and the like.

*Quarterly Review*, Volume 51, 1834 (p. 59)

The principles which constituted the triumph of preceding stages of science may appear to be subverted and ejected by later discoveries, but in fact they are (so far as they are true) taken up into the subsequent doctrines and included in them. They continue to be an essential part of the science. The earlier truths are not expelled but absorbed, not contradicted but extended; and the history of each science which may thus appear like a succession of revolutions is, in reality, a series of developments.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume the First)

Introduction (p. 10)

John W. Parker. London, England. 1837

...two things are requisite to science — facts and ideas...

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume 1)

Book I, Chapter III, Section 2 (p. 79)

John W. Parker. London, England. 1837

Man is the interpreter of Nature, Science is the right interpretation.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 2)

Aphorisms Concerning Ideas, Aphorism I (p. 443)

John W. Parker. London, England. 1847

**White, Leslie Alvin** 1900–75

American anthropologist

Science is sciencing.

Science Is Sciencing

*Philosophy of Science*, Volume 5, 1938

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Science is the organisation of thought.

*The Organisation of Thought*

Chapter VI (p. 106)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

Science is in the minds of men, but men sleep and forget, and at their best in any one moment of insight entertain but scanty thoughts. Science therefore is nothing but a confident expectation that relevant thoughts will occasionally occur.

*An Enquiry Concerning the Principles of Natural Knowledge*

Part I, Chapter I (p. 10)

At The University Press. Cambridge, England. 1919

Science is either an important statement of systematic theory correlating observations of a common world or is the daydream of a solitary intelligence with a taste for the daydream of publication.

*Process and Reality: An Essay in Cosmology*

Part IV, Chapter V, Section IV (p. 502)

The Macmillan Company. New York, New York, USA. 1929

Science has always suffered from the vice of overstatement. In this way conclusions true within strict limitations have been generalized dogmatically into a fallacious universality.

*The Function of Reason*

Chapter I (p. 22)

Beacon Press. Boston, Massachusetts, USA. 1929

Science is even more changeable than theology.

*Science and the Modern World*

Chapter XII (p. 183)

The Macmillan Company. New York, New York, USA. 1929

Aristotle discovered all the half-truths which were necessary to the creation of science.

In Lucien Price

*Dialogues of Alfred North Whitehead*

Dialogue XLII September 11, 1945 (p. 344)

Little Brown. Boston, Massachusetts, USA. 1954

Science is a river with two sources, the practical source and the theoretical source. The practical source is the desire to direct our actions to achieve predetermined ends.... The theoretical source is the desire to understand.

*The Organisation of Thought*

Chapter VI (p. 106)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

A science which hesitates to forget its founders is lost.

*The Organisation of Thought*

Chapter VI (p. 115)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

**Whyte, Lancelot Law** 1896–1972

Scottish physicist

Science starts with an assumption which is always present, though it may be unconscious, may be forgotten, and may sometimes even be denied.

*Accent on Form: An Anticipation of the Science of Tomorrow*

Chapter IV (p. 59)

Harper & Brothers. New York, New York, USA. 1954

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

There is no natural phenomenon that is comparable with the sudden and apparently accidentally timed development of science, except perhaps the condensation of a super-saturated gas or the explosion of some unpredictable explosives. Will the fate of science show some similarity to one of these phenomena?

*Proceedings of the American Philosophical Society*, Volume 94, Number 5, 1950

**Wilde, Oscar** 1854–1900  
Irish wit, poet, and dramatist

The advantage of the emotions is that they lead us astray,  
and the advantage of Science is that it is not emotional.

*The Picture of Dorian Gray*

Chapter 3 (p. 45)

The Modern Library. New York, New York, USA. 1992

Science can never grapple with the irrational. That is why  
there is no future before it, in this world.

*The Plays of Oscar Wilde*

An Ideal Husband

Act I (p. 9)

The Modern Library. New York, New York, USA. No date

Science is out of the reach of morals, for her eyes are  
fixed upon eternal truths.

*The Works of Oscar Wilde* (Volume 10)

Intentions

The Critic as Artist, Part 2 (p. 394)

AMS Press. New York, New York, USA. 1909

**Wilson, Edward O.** 1929–  
American biologist and author

To a considerable degree science consists in originating  
the maximum amount of information with the minimum  
expenditure of energy. Beauty is the cleanness of line in  
such formulations along with symmetry, surprise, and  
congruence with other prevailing beliefs.

*Biophilia*

The Poetic Species (p. 60)

Harvard University Press. Cambridge, Massachusetts. 1984

Important science is not just any similarity glimpsed for  
the first time. It offers analogues that map the gateways  
to unexplored terrain.

*Biophilia*

The Poetic Species (p. 67)

Harvard University Press. Cambridge, Massachusetts. 1984

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
Austrian-born English philosopher

Man has to awaken to wonder — and so perhaps do peo-  
ples. Science is a way of sending him to sleep again.

Translated by Peter Winch

*Culture and Value* (p. 5e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wolpert, Lewis** 1929–  
British embryologist

When we come to face the problems before us — poverty,  
pollution, overpopulation, illness — it is to science that  
we must turn, not to gurus. The arrogance of scientists is  
not nearly as dangerous as the arrogance that comes from  
ignorance.

In Mary Midgley

Can Science Save Its Soul?

*New Scientist*, Volume 135, Number 1832, 1 August 1992 (p. 24)

**Wordsworth, William** 1770–1850  
English poet

Science appears but what in truth she is,  
Not as our glory and our absolute boast,  
But as a succedaneum and a prop  
To our infirmity. No officious slave  
Art thou of that false secondary power  
By which we multiply distinctions, then  
Deem that our puny boundaries are things  
That we perceive, and not that we have made.

*The Complete Poetical Works of William Wordsworth*

The Prelude, Book II, l. 212–219

Crowell. New York, New York, USA. 1888

**Wright, Chauncey** 1830–75  
American philosopher of science

The accidental causes of science are only “accidents”  
relatively to the intelligence of a man.

*The Philosophical Writings of Chauncey Wright*

The Genesis of Species (p. 37)

The Liberal Arts Press. New York, New York, USA. 1958

**Wright, Frank Lloyd** 1869–1959  
American architect

I have seemed to belittle the nature of our time and the  
great achievements of science, but I have intended to do  
neither because I believe human nature still sound, and  
recognize that science has done a grand job as well; but  
well I know that Science cannot save us.

An Organice Architecture, Speech

London, England, May 1939

**Yates, Frances** 1899–1981  
English historian

Is not all science a gnosis, an insight into the nature of the  
All, which proceeds by successive revelations?

*Giordano Bruno and the Hermetic Tradition*

Chapter XXII (p. 452)

The University of Chicago Press. Chicago, Illinois, USA. 1964

**Ziman, John M.** 1925–2005  
British physicist

Penicillin is not Science, any more than a cathedral is  
Religion or a witness box is Law.

In E.D. Klemke, Robert Hollinger and A. David Kline

*Introductory Readings in the Philosophy of Science*

What Is Science? (p. 36)

Prometheus Books. Buffalo, New York, USA. 1980

In science, to echo Beethoven’s dictum about music,  
“Everything should be both surprising and expected.”

*Reliable Knowledge*

Chapter 3 (fn 17, p. 71)

Cambridge University Press. Cambridge, England. 1978

**Zinkernagel, Rolf M.** 1944–  
Swiss immunologist and pathologist

...in science there are collectors, classifiers, compulsory tidiers-up and permanent contesters, detectives, some artists and many artisans, there are poet-scientists and philosophers and even a few mystics.

*Les Prix Nobel. The Nobel Prizes in 1996*  
Nobel banquet speech for award received in 1996  
Nobel Foundation. Stockholm, Sweden. 1997

**Zinsser, Hans** 1878–1940  
American bacteriologist

Science is but a method. Whatever its material, an observation accurately made and free of compromise to bias and desire, and undeterred by consequence, is science.

Untheological Reflections  
*The Atlantic Monthly*, July 1929 (p. 91)

## SCIENCE, AGE OF

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

We live in an age of science. I do not say “an age of technology” for every age has been an age of technology. We recognize this when we describe past civilizations as the Stone Age, the Bronze Age, and the Age of Steam or of Steel, thus implicitly admitting that the stage of civilization is determined by the tools at man’s disposal — in other words, by his technology....

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 1)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Kronenberger, Louis** 1904–80  
American author and critic

Nominally a great age of scientific inquiry, ours has actually become an age of superstition about the infallibility of science; of almost mystical faith in its nonmystical methods; above all...of external verities; of traffic-cop morality and rabbit-test truth.

*Company Manners: A Cultural Inquiry into American Life*  
Chapter 4 (p. 94)  
The Bobbs-Merrill Company, Inc. Indianapolis, Indiana, USA. 1954

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

To say that we live in an age of science is a common place, but like most common places, it is only partially true. From the point of view of our predecessors, if they could view our society, we should, no doubt, appear to be very scientific, but from the point of view of our successors, it is probable that the exactly opposite would seem to be the cause.

*The Scientific Outlook*  
Introduction (p. 9)  
George Allen & Unwin Ltd. London, England. 1931

[T]heoretical science...is an attempt to understand the world. Practical science, which is an attempt to change the world, has been important from the first, and has continually increased in importance, until it has almost ousted theoretical science from men’s thoughts....

*A History of Western Philosophy*  
Book Three, Part I, Chapter I (p. 492–493, 493)  
Simon & Schuster. New York, New York, USA. 1945

The triumph of science has been mainly due to its practical utility, and there has been an attempt to divorce this aspect from that of theory, thus making science more and more a technique, and less and less a doctrine as to the nature of the world. The penetration of this point of view to philosophers is very recent.

*A History of Western Philosophy*  
Book Three, Part I, Chapter I (p. 492–493, 493)  
Simon & Schuster. New York, New York, USA. 1945

## SCIENCE, APPLIED

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Even when men build any science and theory upon experiment, yet they almost always turn with premature and hasty zeal to practise, not merely on account of the advantage and benefit to be derived from it, but in order to seize upon some security in a new undertaking of their not employing the remainder of their labor unprofitably, and by making themselves conspicuous, to acquire a greater name for their pursuit.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 70 (p. 116)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

Applied science is not an end in itself, but it is the most powerful means ever discovered for supplying the opportunity to secure the finest things of life.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 9)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Einstein, Albert** 1879–1955  
German-born physicist

Why does this magnificent applied science which saves work and makes life easier bring us so little happiness? The simple answer runs: Because we have not yet learned to make sensible use of it.

Einstein Seeks Lack in Applying Science  
*The New York Times*, February 17, 1931 (p. 6)

It is not enough that you should understand about applied science in order that your work may increase man’s

blessings. Concern for the man himself and his fate must always form the chief interest of all technical endeavors; concern for the great unsolved problems of the organization of labor and the distribution of our mind shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations.

Einstein Seeks Lack in Applying Science  
*The New York Times*, February 17, 1931 (p. 6)

**Huxley, Aldous** 1894–1963

English writer and critic

Applied Science is a conjurer, whose bottomless hat yields impartially the softest of Angora rabbits and the most petrifying of Medusas.

*Tomorrow and Tomorrow and Tomorrow and Other Essays*  
The Desert (p. 82)  
Harper & Brothers. New York, New York, USA. 1956

**Huxley, Thomas Henry** 1825–95

English biologist

I often wish that this phrase “applied science,” had never been invented. For it suggests that there is a sort of scientific knowledge of direct practical use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed “pure science.” But there is no more complete fallacy than this.

*Collected Essays* (Volume 3)  
*Science and Education*  
Science and Culture (p. 137)  
Macmillan & Company Ltd. London, England. 1904

**Pasteur, Louis** 1822–95

French chemist

There does not exist a category of science to which one can give the name applied science. There are science and the applications of science, bound together as the fruit of the tree which bears it.

*Revue Scientifique*  
Pourquoi la France n’a pas trouvé hommes supérieurs au montent du péril (1871)

**Porter, George** 1920–2002

English chemist

To feed applied science by starving basic science is like economising on the foundations of a building so that it may be built higher.

Lest the Edifice of Science Crumble  
*New Scientist*, Volume 111, Number 1524, September 1986 (p. 16)

**Wheeler, Edgar C.**

No biographical data available

...[researchers] cannot remain indefinitely in any field of pure research. For every time they come upon a new bit of knowledge, almost instantly they discover some practical application. Thus the dividing line between pure science and applied science becomes thin.

Makers of Lightning  
*The World’s Work*, January 1927 (p. 271)

**SCIENCE, COMMUNICATION OF**

**Casimir, Hendrik B. G.** 1909–2000

Dutch physicist

There exists today a universal language that is spoken and understood almost everywhere: it is Broken English. [It] is used by the waiters in Hawaii, prostitutes in Paris and ambassadors in Washington, by businessmen from Buenos Aires, by scientists at international meetings and by dirty-postcard peddlers in Greece — in short, by honorable people like myself all over the world.

*Haphazard Reality: Half a Century of Science*  
Chapter 4 (p. 122)  
Harper & Row, Publishers. New York, New York, USA. 1983

**Chargaff, Erwin** 1905–2002

Austrian biochemist

There is no real popularization [of science] possible, only vulgarization that in most instances distorts the discoveries beyond recognition.

Bitter Fruits from the Tree of Knowledge  
*Perspectives in Biology and Medicine*, Volume 16, Summer, 1973 (p. 491)

...Scientists, like little fishes, swim in schools. When we open one of our scientific journals these days, we find a very uneven distribution of topics. Some important fields are almost entirely neglected, others seem to explode into bursts of unbelievable mediocrity. Really valuable contributions in the fields most in vogue at present probably are just as scarce as those dealing with the stepchildren of present-day biochemistry. But not all disciplines make it so easy to call each mush a “homogenate”, each soup a “partially purified extract”, and so to speak — when you have nothing whatever — of a “system.” There is a real danger that our science may suffocate in its own excrements.

*Essays on Nucleic Acids*  
Chapter 10 (p. 162)  
Elsevier Publishing Company. Amsterdam, Netherlands. 1963

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Scientific phrases are used like scientific wheels and piston-rods to make swifter and smoother yet the path of the comfortable.

*Orthodoxy*  
Chapter VIII (p. 230)  
John Lane Company. New York, New York, USA. 1918

**Dancoff, S. M.**

American physicist

When you set out in a new field and choose a terminology you have the choice of using old, familiar words in new meanings or else you can make up new words for

the new meanings. If you use old words you make the theory look homey and inviting, but you run the risk of confusing the issue every time the old word is used. If you use new words you make the thing look excessively highbrow and frighten off any who might be interested.

Does the Neutrino Really Exist?

*Bulletin of the Atomic Scientists*, Volume 8, Number 5, June 1952 (p. 139)

**Dornan, Christopher** 1957–

American journalism professor

Science is seen as an avenue of access to assured findings, and scientists — in the dissemination of these findings — as the initial sources. The members of the laity are understood purely as recipients of this information. Journalists and public relations personnel are viewed as intermediaries through which the scientific findings filter. The task for science communication is to transmit as much information as possible with maximum fidelity.

Some Problems of Conceptualizing the Issues of “Science and the Media” *Critical Studies in Mass Communication*, Volume 7, Number 1, March 1990 (p. 51)

**Feynman, Richard P.** 1918–88

American theoretical physicist

We have a habit in writing articles published in scientific journals to make the work as finished as possible, to cover all the tracks, to not worry about the blind alleys or describe how you had the wrong idea first, and so on. So there isn’t any place to publish, in a dignified manner what you actually did in order to do the work....

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1965

The Development of the Space-Time View of Quantum Electrodynamics (p. 155)

Elsevier Publishing Company. Amsterdam, Netherlands. 1972

**Fischer, Martin H.** 1879–1962

German-American physician

You must learn to talk clearly. The jargon of scientific terminology which rolls off your tongues is mental garbage.

In Howard Fabing and Ray Marr

*Fischerisms*

C.C. Thomas. Springfield, Illinois, USA. 1944

**Gibbs, J. Willard** 1839–1903

American mathematician

...science is, above all, communication.

In H.N. Parton

*Science Is Human*

Science and the Liberal Arts (p. 11)

University of Otago Press. Dunedin, New Zealand. 1972

**Huxley, Thomas Henry** 1825–95

English biologist

...there is assuredly no more effectual method of clearing up one’s own mind on any subject than by talking it over

so to speak, with men of real power and grasp, who have considered it from a totally different point of view.

*Collected Essays* (Volume 1)

*Method and Result*

Animal Automatism (p. 202)

Macmillan & Company Ltd. London, England. 1904

**Large, E. C.**

American author

[I]t was contended that...compartments labeled Chemistry, Mycology, Bacteriology...were never really fish-tanks for myopic specialists to swim about in, but merely convenient departments in one splendid and sunlit edifice of science, separated at the most by glass walls, decorated with the flags of all nations, and provided with innumerable intercommunicating doors. If so many stacks of old scientific papers got piled up on each side of the glass partitions that in the end no one could see through them, that was certainly regrettable; and if some of the doors were locked for periods ranging from a decade to a century, well, that also was a pity — but who wanted to work in a draught?

*The Advance of the Fungi*

Chapter XXIII (p. 317)

Henry Holt & Company. New York, New York, USA. 1940

**Lemke, J.**

No biographical data available

True Dialogue occurs when teachers ask questions to which they do not presume to already know the “correct answer.”

*Talking Science: Language, Learning and Values*

Chapter 3 (p. 55)

Ablex Publishing Corporation. Norwood, New Jersey, USA. 1990

**Loomis, Frederic Brewster** 1873–1937

American geologist

Everyone, who is alert as he wanders about this world, wants to know what he is seeing and what it is all about. Here and there with the aid of capable guides a few have been introduced into the sphere that wide and fascinating knowledge of Nature which has been so rapidly accumulated during this and the latter part of the last century. It is a full treasure house constantly being enriched, but unfortunately the few who have been initiated have soon acquired technical language and habit, so that their knowledge and new acquisitions are communicated to but a few.

*Field Book of Common Rocks and Minerals*

Preface (p. vii)

**Macdonald, Sharon**

No biographical data available

...science communication involves selection and definition, not just of which “facts” are presented to the public,

but of what is to count as science and of what kind of entity or enterprise science is to be. That is, science communicators act as authors of science for the public. They may also, however, by dint of their own institutional status, give implicit stamps of approval or disapproval to particular visions or versions of science. That is, they may act as authors with special authority on science — as authorisers of science.

In Alan Irwin and Brian Wynne (eds.)

*Misunderstanding Science? The Public Reconstruction of Science and Technology*

Authorizing Science: Public Understanding of Science in Museums (p. 152)  
Cambridge University Press. Cambridge, England. 1996

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Science is communicated by instruction, in order that one man may profit by the experience of another and be spared the trouble of accumulating it for himself; and thus, to spare posterity, the experiences of whole generations are stored up in libraries.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter IV, Part IV, Section 1 (p. 578)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

### **Michelson, Albert Abraham** 1852–1931

German-American physicist

Science, when it has to communicate the results of its labor, is under the disadvantage that its language is but little understood. Hence it is that circumlocution is inevitable and repetitions are difficult to avoid.

*Light Waves and Their Uses*

Lecture I (p. 1)

The University of Chicago Press. Chicago, Illinois, USA. 1903

### **Moore, John A.**

American writer and professor of genetics and biology

... recall some of the lectures you may have heard recently. Did you always know why the research had been done? Was it clear what problem was being illuminated by the data presented?

Science as a Way of Knowing

*American Zoologist*, Volume 24, Number 2, 1984 (p. 471)

### **Moravcsik, M. J.**

No biographical data available

New theories, when first proposed, may appear on the first page of the New York Times, but their demise, a few years later, never makes even page 68.

*Research Policy*, Volume 17, 1988 (p. 293)

### **Neal, Patricia** 1926–

American actress

Gort, *Klaatu berada nikto!*

*The Day the Earth Stood Still*

Film (1951)

### **Oppenheimer, J. Robert** 1904–67

American theoretical physicist

The true responsibility of a scientist, as we all know, is to the integrity and vigor of his science. And because most scientists, like all men of learning, tend in part also to be teachers, they have a responsibility for the communication of the truths they have found. This is at least a collective, if not an individual responsibility. That we should see in this any insurance that the fruits of science will be used for man's benefit, or denied to man when they make for his distress or destruction, would be a tragic naïveté.

*The Open Mind*

Chapter V (p. 91)

Simon & Schuster. New York, New York, USA. 1955

Often the very fact that the words of science are the same as those of our common life and tongues can be more misleading than enlightening, more frustrating to understanding than recognizably technical jargon.

*Science and the Common Understanding*

Chapter 1 (p. 5)

Simon & Schuster. New York, New York, USA. 1954

It is proper to the role of the scientist that he not merely find new truth and communicate it to his fellows, but that he teach, that he try to bring the most honest and intelligible account of new knowledge to all who will try to learn.

*The Open Mind: Lectures*

Prospects in the Arts and Sciences (p. 138)

Simon & Schuster. New York, New York, USA. 1955

### **Parton, H. N.**

No biographical data available

Scientists have the duty to communicate, firstly with each other, that is with those who are interested in the same or allied problems, and secondly with laymen: by layman I mean anyone not familiar with their special science, for specialization has raised the level of scientific achievement so much, that chemists, for example, are usually laymen in say, biology; we may hope, intelligent laymen.

*Science Is Human*

Science and the Liberal Arts (p. 12)

University of Otago Press. Dunedin. 1972

Aldous Huxley, in a lecture on his grandfather, said that all communication is literature, and even in scientific writing there is wide room for the exercise of art.

*Science Is Human*

Science and the Liberal Arts (p. 14)

University of Otago Press. Dunedin. 1972

### **Pool, Ithiel de Sola** 1917–84

No biographical data available

Computing and communication are becoming one...

*Technologies Without Boundaries: On Telecommunications in a Global Age*

Part I, Chapter I (p. 8)

Harvard University Press. Cambridge, Massachusetts, USA. 1990

**Priestley, Joseph** 1733–1804  
English theologian and scientist

When for the sake of a little more reputation, men can keep brooding over a new fact, in the discovery of which they might, possibly, have very little real merit, till they think they can astonish the world with a system as complete as it is new, and give mankind a high idea of their judgment and penetration; they are justly punished for their ingratitude to the fountain of all knowledge, and for their want of a genuine love of science and of mankind, in finding their boasted discoveries anticipated, and the field of honest fame pre-occupied, by men, who, from a natural ardour of mind engage in philosophical pursuits, with an ingenious simplicity immediately communicate to others whatever occurs to them in their inquiries.

*Experiment and Observations on Different Kinds of Air* (Volume 1)  
The Preface (pp. xvii–cviii)  
Printed by Thomas Pearson. Birmingham, England. 1740

**Roe, Anne** 1904–1991  
American psychologist

Nothing in science has any value to society if it is not communicated. . . .

*The Making of a Scientist*  
Chapter I (p. 17)  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1973

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

Bohr's . . . approach to atomic problems . . . is really remarkable. He is completely convinced that any understanding in the usual sense of the word is impossible. Therefore the conversation is almost immediately driven into philosophical questions, and soon you no longer know whether you really take the position he is attacking, or whether you really must attack the position that he is defending.

In W. Moore  
*Schrodinger: Life and Thoughts*  
Chapter 6, Letter to W. Wein 1926 (p. 228)  
Cambridge University Press. Cambridge, England. 1989

If you cannot — in the long run — tell everyone what you have been doing, your doing has been worthless.

*Science and Humanism: Physics in Our Time*  
The Spiritual Bearing of Science on Life (pp. 8–9)  
At The University Press. Cambridge, England. 1952

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

The present age has a bad habit of being abstruse in the sciences. We remove ourselves from common sense without opening up a higher one; we become transcendent, fantastic, fearful of intuitive perception in the real world, and when we wish to enter the practical realm, or need to, we suddenly turn atomistic and mechanical.

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 308–309)  
Suhrkamp. New York, New York, USA. 1988

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Nobody has a right to speak more clearly than he thinks.  
*Washingtonian*, Volume 15, Number 143, November 1979

**Wiener, Norbert** 1894–1964  
American mathematician

[T]he more probable the message, the less information it gives. Clichés, for example, are less illuminating than great poems.

*The Human Use of Human Beings*  
Chapter I (p. 21)  
Da Capo Press. New York, New York, USA. 1988

**Ziman, John M.** 1925–2005  
British physicist

The cliché of scientific prose betrays itself “Hence we arrive at the conclusion that. . . .” The audience to which scientific publications are addressed is not passive; by its cheering or booing, its bouquets or brickbats, it actively controls the substance of the communications that it receives.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*  
Chapter 1 (p. 9)  
Cambridge University Press. Cambridge, England. 1968

It is not enough to observe, experiment, theorize, calculate and communicate; we must also argue, criticize, debate, expound, summarize, and otherwise transform the information that we have obtained individually into reliable, well established, public knowledge.

Information, Communication, Knowledge  
*Nature*, Volume 224, Number 5217, October 25, 1969 (p. 324)

## SCIENCE, HISTORY OF

**Appleton, Sir Edward** 1892–1965  
English physicist

. . . the history of science has proved that fundamental research is the lifeblood of individual progress and that the ideas which lead to spectacular advances spring from it.

In J. Edwin Holmstrom  
*Records and Research in Engineering and Industrial Science*  
Chapter One (p. 7)  
Chapman & Hall. London, England. 1956

**Asimov, Isaac** 1920–92  
American author and biochemist

A number of years ago, when I was a freshly-appointed instructor, I met, for the first time, a certain eminent historian of science. At the time I could only regard him with tolerant condescension. I was sorry for a man who, it seemed to me, was forced to hover about the edges of



science.... In a lifetime of being wrong at many a point, I was never more wrong. It was I, not he, who was wandering in the periphery. It was he, not I, who lived in the blaze. I had fallen victim to the fallacy of the "growing edge"; the belief that only the very frontier of scientific advance counted; that everything that had been left behind by that advance was faded and dead.

*Adding a Dimension*

Introduction (p. 7)

Lancer Books, New York, New York, USA. 1969

### **Bernal, John Desmond** 1901–71

Irish-born physicist and x-ray crystallographer

The whole history of modern science, has been that of a struggle between ideas derived from observation and practice, and pre-conceptions derived from religious training. It was not...that Science had to fight an external enemy, the Church; it was that the Church itself — its dogmas, its whole way of conceiving the universe — was within the scientists themselves.... After Newton, God ruled the visible world by means of Immutable Laws of Nature, set in action by one creative impulse, but He ruled the moral world by means of absolute intimations of moral sanctions, implanted in each individual soul, reinforced and illuminated by Revelation and the Church....

In W.H. Waddington

*Science and Ethics*

A Marxist Critique (pp. 115–116)

George Allen & Unwin Ltd. London, England. 1942

The role of God in the material world has been reduced stage by stage with the advance of Science, so much so that He only survives in the vaguest mathematical form in the minds of older physicists and biologists.

In W.H. Waddington

*Science and Ethics*

A Marxist Critique (pp. 115–116)

George Allen & Unwin Ltd. London, England. 1942

### **Butterfield, Herbert** 1900–79

English historian and philosopher of history

The greatest obstacle to the understanding of the history of science is our inability to unload our minds of modern views about the nature of the universe.

*The History of Science, Origins and Results of the Scientific Revolution: A Symposium*

Dante's View of the Universe (p. 15)

Free Press, Glencoe, Illinois, USA. 1953

One of the safest speculations that we could make...[is] that very soon the history of science is going to acquire an importance...incommensurate with anything that it has hitherto possessed. It...is no longer merely an account of one of many human activities like the history of music or...of cricket.... Because it deals with one of the main constituents of the modern world and the modern mind, we cannot construct a respectable history of Europe or

a tolerable survey of western civilization without it. It is going to be as important for us for the understanding of ourselves as Graeco-Roman antiquity was for Europe during a period of over a thousand years.

*The History of Science and the Study of History*

*Harvard Library Bulletin*, Volume 13, 1959 (pp. 330–331)

Free Press, Glencoe, Illinois, USA. 1953

[The scientific revolution] outshines everything since the rise of Christianity and reduces the Renaissance and Reformation to the ranks of mere episodes, mere internal displacements, within the system of medieval Christendom...it looms so large as the real origin of the modern world and the modern mentality that our customary periodization of European history has become an anachronism and an encumbrance.

*The Origins of Modern Science*

Introduction (pp. vii–viii)

The Macmillan Company, New York, New York, USA. 1961

### **Chamberlain, Owen** 1920–2006

American physicist

The most that any scientist can ask is that he help to lay a few stones of a partially-built edifice that we call scientific knowledge. To him this edifice is a beautiful structure, although it will never be finished.

*Les Prix Nobel. the Nobel Prizes in 1959*

Nobel banquet speech for award received in 1959

Nobel Foundation, Stockholm, Sweden. 1960

### **Cohen, I. Bernard** 1914–2003

American physicist and science historian

History with the history of science, to alter slightly an apothegm of Lord Bacon, resembles a statue of Polyphemus without his eye — that very feature being left out which most marks the spirit and life of the person. My own thesis is complementary: science taught...without a sense of history is robbed of those very qualities that make it worth teaching to the student of the humanities and the social sciences.

In I. Bernard Cohen and Fletcher G. Watson (eds.)

*General Education in Science* (p. 71)

*The History of Science and the Teaching of Science* (p. 71)

Harvard University Press, Cambridge, Massachusetts, USA. 1952

### **Conant, James Bryant** 1893–1978

American educator and scientist

We can put it down as one of the principles learned from the history of science that a theory is only overthrown by a better theory, never merely by contradictory facts.

*On Understanding Science*

Chapter II (p. 36)

Yale University Press, New Haven, Connecticut, USA. 1947

The history of science demonstrates beyond doubt that the really revolutionary and significant advances come not from empiricism but from new theories.

*Modern Science and Modern Man*

Science and Technology (p. 30)

Columbia University Press. New York, New York, USA. 1952

**Darwin, Charles Robert** 1809–82

English naturalist

Great is the power of steady misrepresentation — but the history of science shows how, fortunately, this power does not long endure.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XV (p. 239)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Draper, John William** 1811–82

American scientist, philosopher, and historian

The history of science is not a mere record of isolated discoveries; it is a narrative of the conflict of two contending powers, the expansive force of the human intellect on one side, and the compression arising from traditionary faith and human interest on the other.

*History of the Conflict Between Religion and Science*

Preface (p. vi)

D. Appleton and Company. New York, New York, USA. 1898

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

...the history of science alone can keep the physicist from the mad ambitions of dogmatism as well as the despair of Pyrrhonian skepticism.

*The Aim and Structure of Physical Theory*

Part II, Chapter VII (p. 270)

Princeton University Press. Princeton, New Jersey, USA. 1954

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

The history of science, after all, does not just consist of facts and conclusions drawn from facts. It also contains ideas, interpretations of facts, problems created by conflicting interpretations, mistakes, and so on. On closer analysis we even find that science knows no “bare facts” at all but that the “facts” that enter our knowledge are already viewed in a certain way and are, therefore, essentially ideational.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Introduction (p. 19)

Verso. London, England. 1978

...the history of science will be as complex, chaotic, full of mistakes, and entertaining as the ideas it contains, and these ideas in turn will be as complex, chaotic, full of mistakes, and entertaining as are the minds of those who invented them.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Introduction (p. 19)

Verso. London, England. 1978

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

More attention to the History of Science is needed, as much by scientists as by historians, and especially by biologists, and this should mean a deliberate attempt to understand the thoughts of the great masters of the past, to see in what circumstances or intellectual milieu their ideas were formed, where they took the wrong turning or stopped short on the right track.

Natural Selection from the Genetical Standpoint

*Australian Journal of Science*, Volume 22, 1959

**Foster, Sir Michael** 1836–1907

English physiologist and educator

When we look into the past of science and trace our the first buddings of what afterwards grow to be umbrageous branches, it sometimes seems as if every time, and almost every year, marked an epoch.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1898*

Recent Advances in Science, and Their Bearing on Medicine and Surgery (p. 345)

Government Printing Office. Washington, D.C. 1899

It is one of the lessons of the history of science that each age steps on the shoulders of the ages which have gone before.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 5 (p. 51)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Geikie, Sir Archibald** 1835–1924

English geologist

In science, as in all other departments of inquiry, no thorough grasp of a subject can be gained unless the history of its development is clearly appreciated.

*The Founders of Geology*

Lecture I (p. 1)

Macmillan & Company Ltd. London, England. 1897

**Hall, Alfred Rupert** 1920–

English historian of science

The difficulty [in understanding science history] is the greater because the history of science is not, and cannot be, a tight unity. The different branches of science are themselves unlike in complexity, in techniques, and in their philosophy. They are not all affected equally, or at the same time, by the same historical factors, whether internal or external. It is not even possible to trace the development of a single scientific method, some formulation of principles and rules of operating which might be imagined as applicable to every scientific inquiry, for there is no such thing.

*The Scientific Revolution, 1500–1800*

Introduction (p. xiv)

Longmans, Green & Company. London, England. 1954

**Hall, Marie Boas** 1919–

English historian of science

For the...student whose chief interest does lie in science, for whom history as a course of study so often seems to deal solely with subjects remote from his intellectual turn of mind, the history of science provides a valid and useful point of contact with history, through which he may learn to develop wider humanistic interests. For the non-scientist, bored and baffled by the technical problems of science, the history of science may provide some insight into the scientific point of view and prevent the feeling of isolation which too often makes the scientist and the humanist appear to move in separate worlds.

*History of Science* (p. 1)

American Historical Association. Washington, D.C. 1958

### **Holton, Gerald** 1922–

Research professor of physics and science history

And yet, on looking into the history of science, one is overwhelmed by evidence that all too often there is no regular procedure, no logical system of discovery, no simple, continuous development. The process of discovery has been as varied as the temperament of the scientist.

*Thematic Origins of Scientific Thought: Kepler to Einstein*

Chapter 11 (pp. 384–385)

Harvard University Press. Cambridge, Massachusetts, USA. 1973

### **Huxley, Thomas Henry** 1825–95

English biologist

...any one acquainted with the history of science will admit that its progress has meant, in all ages and now more than ever, the extension of the province of matter and causation, and the gradual banishment from human thought of what we call spirit and spontaneity.

*Collected Essays* (Volume 1)

*Method and Result*

On the Physical Basis of Life (p. 159)

Macmillan & Company Ltd. London, England. 1904

### **Knickerbocker, William Skinkle** 1892–1972

American professor of English and author

...the history of science is as inspiring in its human values as are the legends of the saints. Contemplate the heroism of a Galileo, the patience of a Darwin, the humility of a Pasteur; a modern eleventh chapter of Hebrews might be written listing the names of all those men of faith who by quiet work, unremitting in their zeal, one by one discovered facts which made man's lot easier and happier in what was otherwise to him a hostile and unhappy universe.

*Classics of Modern Science*

Preface

Alfred A Knopf. New York, New York, USA. 1927

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

### **Kuhn, Thomas S.** 1922–96

American historian of science

Though the gap seems small, there is no chasm that more needs bridging than that between the historian of ideas and the historian of science.

*International Encyclopedia of the Social Sciences*

Volume 14, History of Science (p. 78)

The Macmillan Company. New York, New York, USA. 1968

### **Lakatos, Imre** 1922–74

Hungarian-born philosopher

Philosophy of science without history of science is empty; history of science without philosophy of science is blind.

In R. Buck and R. Cohen (eds.)

*Boston Studies in the Philosophy of Science* (Volume 8)

History of Science and Rational Reconstructions (p. 91)

D. Reidel Publishing Company. Dordrecht, Netherlands.

### **Lavoisier, Antoine Laurent** 1743–94

French chemist

...if I had allowed myself to enter into long dissertations on the history of the science, and the works of those who have studied it, I must have lost sight of the true object I had in view, and produced a work, the reading of which must have been extremely tiresome to beginners. It is not to the history of the science, or of the human mind, that we are to attend in an elementary treatise: Our only aim ought to be ease and perspicuity, and with the utmost care to keep every thing out of view which might draw aside the attention of the student; it is a road which we should be continually rendering more smooth, and from which we should endeavor to remove every obstacle which can occasion delay.

*Elements of Chemistry in a New Systematic Order*

Preface of the Author (pp. xxxii–xxxiii)

Printed for William Creech. Edinburgh, Scotland. 1790

### **Lévi-Strauss, Claude** 1908–

French social anthropologist and structuralist

...scientific knowledge advances haltingly and is stimulated by contention and doubt.

Translated by John and Doreen Weightman

*The Raw and the Cooked*

Overture (p. 7)

Harper & Row, Publishers. New York, New York, USA. 1975

### **Libby, Walter** 1867–1955

American science historian

The history of science has something to offer to the humblest intelligence. It is a means of imparting a knowledge of scientific facts and principles to unschooled minds.

*An Introduction to the History of Science*

Preface (p. v)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1917

The history of science is an aid in scientific research. It places the student in the current of scientific thought, and gives him a clue to the purpose and necessity of the theories he is required to master. It presents science as the constant pursuit of truth rather than the formulation of truth long since revealed; it shows science as progressive

rather than fixed; dynamic rather than static, a growth to which each may contribute.

*An Introduction to the History of Science*

Preface (p. v)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1917

The history of science is hostile to the spirit of caste. It shows the sciences rising from daily needs and occupations, formulated by philosophy, enriching philosophy, giving rise to new industries, which react in turn upon the sciences.

*An Introduction to the History of Science*

Preface (p. vi)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1917

The history of science studies the past for the sake of the future. It is a story of continuous progress. It is rich in biographical material. It shows the sciences in their interrelations, and saves the student from narrowness and premature specialization.

*An Introduction to the History of Science*

Preface (p. vi)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1917

### **Mach, Ernst** 1838–1916

Austrian physicist and philosopher

[N]ot only a knowledge of the ideas that have been accepted and cultivated by subsequent teachers is necessary for the historical understanding of a science, but also that the rejected and transient thoughts of the inquirers, may even apparently erroneous notions, may be very important and very instructive. The historical investigation of the development of a science is most needful, lest the principles treasured up in it become a system of half-understood prescripts, or worse, a system of prejudices.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter II, Part VIII, Section 7 (p. 316)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

Historical investigation not only promotes the understanding of that which now is, but also brings new possibilities before us, by showing that which exists to be in great measure conventional and accidental. From the higher point of view at which different paths of thought converge we may look about us with freer vision and discover routes before unknown.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter II, Part VIII, Section 7 (p. 316)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

The knowledge of the development of a science rests on the study of writings in their historical sequence and in their historical connection.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter I, Part V, Section 9 (p. 97)

The Open Court Publishing Company. La Salle, Illinois, USA. 1942

### **Macquer, Pierre Joseph** 1718–84

French chemist

As the History of any Science ought to relate the labours, the discoveries, and the errors of the cultivators of that Science; and to shew the obstacles which they have been obliged to surmount, and the mistaken paths into which they have sometimes been misled; it cannot therefore fail of being very useful to persons engaged in the same pursuits.

*A Dictionary of Chemistry* (Volume 1)

A Preliminary Discourse Concerning the Origin and Progress of Chemistry (p. 1)

Printed for T. Caldwell & R.F. Elmsly. London, England. 1771

### **Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The history of science, like the history of all human ideas, is a history of irresponsible dreams, of obstinacy, and of error.

*Conjectures and Refutations: The Growth of Scientific Knowledge*

Chapter 10, Section I (p. 216)

Harper & Row, Publishers. New York, New York, USA. 1963

### **Richet, Charles** 1850–1935

French physiologist

In the history of science, nobody has left his mark on the world unless he has been, in this sense, an innovator.

*The Natural History of a Savant*

Chapter VI (p. 38)

J.M. Dent & Sons Ltd. London, England. 1927

### **Rostand, Jean** 1894–1972

French biologist and philosopher

By showing us the extreme diversity of the factors involved in scientific creativity, the history of science teaches us that we should open the doors of our laboratories more widely. If we put that lesson into practice, our reflection on the past will have had a beneficial effect on the future.

*Humanly Possible: A Biologist's Note on the Future of Mankind*

On the History of Science (p. 182)

Saturday Review Press. New York, New York, USA. 1970

If there is one notion that clearly emerges from the history of science, and from which we can learn something, it is, I believe, the extreme diversity of the personal qualities and abilities that have contributed to the advancement of our knowledge.

*Humanly Possible: A Biologist's Note on the Future of Mankind*

On the History of Science (p. 180)

Saturday Review Press. New York, New York, USA. 1970

### **Sarton, George** 1884–1956

Belgian-born American scholar and writer

From the point of view of the history of science, transmission is as essential as discovery.

*Introduction to the History of Science* (Volume 2)

Introductory Chapter (p. 15)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

The study of history, and especially of the history of science, may thus be regarded, not only as a source of

wisdom and humanism, but also as a regulator for our consciences: it helps us not to be complacent, arrogant, too sanguine of success, and yet remain grateful and hopeful, and never to cease working quietly for the accomplishment of our own task.

*The History of Science and the New Humanism*

Chapter IV (p. 191)

Indiana University Press. Bloomington, Indiana, USA. 1962

### **Schweizer, Karl W.**

American professor of history

One of the obstructions to a genuine appreciation of history is the existence of a vague unformulated assumption that historical research merely seeks to disinter a fossilized past — merely digs into the memory to recover things which the human race once knew before. On the basis of such an assumption it is possible for people to have the feeling that history can never produce anything which is fundamentally novel, but merely fills our minds with the lumber of bygone ages.

*Herbert Butterfield: Essays on the History of Science*

Chapter II (p. 19)

Edwin Mellon Press. Lewiston, New York, USA. 1998

### **Silver, Brian L.**

Israeli professor of physical chemistry

The essence of scientific history has been conflict.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

### **Tannery, Paul** 1843–1904

French mathematician and historian of science

The scientist in so far as he is a scientist is only drawn to the history of the particular science that he studies himself; he will demand that this history be written with every possible technical detail, for it is only thus that it can supply him with materials of any possible utility. But what he will particularly require is the study of the thread of ideas and the linking together of discoveries. His chief object is to rediscover in its original form the expression of his predecessors' actual thoughts, in order to compare them with his own; and to unravel the methods that served in the construction of current theories, in order to discover at what point and towards what goal an effort towards innovation may be made.

In A. Rupert Hall

Can the History of Science Be History?

*The British Journal for the History of Science*, Volume 4, Part III, Number 15, June 1969 (p. 212)

### **Turner, H. H.**

No biographical data available

It is a familiar fact that there are epochs in the history of a science when it acquires new vigor; when new branches are put forth and old branches bud afresh or blossom

more plenteously. The vivifying cause is generally to be found either in the majestic form of the discovery of a new law of nature or in the humbler guise of the invention of a new instrument of research.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1904*

Some Reflections Suggested by the Application of Photography to

Astronomical Research (p. 171)

Government Printing Office. Washington, D.C. 1905

### **Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

It was a heroic period [about 1922–1930] without any parallel in the history of science, the most fruitful and interesting one of modern physics.... In this great period of physics, Bohr and his associates touched the nerve of the universe. The intellectual eye of man was opened to the inner workings of nature.

In A.P. French and P.J. Kennedy (eds.)

*Niels Bohr: A Centenary Volume*

Niels Bohr, the Quantum, and the World (p. 22)

Harvard University Press. Cambridge, Massachusetts, USA. 1985

### **Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

History is no exception amongst the sciences; as the gaps fill in, the outline simplifies; as the outlook broadens, the clustering multitude of details dissolve into general laws.

*The Outline of History*

Introduction (p. vi)

The Macmillan Company. New York, New York, USA. 1921

### **Whewell, William** 1794–1866

English philosopher and historian

We may best hope to understand the nature and conditions of real knowledge by studying the nature and conditions of the most certain and stable portions of knowledge which we already possess: and we are most likely to learn the best methods of discovering truth by examining how truths, now universally recognized, have really been discovered. *The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 1)

Book I, Chapter I (p. 1)

John W. Parker. London, England. 1847

[T]here do exist among us doctrines of solid and acknowledged certainty, and truths of which the discovery has been received with universal applause. These constitute what we commonly term Sciences; and of these bodies of exact and enduring knowledge, we have within our reach so large and varied a collection, that we may examine them, and the history of their formation, with good prospect of deriving from the study such instruction as we seek.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 1)

Book I, Chapter I (p. 2)

John W. Parker. London, England. 1847

It will be universally expected that a history of Inductive Science should...afford us some indication of the most promising mode of directing our future efforts to add to its extent and completeness.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume the First)

Introduction (p. 5)

John W. Parker. London, England. 1837

[T]he progress of knowledge is the main action of our drama; and all the events which do not bear upon this, though they may relate to the cultivation and the cultivators of philosophy, are not a necessary part of our theme.

*History of the Inductive Sciences, from the Earliest to the Present Time* (Volume the First)

Introduction (pp. 9, 12)

John W. Parker. London, England. 1837

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Science is concerned with the facts of bygone transition. History relates the aim at ideals. And between Science and History, lies the operation of the Deistic impulse of energy. It is the religious impulse in the world which transforms the dead facts of Science into the living drama of History. For this reason Science can never foretell the perpetual novelty of History.

*Modes of Thought*

Chapter II, Lecture Five (p. 142)

The Macmillan Company. New York, New York, USA. 1938

**Williams, L. Pearce**

American historian of science

...the history of science is a professional and rigorous discipline demanding the same level of skills and scholarship as any other scholarly field. It is time for the scientists to realize that he studies nature and others study him. He is no more nor no less competent to comment on his own activities and the activities of his fellow scientist than is the politician. Critical political history is rarely written by the politician and the same is true of the history of science.

Letter to the Editor

*Scientific American*, Volume 214, Number 6, June 1966 (p. 8)

**Willstätter, Richard** 1872–1942

German chemist

I consider the teaching and study of the historical development of science as indispensable.... Our textbooks fail in this respect.

In Rolf Huisgen

Adolf von Baeyer's Scientific Achievements — A Legacy

*Angewandte Chemie International Edition in English*, Volume 25, Number 4, April 1986 (p. 297)

## SCIENCE, MAN OF

**Barrie, Sir James M.** 1860–1937

Scottish journalist, writer, and dramatist

The man of science appears to be the only man who has something to say, just now — and the only man who does not know how to say it.

*Applied Physics*, Volume 2, 1963

**Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

Query: Whether the difference between a mere computer and a man of science be not, that the one computes on principles clearly conceived, and by rules evidently demonstrated, whereas the other doth not?

In A. Luce and T. Jessop (eds.)

*The Works of George Berkeley, Bishop of Cloyne* (Volume 4)

The Analyst

Nelson. London, England. 1948

**Bernard, Claude** 1813–78

French physiologist

Men of science, then, do not seek for the pleasure of seeking; they seek the truth to possess it, and they possess it already within the limits expressed in the present state of science.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter IV, Section IV (p. 222)

Henry Schuman, Inc. New York, New York, USA. 1927

...men of science must not halt on the road; they must climb ever higher and strive toward perfection; they must always seek as long as they see anything to be found.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter IV, Section IV (p. 222)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bradley, Omar** 1893–1981

American Army general

With the monstrous weapons man already has, humanity is in danger of being trapped in this world by its moral adolescents. Our knowledge of science has already outstripped our capacity to control it. We have many men of science, too few men of God.

Address

Boston, November 10, 1948

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

I do not know whether my distrust of men of science is congenital or acquired, but I think I should have transmitted it to descendants.

In Geoffrey Keynes and Brian Hill (eds.)

*Samuel Butler's Notebooks*

Myself and Distrust of Men of Science (p. 32)

Jonathan Cape. London, England. 1951

If [men of science] are worthy of the name, [they] are indeed about God's path and about his bed and spy out all his ways.

In Geoffrey Keynes and Brian Hill (eds.)  
*Samuel Butler's Notebooks*  
 Men of Science (p. 204)  
 Jonathan Cape. London, England. 1951

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
 English author

Far away in some strange constellation in skies infinitely remote, there is a small star, which astronomers may some day discover. At least, I could never observe in the faces or demeanor of most astronomers or men of science any evidence that they had discovered it; though as a matter of fact they were walking about on it all the time. It is a star that brings forth out of itself very strange plants and very strange animals; and none stranger than the men of science.

*The Everlasting Man*  
 Chapter I (p. 1)  
 Dodd, Mead & Company. New York, New York, USA. 1925

...the ordinary scientific man is strictly a sentimentalist. He is a sentimentalist in this essential sense, that he is soaked and swept away by mere associations.

*Orthodoxy*  
 Chapter IV (pp. 94–95)  
 John Lane Company. New York, New York, USA. 1918

**Clifford, William Kingdon** 1845–79  
 English philosopher and mathematician

A man of science...explains as much as ever he can, and then he says, "This is all I can do; for the rest you must ask the next man."

In Leslie Stephen and Frederick Pollock (eds.)  
*Lectures and Essays* (Volume 2)  
 Body and Mind (p. 32)  
 Macmillan & Company. London, England. 1879

**Darwin, Charles Robert** 1809–82  
 English naturalist

Children are one's greatest happiness, but often and often a still greater misery. A man of science ought to have none — perhaps not a wife; for then there would be nothing in this wide world worth caring for, and a man might (whether he could is another question) work away like a Trojan.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 1)  
 Letter 139, Darwin Asa Gray, July 11, 1862 (p. 202)  
 D. Appleton & Company. New York, New York, USA. 1903

...my success as a man of science, whatever this may have amounted to, has been determined, as far as I can judge, by complex and diversified mental qualities and conditions. Of these, the most important have been — the love of science, unbounded patience in long reflecting over any subject, industry in observing and collecting facts, and a fair share of invention as well as of common-sense. With such moderate abilities as I possess,

it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some important points.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
 Chapter II (p. 85)  
 D. Appleton & Company. New York, New York, USA. 1896

**Dumas, Jean Baptiste-Andre** 1800–84  
 French biochemist

The recollection of an already long life has permitted me to become acquainted with a great variety of personages. And if I call on memory to picture to me how the type of true happiness is realized on earth I do not see it under the form of the powerful man clothed in high authority, nor under that of the rich man to whom the splendors of luxury and the delicacies of well-being are granted, but under that of the man of science, who consecrates his life to penetrating the secrets of Nature and to the discovery of new truths.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
 Chapter I (p. 18)  
 Macmillan & Company Ltd. London, England. 1918

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

Verily, it is easier for a camel to pass through the eye of a needle than for a scientific man to pass through a door. And whether the door be barn door or church door it might be wiser that he should consent to be an ordinary man and walk in rather than wait till all the difficulties involved in a really scientific ingress are resolved.

*The Nature of the Physical World*  
 Chapter XV (p. 342)  
 The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955  
 German-born physicist

It has often been said, and certainly not without justification, that the man of science is a poor philosopher. Why then should it not be the right thing for the physicist to let the philosopher do the philosophizing? ...At a time like the present, when experience forces us to seek a newer and more solid foundation, the physicist cannot simply surrender to the philosopher the critical contemplation of the theoretical foundations; for, he himself knows best, and feels more surely where the shoe pinches. In looking for a new foundation, he must try to make clear in his own mind just how far the concepts which he uses are justified, and are necessities.

*Physik and Realität*  
*Journal of the Franklin Institute*, Volume 221, 1936

**Emerson, Ralph Waldo** 1803–82  
 American lecturer, poet, and essayist

We hearken to the man of science, because we anticipate the sequence in natural phenomena which he uncovers.

*The Complete Works of Ralph Waldo Emerson* (Volume 4)

Representative Men

Chapter IV (p. 170)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Froude, James Anthony** 1818–94

English historian and biographer

The secrets of nature have been opened out to us on a thousand lines; and men of science of all creeds can pursue side by side their common investigations.

*Short Studies on Great Subjects* (Volume 1)

Times of Erasmus, Desiderius and Luther, Lecture I (p. 41)

Longmans, Green & Company. London, England. 1879

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The scientific man has to work for truth so far as her ways can be comprehended by him, but he is never more than a trustee for posterity, and has no authority to define the functions or limit the freedom of those who follow him.

*Discovery; or The Spirit and Service of Science*

Chapter II (p. 30)

Macmillan & Company Ltd. London, England. 1918

The man of science, by virtue of his training, is alone capable of realising the difficulties — often enormous — of obtaining accurate data upon which just judgment may be based.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 40)

Macmillan & Company Ltd. London, England. 1918

To the popular mind, a man of science is a callous necromancer who has cut himself off from communion with his fellows, and has thereby lost the throbbing and compassionate heart of a full life: he is a Faust who has not yet made a bargain with Mephistopheles, and is therefore without human interest.

*Discovery; or, The Spirit and Service of Science*

Preface (p. v)

Macmillan & Company Ltd. London, England. 1918

**Hall, Asaph** 1829–1907

American astronomer

When men are striving for the discovery of truth in its various manifestations, they learn that it is by correcting the mistakes of preceding investigators that progress is made, and they have charity for criticism. Hence persecution for difference of opinion becomes an absurdity. The labours of scientific men are forming a great body of doctrine that can be appealed to with confidence in all countries. Such labours bring people together, and tend to break down national barriers and restrictions.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (pp. 30–31)

Macmillan & Company Ltd. London, England. 1918

**Huxley, Thomas Henry** 1825–95

English biologist

The man of science has learned to believe in justification, not by faith, but by verification.

*Collected Essays* (Volume 1)

*Method and Result*

On Improving Natural Knowledge (p. 41)

Macmillan & Company Ltd. London, England. 1904

**Laplace, Pierre Simon** 1749–1827

French mathematician, astronomer, and physicist

The isolated man of science can dedicate himself without fear to dogmatism; he hears only from afar contradictions of his ideas. But in a scientific society the impact of dogmatic ideas soon results in their destruction, and the desire to win one another over to their point of view establishes necessarily among members the convention of admitting only the results of observations and calculation.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 2 (p. 34)

Cambridge University Press. Cambridge, England. 1978

**Mather, Kirtley F.** 1888–1978

American geologist

To the man of science every event in the history of the universe is a miracle. It is both awe-inspiring and significant, a “sign and wonder.”

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (p. 3)

Thomas Y. Crowell Company, Publishers. New York, New York, USA. 1931

**Melville, Herman** 1819–91

American novelist

...a man of true science...uses but few hard words, and those only when none other will answer his purpose; whereas the smatterer in science...thinks, that by mouthing hard words, he proves that he understands hard things.

*White Jacket*

Chapter LXIII (p. 277)

Northwestern University Press. Evanston, Illinois, USA. 1970

**Pearson, Karl** 1857–1936

English mathematician

The scientific man has above all things to strive at self-elimination [elimination of self] in his judgments....

*The Grammar of Science*

Introductory, Section 2 (p. 7)

Charles Scribner's Sons. London, England. 1892

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer



The true man of science has no such expression in his vocabulary as useful science...if there can be no science for science's sake there can be no science.

In James Kip Finch  
Engineering and Science  
*Technology and Culture*, Fall 1961 (p. 330)

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...it is not his possession of knowledge, of irrefutable truth, that makes the man of science, but his persistent and recklessly critical quest for truth.

*The Logic of Scientific Discovery*  
Part II, Chapter X, Section 85 (p. 281)  
Basic Books, Inc. New York, New York, USA. 1959

**Renan, Ernest** 1823–92

French philosopher and Orientalist

With the saints, the heroes, the great men of all ages we may fearlessly compare our men of scientific minds, given solely to the research of truth, indifferent to fortune, often proud of their poverty, smiling at the honors they are offered, as careless of flattery as of obloquy, sure of the worth of that they are doing, and happy because they possess truth.

The Nobility of Science  
*Scientific American*, Volume 40, Number 20, New Series, 17 May 1879 (p. 310)

**Robinson, James Harvey** 1863–1936

American historian

**Beard, Charles A.** 1874–1948

American historian

It may well be that men of science, not kings, or warriors, or even statesmen are to be the heroes of the future.

*The Development of Modern Europe: An Introduction to the Study of Current History* (Volume 2)  
Chapter XXXI (p. 421)  
Ginn & Company. Boston, Massachusetts, USA. 1908

**Ross, Sir Ronald** 1857–1932

English bacteriologist

A witty friend of mine once remarked that the world thinks of the man of science as one who pulls out his watch and exclaims, "Ha! half an hour to spare before dinner: I will just step down to my laboratory and make a discovery."

Who but men of science themselves are to blame for such a misconception? Out of the many memoirs...[o]ur books of science are records of results rather than of that sacred passion for discovery which leads to them. Yet many discoveries have really been the climax of an intense drama... in which the protagonists are man and nature, and the issue a decision for all the ages.

*Memoirs*  
Preface (pp. v–vi)  
Publisher undetermined

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The man of science looks for facts that are significant, in the sense of leading to general laws; and such facts are frequently quite devoid of intrinsic interest.

*The Scientific Outlook*  
Chapter I (p. 49)  
George Allen & Unwin Ltd. London, England. 1931

All the conditions of happiness are realized in the life of the man of science.

*The Conquest of Happiness*  
Chapter X (p. 146)  
Liverwright Publishing Corporation. New York, New York, USA. 1930

**Spencer, Herbert** 1820–1903

English social philosopher

Only the sincere man of science (and by this title we do not mean the mere calculator of distances, or analyser of compounds, or labeler of species; but him who through lower truths seeks higher, and eventually the highest) — only the genuine man of science, we say, can truly know how utterly beyond, not only human knowledge, but human conception, is the Universal Power of which Nature, and Life, and Thought are manifestations.

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 84)  
A.L. Fowle. New York, New York, USA. 1860

**Suits, C. G.**

American physicist

I've never met that "coldly calculating man of science" whom the novelists extol.... I doubt that he exists; and if he did exist I greatly fear that he would never make a startling discovery or invention.

In Frederic Brownell  
Heed that Hunch  
*The American Magazine*, December 1945 (p. 142)

**Sullivan, John William Navin** 1886–1937

Irish mathematician

...outside their views on purely scientific matters there is nothing characteristic of men of science.

*Aspects of Science*  
Scientific Citizen (p. 120)  
J. Cape & H. Smith. New York, New York, USA. 1927

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

He is not a true man of science who does not bring some sympathy to his studies, and expect to learn something by behavior as well as by application. It is childish to rest in the discovery of mere coincidences, or of partial and extraneous laws. The study of geometry is a petty and idle exercise of the mind if it is applied to no larger system than the starry one.

*The Writings of Henry David Thoreau* (Volume 1)  
A Week on the Concord and Merrimack Rivers  
Friday (p. 477)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

The true man of science will know nature better by his finer organization; he will smell, taste, see, hear, feel, better than other men. His will be a deeper and finer experience. We do not learn by inference and deduction and the application of mathematics to philosophy, but by direct intercourse and sympathy. It is with science as with ethics, — we cannot know truth by contrivance and method; the Baconian is as false as any other, and with all the helps of machinery and the arts, the most scientific will still be the healthiest and friendliest man, and possess a more perfect Indian wisdom.

*The Writings of Henry David Thoreau* (Volume 9)  
Natural History of Massachusetts (pp. 161–162)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

The surest way for a nation's scientific men to prove that they were proud and ignorant was to claim to have found out something fresh in the course of a thousand years or so. Evidently the peoples of this book's day regarded themselves as children, and their remote ancestors as the only grown-up people that had existed. Consider the contrast:... our own scientific men may and do regard themselves as grown people and their grandfathers as children. The change... is probably the most sweeping that has ever come over mankind in the history of the race. It is the utter reversal, in a couple of generations, of an attitude which had been maintained without challenge or interruption from the earliest antiquity.... The change from reptile to bird was not more tremendous, and it took longer.

*The Complete Humorous Sketches and Tales of Mark Twain*  
A Majestic Literary Fossil (p. 534)  
Hanover House. Garden City, New York, USA. 1961

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Scientific man is supposed to limit himself to his immediate surroundings. However if he should occasionally want to step forth as a poet, he certainly should not be prevented from doing so.

In Karl J. Fink  
*Goethe's History of Science*  
Chapter 9 (p. 125)  
Cambridge University Press. Cambridge, England. 1991

**von Helmholtz, Hermann** 1821–94  
German scientist and philosopher

In fact, men of science form, as it were, an organised army, labouring on behalf of the whole nation, and gen-

erally under its direction and at its expense, to augment the stock of such knowledge as may serve to promote industrial enterprises, to increase wealth, to adorn life, to improve political and social relations, and to further the moral development of individual citizens.

*Popular Lectures on Scientific Subjects*  
Lecture I  
Volume 2, 1846 (p. 28)  
D. Appleton & Company. New York, New York, USA. 1885

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

The training of a scientific man is a training in what an illiterate lout would despise as a weakness, it is a training in blabbing, in blurring things out, in telling just as plainly as possible and as soon as possible what it is he has found.

*New Worlds for Old*  
Chapter II (p. 23)  
The Macmillan Company. New York, New York, USA. 1918

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

No man of science wants merely to know. He acquires knowledge to appease his passion for discovery. He does not discover in order to know, he knows in order to discover.

*The Orginsation of Thought*  
Chapter II (p. 37)  
Greenwood Press Publishers. Westport, Connecticut, USA. 1974

**Whitney, Willis Rodney** 1868–1958  
American chemical and electrical engineer

For the engineer "safety first" is a good slogan, but "safety last" is better for the man of research.

The Stimulation of Research in Pure Science Which Has Resulted from the Needs of Engineers and of Industry  
*Science*, Volume 65, Number 1862, March 25, 1927 (p. 289)

**Wordsworth, William** 1770–1850  
English poet

If the labours of men of Science should ever create any material revolution, direct or indirect, in our condition, and in the impressions which we habitually receive, the Poet will sleep then no more than at present, but he will be ready to follow the steps of the Man of Science, not only in those general indirect effects, but he will be at his side, carrying sensation into the midst of the objects of the Science itself. The remotest discoveries of the Chemist, the Botanist, or Mineralogist will be as proper objects of the Poet's art as any upon which I can be employed, if the time should ever come when these things shall be familiar to us... In R.L. Brett and A.R. Jones (eds.)

*Lyrical Ballads*  
Preface (pp. 259–260)  
Methuen & Company Ltd. London, England. 1963

**SCIENCE, PROGRESS OF****Abernethy, John** 1680–1740

Irish Presbyterian minister, theologian, and dissenter

Although knowledge has at times appeared to exhibit something of uniformity in its advances, yet it can not have escaped the least observant that, as a whole, the Progress of Science has been marked by very variable activity. At once time marvelously rapid; at another, indefinitely slow; now merged in darkness or obscurity, and not blazing forth with meridian splendor.

*Memoirs of John Abernethy*

Chapter I (p. 1)

Harper &amp; Brothers. New York, New York, USA. 1853

**Ardrey, Robert** 1908–80

American anthropologist

The contemporary revolution in the natural sciences has proceeded in something more striking than silence. It has proceeded in secret. Like our tiny, furry, squirrel-like, earliest primate ancestors, seventy million years ago, the revolution has found obscurity its best defence and modesty the key to its survival. For it has challenged larger orthodoxies than just those of science, and its enemies exist beyond counting. From seashore and jungle, from ant-heap and travertine cave have been collected the inflammable materials that must some day explode our most precious intellectual movement seeking light under darkest cover.

*African Genesis*

Chapter I, Section 2 (p. 13)

Athenaeum. New York, New York, USA. 1968

**Bernard, Claude** 1813–78

French physiologist

The progress of experimental method consists in this, — that the sum of truths grows larger in proportion as the sum of errors grows less. But each one of these particular truths is added to the rest to establish more general truths. In this fusion, the names of promoters of science disappear little by little, and the further science advances, the more it takes an impersonal form and detaches itself from the past.

*An Introduction to the Study of Experimental Medicine*

Part I, Chapter II, Section iv (p. 42)

Henry Schuman, Inc. New York, New York, USA. 1927

**Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

The progress of science is the discovery at each step of a new order which gives unity to what had long seemed unlike.

*Science and Human Value*

The Creative Mind (p. 26)

Harper &amp; Row, Publishers. New York, New York, USA. 1965

**Cohen, Morris Raphael** 1880–1947

American philosopher

...the progress of science always depends upon our questioning the plausible, the respectably accepted, and the seemingly self-evident.

*Reason and Nature*

Book III

Chapter One, Section II (p. 348)

Free Press. Glencoe, Georgia, USA. 1953

**Coles, Abraham** 1813–91

American physician, hymnist, and poet

Believing needless ignorance a crime,  
You strive to reach the summit of your time;  
To old age learning up from early youth  
Your life one long apprenticeship to truth.

Wisely suspicious sometimes of the new,  
Ye give alert acceptance to the true:

Even though it make old science obsolete,  
It with a thousand welcomes still you greet...

Each Year adds something — many things ye know  
Your sires knew not a Hundred Years ago.

*The Microcosm and Other Poems*

The Microcosm

Physician's Character and Aims — Science Progressive

D. Appleton &amp; Company. New York, New York, USA. 1881

**Daly, Reginald Aldworth** 1871–1957

Canadian-American geologist

Inasmuch as cosmogony and geology are both young sciences, consensus of opinions about the earth's origin and history is still reserved for the future. Meantime these sciences are advancing through the erection and testing of competing hypotheses; in other words, through speculation, controlled by all the available facts. Science progresses through systematic guessing in the good sense of the world.

*Our Mobile Earth*

Introduction (p. xx)

Charles Scribner's Sons. New York, New York, USA. 1926

**Dewar, James** 1842–1923

English physicist and chemist

In a legitimate sense all genuine scientific workers feel that they are "inheritors of unfulfilled renown." The battlefields of science are the centers of a perpetual warfare, in which there is no hope of final victory, although partial conquest is ever triumphantly encouraging the continuance of the disciplined and strenuous attack on the seemingly impregnable fortress of nature.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*

History of Cold and the Absolute Zero (p. 240)

Government Printing Office. Washington, D.C. 1903

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

Is it not evident, in these last hundred years (when the Study of Philosophy has been the business of all the Virtuosi in Christendom) that almost a new Nature has been reveal'd to us? that more errors of the School have been detected, more useful Experiments in Philosophy have been made, more Noble Secrets in Opticks, Medicine, Anatomy, Astronomy, discover'd, than in all those credulous and doting Ages from Aristotle to us? so true it is that nothing spreads more fast than Science, when rightly and generally cultivated.

*Of Dramatick Poesie: An Essay* (Volume 1) (p. 12)  
Printed for Henry Herringman. London, England. 1684

**Duclaux, Pierre Émile** 1840–1904  
French biochemist

It is because science is sure of nothing that it is always advancing.

In William Osler  
*Evolution of Modern Medicine*  
Chapter VI (p. 219)  
Yale University Press. New Haven, Connecticut, USA. 1921

A series of judgments, revised without ceasing, goes to make up the incontestable progress of science.

In W. Mansfield Clark  
*The Determination of Hydrogen Ions*  
Chapter VIII (p. 177)  
The Williams & Wilkins Company. Baltimore, Maryland, USA. 1928

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968  
Polish physicist

Science forces us to create new ideas, new theories. Their aim is to break down the wall of contradictions which frequently blocks the way of scientific progress. All the essential ideas in science were born in a dramatic conflict between reality and our attempts at understanding.

*The Evolution of Physics*  
Quanta (p. 280)  
Simon & Schuster. New York, New York, USA. 1934

**Enriques, Federigo** 1871–1946  
Italian mathematician

[T]he progress of science is dependent upon science itself, it is an extension and not a creation.

*Problems of Science*  
Chapter 3, Section 37 (p. 165)  
The Open Court Publishing Company. Chicago, Illinois, USA. 1914

**Foster, Sir Michael** 1836–1907  
English physiologist and educator

The path [of progress in science] may not always be in a straight line; there may be swerving to this side and to that; ideas may seem to return again and again to the same point of the intellectual compass; but it will always

be found that they have reached a higher level.... Moreover, science is not fashioned as is a house, by putting brick to brick, that which is once put remaining as it was put to the end. The growth of science is that of a living being. As is the embryo, phases follows phase, and each member or body puts on in succession different appearances, though all the while the same member, so a scientific conception of one age seems to differ from that of a following age...

*Annual Report of the Smithsonian Institution For 1899*  
The Growth of Science in the Nineteenth Century  
Government Printing Office. Washington, D.C. 1900

**France, Anatole (Jean Jacques Brousseau)** 1844–1924  
French writer

The progress of science renders useless the very books which have been the greatest aid to that progress. As those works are no longer useful, modern youth is naturally inclined to believe they never had any value; it despises them, and ridicules them if they happen to contain any superannuated opinion whatever.

Translated by Lafcadio Hern  
*The Crime of Sylvester Bonnard*  
June 4 (p. 168)  
Harper & Brothers. New York, New York, USA. 1890

**Free, E. E.**  
No biographical data available

Like a man on a bicycle science cannot stop; [science] must progress or collapse.

The Electric Brains in the Telephone  
*The World's Work*, Volume LIII, Number 4, February 1927 (p. 429)

**Garrod, Archibald** 1857–1936  
English physician

In these days of rapid scientific progress there is a tendency to accept the facts of nature, as at present known, without glancing back at the slow and difficult stages by which the knowledge of these facts has been arrived at. Yet such a retrospect is by no means unprofitable, since it warns us that hasty generalizations upon insufficient data retard rather than advance the progress of knowledge, and that the theories of the day must not be accepted as necessarily expressing absolute truths.

In Alexander G. Bearn  
*Archibald Garrod and the Individuality of Man*  
Chapter 3 (p. 25)  
Clarendon Press. Oxford, England. 1993

**Greene, Brian** 1963–  
American physicist

Progress in science proceeds in fits and starts. Some periods are filled with great breakthroughs, in other times researchers experience dry spells. Scientists put forward results, both theoretical and experimental. The results are debated by the community, sometimes they are discarded,

sometimes they are modified, and sometimes they provide inspirational jumping-off points for new and more accurate ways of understanding the physical universe. In other words, science proceeds along a zigzag path toward what we hope will be ultimate truth, a path that began with humanity's earliest attempts to fathom the cosmos and whose end we cannot predict.

*The Elegant Universe*

Chapter 1 (p. 20)

W.W. Norton & Company, Inc. New York, New York, USA.2003

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Science progresses not only because it helps to explain newly discovered facts, but also because it teaches us over and over again what the word “understanding” may mean.

*Physics and Beyond*

Chapter 10 (p. 124)

Harper & Row, Publishers. New York, New York, USA. 1971

### **Kuhn, Thomas S.** 1922–96

American historian of science

... we must explain why science — our surest example of sound knowledge — progresses as it does, and we first must find out how, in fact, it does progress.

In Imre Lakatos and Alan Musgrave (eds.)

*Criticism and the Growth of Knowledge*

Logic of Discovery or Psychology of Research (p. 20)

Cambridge University Press. Cambridge, England. 1970

Does a field make progress because it is a science, or is it a science because it makes progress?

*The Structure of Scientific Revolutions* (2<sup>nd</sup> edition)

Chapter XIII (p. 162)

The University of Chicago Press. Chicago, Illinois, USA. 1970

### **Lee, Tsung Dao** 1926–

Chinese-born American nuclear physicist

The progress of science has always been the result of a close interplay between our concepts of the universe and our observations on nature. The former can only evolve out of the latter and yet the latter is also conditioned greatly by the former. Thus, in our exploration of nature, the interplay between our concepts and our observations may sometimes lead to totally unexpected aspects among already familiar phenomena.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1957

Weak Interactions and Nonconservation of Parity (p. 417)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

### **Lindley, David** 1956–

English astrophysicist and author

Progress in science is a matter of jumping to conclusions. The trick is to jump to useful and interesting conclusions. Generalizing from small scraps of evidence may lead one astray, but sticking strictly to what limited evidence

one has, and refusing to countenance anything that is not directly provable, leads nowhere at all. The scientist has to generate new ideas and hypotheses, then act upon them.

*Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think*

An Engineer, a Physicist, and a Philosopher... (p. 157)

Basic Books, Inc. New York, New York, USA. 1996

### **Lowie, Robert H.** 1883–1957

Austrian-born American anthropologist

The clarification of concepts...directly gauges scientific progress.

*The History of Ethnological Theory*

Chapter XIV (p. 281)

Rinehart & Company, Inc. New York, New York, USA. 1937

### **Mayr, Ernst** 1904–2005

German-born American biologist

Any scientific revolution has to accept all sorts of black boxes, for if one had to wait until all black boxes are opened, one would never have any conceptual advances.

*One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Thought*

Chapter Ten (p. 146)

Harvard University Press. Cambridge, Massachusetts, USA. 1991

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

It can be said that Science progresses only by peeling away, one after another, all the covering of apparent stability in the world; disclosing beneath the immobility of the infinitely small, movement of extra rapidity, and beneath the immobility of the Immense, movement of extra slowness.

*The Future of Man*

Some Reflections on Progress (p. 62)

Methuen & Company Ltd. London, England. 1960

### **Planck, Max** 1858–1947

German physicist

It is a rather zigzag pattern than the curve of scientific progress follows; indeed I might say that the forward movement is of an explosive type, where the rebound is an attendant characteristic of the advance. Every applied hypothesis which succeeds in throwing the searchlight of a new vision across the field of physical science represents a plunge into the darkness; because we cannot at first reduce the vision to a logical statement. Then follows the birth-struggle of a new theory. Once this has seen the light of day it has to go forward willy-nilly until the stamp of its destiny is put on it when the test of the research measurements is applied.

*Where Is Science Going?*

Nature's Image in Science (pp. 90–91)

W.W. Norton & Company, Inc. New York, New York, USA.1932

An important scientific innovation rarely makes its way by gradually winning over and converting its opponents:

it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning...

*The Philosophy of Physics*

Chapter III (p. 97)

W.W. Norton & Company, Inc. New York, New York, USA. 1936

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

In science it would be a tremendous loss if we were to say: “We are not making very much progress. Let us sweep away all science and start afresh.” The rational procedure is to correct it and to revolutionize it, but not to sweep it away. You may create a new theory, but the new theory is created in order to solve those problems which the old theory did not solve.

*Conjectures and Refutations*

Chapter 4 (p. 132)

Harper & Row, Publishers. New York, New York, USA. 1963

...in order that a new theory should constitute a discovery or a step forward it should conflict with its predecessor...it should contradict its predecessor; it should overthrow it. In this sense, progress in science — or at least a striking progress — is always revolutionary.

In Rom Harré

*Problems of Scientific Revolution*

The Rationality of Scientific Revolutions (pp. 82–83)

The Clarendon Press. Oxford, England. 1975

**Price, Don K.** 1910–1995

American presidential advisor and educator

...most scientists are prepared to work most of the time within the framework of ideas developed by their acknowledged leaders. In that sense...science is ruled by oligarchs who hold influence as long as their concepts and systems are accepted as the most successful strategy.... Once in a great while, a rival system is proposed; then there can usually be no settlement of the issue by majority opinion. The metaphor of “scientific revolution” suggests the way in which the losing party is displaced from authority, discredited and its doctrines eliminated from textbooks.

*The Scientific Estate*

Chapter 6 (p. 172)

Harvard University Press. Cambridge, Massachusetts, USA. 1965

**Priestley, Joseph** 1733–1804

English theologian and scientist

If the progress continues the same in another period, of equal length, what a glorious science shall we see unfold, what a fund of entertainment is there in store for us, and what important benefits must derive mankind.

Quoted by John G. McEvoy

Electricity, Knowledge, and the Nature of Progress in Priestley’s

Thought *The British Journal for the History of Science*, Volume 12,

Number 40, 1979 (p. 76)

**Richet, Charles** 1850–1935

French physiologist

One can only progress in the sciences — with the exception of Mathematics — at the price of great pecuniary sacrifice.

Translated by Sir Oliver Lodge

*The Natural History of a Savant*

Chapter II (p. 21)

J.M. Dent & Sons Ltd. London, England. 1927

All progress in science is progress in civilization, and consequently contributes to the welfare of man.

Translated by Sir Oliver Lodge

*The Natural History of a Savant*

Chapter XIII (p. 145)

J.M. Dent & Sons Ltd. London, England. 1927

**Rindos, David** 1947–96

American educator

Progress in science depends not only upon new data but also upon the careful elaboration of new approaches to old data as well as new.

In Michael B. Schiffer (ed.)

*Archaeological Method and Theory* (Volume 1)

Chapter I (p. 1)

University of Arizona Press. Tucson, Arizona, USA. 1989

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

Science is the key to the progress of the world.

*Encyclopedia of Thoughts*

Aphorism 20

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Thomson, Sir George** 1892–1975

English physicist

...the progress of science is a little like making a jig-saw puzzle. One makes collections of pieces which certainly fit together, though at first it is not clear where each group should come in the picture as a whole, and if at first one makes a mistake in placing it, this can be corrected later without dismantling the whole group.

*The Inspiration of Science*

Introduction (pp. 5–6)

Oxford University Press, Inc. London, England. 1961

**von Bertalanffy, Ludwig** 1901–72

Austrian biologist

The evolution of science is not a movement in an intellectual vacuum; rather it is both an expression and a driving force of the historical process.

*Problems of Life: An Evaluation of Modern Biological Thought*

Chapter Six (p. 202)

Watts & Company, London, England. 1952

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

...we might well mention from our perspective, that there are advantages to entering a field of science which is in a state of crisis, and in which we also find an active, extraordinary person. We are young with young methods, our beginnings reach into a new epoch.

In Karl J. Fink

*Goethe's History of Science*

Chapter 6 (p. 88)

Cambridge University Press. Cambridge, England. 1991

**von Liebig, Justus** 1803–73

German organic chemist

Thus the progress of science is, like the development of nature's works, gradual and expansive. After the buds and branches spring forth the leaves and blossoms, after that blossoms the fruit.

*Familiar Letters on Chemistry*

Letter I (p. 10)

Taylor & Walton. London, England. 1843

**von Neumann, John** 1903–57

Hungarian-American mathematician

**Morgenstern, Oskar** 1902–77

German-born American economist

The great progress in every science came when, in the study of problems which were modern as compared with ultimate aims, methods were developed which could be extended further and further. The free fall is a very trivial physical phenomenon, but it was the study of this exceedingly simple fact and its comparison with the astronomical material, which brought forth mechanics.

*Theory of Games and Economic Behavior*

Chapter 1.3.2 (p. 6)

Princeton University Press. Princeton, New Jersey, USA. 1947

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The progress of Science consists in observing interconnections and in showing with a patient ingenuity that the events of this ever-shifting world are but examples of a few general relations, called laws. To see what is general in what is particular, and what is permanent in what is transitory, is the aim of scientific thought.

*An Introduction to Mathematics*

Chapter 1 (p. 4)

Oxford University Press, Inc. New York, New York, USA. 1958

[S]cience started its modern career by taking over ideas derived from the weakest side of the philosophies of Aristotle's successors. In some respects it was a happy choice. It enabled the knowledge of the seventeenth century to be formulated so far as physics and chemistry were concerned, with a completeness which lasted to the present time. But the progress of biology and psychology has probably been checked by the uncritical assumption of half-truths.

*Science and the Modern World*

Chapter I (pp. 16–17)

The Macmillan Company. New York, New York, USA. 1929

In the conditions of modern life the rule is absolute, the race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated.

*The Organisation of Thought*

Chapter I (p. 28)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

## SCIENCE AND ART

**Asimov, Isaac** 1920–92

American author and biochemist

How often people speak of art and science as though they were two entirely different things, with no interconnection. An artist is emotional, they think, and uses only his intuition; he sees all at once and has no need of reason. A scientist is cold, they think, and uses only his reason; he argues carefully step by step, and needs no imagination. That is all wrong. The true artist is quite rational as well as imaginative and knows what he is doing; if he does not, his art suffers. The true scientist is quite imaginative as well as rational, and sometimes leaps to solutions where reason can follow only slowly; if he does not, his science suffers.

*The Roving Mind*

Chapter 25 (p. 116)

Prometheus Books. Buffalo, New York, New York, USA. 1983

## Author undetermined

Art is personal and science is universal.

In Lecomte du Nouy

*The Road to Reason*

Chapter 1 (p. 31)

Longmans, Green & Company. London, England. 1949

**Blake, William** 1757–1827

English poet, painter, and engraver

He who would do good to another must

do it in Minute Particulars:

General Good is the plea of the scoundrel,  
hypocrite and flatterer;

For art and science cannot exist but in  
minutely organized Particulars.

*The Complete Poetry and Prose of William Blake*

Jerusalem

The Holiness of Minute Particulars, 3, Section 55 (p. 399)

University of California Press. Berkeley, California, USA. 1982

**Brecht, Bertolt** 1898–1956

German writer

But science and art meet on this ground, that both are there to make man's life easier, the one setting out to maintain, the other to entertain us. In the age to come art will create entertainment from that new productivity which can so greatly improve our maintenance, and in itself, if only it is left unshackled, may prove to be the greatest pleasure of all.

Translated by John Willett

*Brecht on Theatre: The Development of an Aesthetic*  
A Short Organon for the Theater, 20 (p. 185)  
Hill & Wang. New York, New York, USA. 1964

**Campbell, Norman R.** 1880–1949  
English physicist and philosopher

Science is the noblest of the arts and men of science the most artistic of all artists.

*Physics: The Elements*  
Chapter VIII (p. 227–228)  
At The University Press. Cambridge, England. 1920

Science, like art, should not be something extraneous, added as a decoration to other activities of existence; it should be part of them, inspiring our most trivial actions as well as our noblest thoughts.

*What Is Science?*  
Chapter VIII (p. 183)  
Dover Publications. New York, New York, USA. 1952

**Cassidy, Harold Gomes**  
No biographical data available

If humans understood science and would effectively make their voices heard, they could, with the aid of scientists, control the forces of cultural change in the process of their actual generation, directing them in the ways that lead toward the morally and ethically just ends that arise from the union of art and science. This union, when it is a union of whole science and whole art, supports and illuminates anew a noble image of man.

*The Sciences and the Arts: A New Alliance*  
Chapter 11 (p. 165)  
Harper & Brothers. New York, New York, USA. 1962

**Cassirer, Ernst** 1874–1945  
German philosopher

Since art and science move in entirely different planes, they cannot contradict or thwart one another.

*An Essay on Man: An Introduction to a Philosophy of Human Culture*  
Chapter IX (p. 170)  
Yale University Press. New Haven, Connecticut, USA. 1944

**Cohen, I. Bernard** 1914–2003  
American physicist and science historian

Great creations whether of science or art — can never be viewed dispassionately.

In the 1952 printing  
*Optics*

Preface (p. ix)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Connolly, Cyril** 1903–74  
English critic and editor

Today the function of the artist is to bring imagination to science and science to imagination, where they meet, in the myth.

*The Unquiet Grave*  
Part III (p. 86)  
Hamish Hamilton. London, England. 1945

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

People with training in the arts still feel that in spite of the alterations made in their life by technology — by the internal combustion engine, by penicillin, by the Bomb — modern science has little to do with what concerns them most deeply. As far as today's science is concerned this is partly true, but tomorrow's science is going to knock their culture right out from under them.

*Of Molecules and Men*  
The Prospect Before Us (p. 95)  
University of Washington Press. Seattle, Washington, USA. 1966

**De Gourmont, Rémy** 1858–1915  
French critic and novelist

Art includes everything that stimulates the desire to live; science, everything that sharpens the desire to know. Art, even the most disinterested, the most disembodied, is the auxiliary of life. Born of the sensibility, it sows and creates it in its turn. It is the flower of life and, as seed, it gives back life. Science, or to use a broader term, knowledge, has its end in itself, apart from any idea of life and propagation of the species.

Translated by Glenn S. Burne  
*Selected Writings*  
Art and Science (p. 170)  
The University of Michigan Press. Ann Arbor, Michigan, USA. 1966

**Delbrück, Max** 1906–81  
German-born American biologist

The books of the great scientists are gathering dust on the shelves of learned libraries. And rightly so. The scientist addresses an infinitesimal audience of fellow composers. His message is not devoid of universality but its universality is disembodied and anonymous. While the artist's communication is linked forever with its original form, that of the scientist is modified, amplified, fused with the ideas and results of others, and melts into the stream of knowledge and ideas which forms our culture.

A Physicist's Renewed Look at Biology: Twenty Years Later  
*Science*, Volume 168, Number 3937, June 12, 1970 (p. 1314)

The scientist has in common with the artist only this: that he can find no better retreat from the world than his work and also no stronger link with the world than his work.



A Physicist's Renewed Look at Biology: Twenty Years Later  
*Science*, Volume 168, Number 3937, June 12, 1970 (p. 1314)

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

Directly or indirectly, the various forms of art reflect the strivings, the struggles, and the sufferings of mankind. The state of health and the ills of a society are recorded not only in the writings of its physicians and scholars but also in the themes and moods of its artists and poets.

Mirage of Health  
Chapter VII (p. 215)  
Harper & Brothers Publishers. New York, New York, USA. 1959

**Durant, William James** 1885–1981  
American historian and essayist

Every science begins as philosophy and ends as art; it arises in hypothesis and flows into achievement.

*The Story of Philosophy*  
Introduction (p. 2)  
Simon & Schuster. New York, New York, USA. 1953

**Einstein, Albert** 1879–1955  
German-born physicist

Science exists for Science's sake, like Art for Art's sake, and does not go in for special pleading or for the demonstration of absurdities.

*Cosmic Religion, with Other Opinions and Aphorisms*  
On Science (p. 100)  
Covici-Fiede. New York, New York, USA. 1931

...one of the strongest motives that lead men to art and science is escape from everyday life with its painful crudity and hopeless dreariness, from the fetters of one's own ever shifting desires. A finely tempered nature longs to escape from personal life into the world of objective perception and thought... Man tries to make for himself in the fashion that suits him best a simplified and intelligible picture of the world; he then tries to some extent to substitute this cosmos of his for the world of experience, and thus to overcome it. This is what the painter, the poet, the speculative philosopher, and the natural scientist do, each in his own way.

*The World as I See It*  
Principles of Research (pp. 20–21)  
Philosophical Library. New York, New York, USA. 1949

**Einstein, Albert** 1879–1955  
German-born physicist

After a certain high level of technical skill is achieved, science and art tend to coalesce in esthetics, plasticity, and form. The greatest scientists are always artists as well.

In Alice Calaprice (ed.)  
*The Quotable Einstein* (p. 171)  
Princeton University Press. Princeton, New Jersey, USA. 1996

**Escher, M. C.** 1898–1972  
Dutch graphic artist

...science and art sometimes can touch one another, like two pieces of the jigsaw puzzle which is our human life, and that contact may be made across the borderline between the two respective domains.

In Doris Schattschneider  
*Visions of Symmetry: Notebooks, Periodic Drawings, and Related Works of M.C. Escher*  
Chapter 2 (p. 104)  
W.H. Freeman & Company. New York, New York, USA. 1990

**Feynman, Richard P.**

I've always been very one-sided about science and when I was younger I concentrated almost all my effort on it. I didn't have time to learn and I didn't have much patience with what's called the humanities, even though in the university there were humanities that you had to take. I tried my best to avoid somehow learning anything and working at it. It was only afterwards, when I got older, that I got more relaxed, that I've spread out a little bit. I've learned to draw and I read a little bit, but I'm really still a very one-sided person and I don't know a great deal. I have a limited intelligence and I use it in a particular direction.

In Jeffrey Robbins (ed.)  
*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*  
Chapter 1 (p. 2)  
Perseus Books. Cambridge, Massachusetts, USA. 1999

**Harvey, William** 1578–1657  
English physician

On the same terms, therefore, as art is attained to, is all knowledge and science acquired; for as art is a habit with reference to things to be done, so is science a habit in respect to things to be known; as that proceeds from the imitation of types or forms so this proceeds from the knowledge of natural things.

In *Great Books of the Western World* (Volume 28)  
*Anatomical Exercises on the Generation of Animals*  
Of the Manner and Order of acquiring Knowledge (p. 333)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

Both science and art form in the course of the centuries a human language by which we can speak about the more remote parts of reality, and the coherent sets of concepts as well as the different styles of art are different words or groups of words in this language.

*Physics and Philosophy: The Revolution in Modern Science*  
Chapter VI (p. 109)  
Harper & Row, Publishers. New York, New York, USA. 1958

**Huxley, Aldous** 1894–1963  
English writer and critic

Unlike art, science is genuinely progressive. Achievement in the fields of research and technology is cumulative;

each generation begins at the point where its predecessor left off.

*Science, Liberty and Peace*

Chapter I (p. 30)

William Morrow & Company, Inc. New York, New York, USA. 1967

Science and art are only too often a superior kind of dope, possessing this advantage over booze and morphia: that they can be indulged in with a good conscience and with the conviction that, in the process of indulging, one is leading the “higher life.”

*Ends and Means*

Chapter XIV (p. 276)

Chatto & Windus. London, England. 1938

**Karanikas, Alexander** 1916–2006

Greek-American professor of English

...science pierces reality like a dagger in search of fact and truth while art caresses reality looking for pleasure, grace and beauty.

*Tillers of a Myth*

Science, the False Messiah (p. 127)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1969

**Kepes, Gyorgy** 1906–2001

Hungarian-born American artist and theorist

The essential vision of reality presents us not with fugitive appearances but with felt patterns of order which have coherence and meaning for the eye and for the mind. Symmetry, balance and rhythmic sequences express characteristics of natural phenomena: the connectedness of nature — the order, the logic, the living process. Here art and science meet on common ground.

*The New Landscape*

In Art and Science

Chapter I (p. 24)

Paul Theobald & Company Chicago, Illinois, USA. 1956

Mathematicians who build new spaces and physicists who find them in the universe can profit from the study of pictorial and architectural spaces conceived and built by men of art.

*The New Landscape*

In Art and Science

Chapter I (p. 28)

Paul Theobald & Company Chicago, Illinois, USA. 1956

**Klee, Paul** 1879–1940

Swiss expressionist painter

...the worst state of affairs is when science begins to concern itself with art.

*The Diaries of Paul Klee 1898–1918*

Diary III, Number 747 (p. 194)

University of California Press. Berkeley, California, USA. 1964

**Knuth, Donald E.** 1938–

Creator of TeX

The difference between art and science is that science is what people understand well enough to explain to a computer. All else is art.

In Robert Slater

*Portraits in Silicon*

Chapter 31 (p. 351)

The MIT Press. Cambridge, Massachusetts, USA. 1987

**Koestler, Arthur** 1905–83

Hungarian-born English writer

Einstein’s space is no closer to reality than Van Gogh’s sky. The glory of science is not in a truth more absolute than the truth of Bach or Tolstoy, but in the act of creation itself. The scientist’s discoveries impose his own order on chaos, as the composer or painter imposes his; an order that always refers to limited aspects of reality, and is based on the observer’s frame of reference, which differs from period to period as a Rembrandt nude differs from a nude by Manet.

*The Act of Creation*

Book One, Part Two, Chapter X (p. 252)

The Macmillan Company. New York, New York, USA. 1964

**Kraus, Karl** 1874–1936

Austrian essayist and poet

Science is spectrum analysis. Art is photosynthesis.

In John D. Barrow

*The Artful Universe* (p. 114)

Clarendon Press. Oxford, England. 1995

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

There is no spiritual copyright in scientific discoveries, unless they should happen to be quite mistaken. Only in making a blunder does a scientist do something which, conceivably, no one else might ever do again. Artists are not troubled by matters of priority, but Wagner would certainly not have spent twenty years on The Ring if he had thought it at all possible for someone else to nip in ahead of him with Götterdämmerung.

*The Act of Creation*

*New Statesman*, 19 June 1964

**Melville, Herman** 1819–91

American novelist

One can envisage an end of science no more readily than one can envisage an end of imaginative literature or the fine arts.

*Advice to a Young Scientist*

Chapter 11 (p. 90)

Basic Books, Inc. New York, New York, USA. 1979

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

Both the man of science and the man of art live always at the edge of mystery, surrounded by it; both always,

as to the measure of their creation, have had to do with the harmonization of what is new with what is familiar, with the balance between novelty and synthesis, with the struggle to make partial order in total chaos.

Prospects in the Arts and Sciences

Speech, 26 December 1954, Columbia University Bicentennial

The frontiers of science are separated now by long years of study, by specialized vocabularies, arts, techniques, and knowledge from the common heritage even of a most civilized society; and anyone working at the frontier of such science is in that sense a very long way from home, a long way too from the practical arts that were its matrix and origin, as indeed they were of what we today call art.

Prospects in the Arts and Sciences

Speech, 26 December 1954, Columbia University Bicentennial

### **Reynolds, Osborne** 1842–1912

English fluid dynamics engineer

I have to deal with facts, and I shall try to deal with nothing but facts. Many of these facts, or the conclusions to be immediately drawn from them, may appear to bear on the possibilities — or, rather, the impossibilities — of art. But in the Society of Arts I need not point out that art knows no limit; where one way is found to be closed, it is the function of art to find another. Science teaches us the results that will follow from a known condition of things; but there is always the unknown condition, the future effect of which no science can predict.

*Papers on Mechanical and Physical Subjects* (Volume 2)

Lecture to the Society of Arts

At The University Press. Cambridge, England. 1900=03

### **Sagan, Carl** 1934–96

American astronomer and author

It is sometimes said that scientists are unromantic, that their passion to figure out robs the world of beauty and mystery. But is it not stirring to understand how the world actually works — that white light is made of colors, that color is the way we perceive the wavelengths of light, that transparent air reflects light, that in so doing it discriminates among the waves, and that the sky is blue for the same reason that the sunset is red? It does no harm to the romance of the sunset to know a little bit about it.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 10 (pp. 159–160)

Random House, Inc. New York, New York, USA. 1994

### **Santayana, George (Jorge Augustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

Science is the response to the demand for information. . . .

Art is the response to the demand for entertainment.

*The Sense of Beauty*

Part I, Section 2 (p. 22)

Transaction Publishers. New Brunswick, New Jersey, USA. 2000

### **Shlain, Leonard**

American surgeon and author

Both art and physics are unique forms of language. Each has a specialized lexicon of symbols that is used in a distinctive syntax. Their very different and specific contexts obscure their connection to everyday language as well as to each other. Nevertheless, it is noteworthy just how often the terms of one can be applied to the concepts of the other. “Volume,” “space,” “mass,” “force,” “light,” “color,” “tension,” “relationship,” and “density” are descriptive words that are heard repeatedly if you trail along with a museum docent. They also appear on the blackboards of freshman college physics lectures.

Quoted by Gerald Noltan

*Art and Physics: Parallel Visions in Space, Time and Light*

Chapter 1

William Morrow & Company, Inc. New York, New York, USA. 1991

The proponents of these two diverse endeavors [art and physics] wax poetic about elegance, symmetry, beauty, and aesthetics. While physicists demonstrate that A equals B or that X is the same as Y, artists often choose signs, symbols, and allegories to equate a painterly image with a feature of experience. Both of these techniques reveal previously hidden relationships.

Quoted by Gerald Noltan

*Art and Physics: Parallel Visions in Space, Time and Light*

Chapter 1

William Morrow & Company, Inc. New York, New York, USA. 1991

### **Silver, Brian L.**

Israeli professor of physical chemistry

Whatever the Sun may be, said D. H. Lawrence, it is certainly not a ball of flaming gas. Helios, the sun god, has more sex appeal than a cloud of gas, however hot.

*The Ascent of Science*

Part IX, Chapter 36 (p. 485)

Solomon Press Book. New York, New York, USA. 1998

[D. H.] Lawrence [saw] science systematically chipping away at the mysterious, but generally benign, unknown and arrogantly replacing it with the dull, prosaic, down-to-earth known. . . . The scientist’s rainbow is the result of the different refractive indices of the various frequencies of light that make up solar radiation. But man evidently prefers mystery to math, and the intrusion of science into the movements of the planets and the stars, into the living cell and into that final sanctuary of the spirit, the mind, has undoubtedly cast a chill over that warm, blurred garden, the theocentric universe. The scientist, ruthlessly buying up desirable property, appears to many people to be building an automated factory in the middle of the garden.

*The Ascent of Science*

Part IX, Chapter 36 (p. 485)

Solomon Press Book. New York, New York, USA. 1998

**Smyth, H. D.**

No biographical data available

We have a paradox in the method of science. The research man may often think and work like an artist, but he has to talk like a bookkeeper in terms of facts, figures and logical sequence of thought.

Quoted by Gerald Nolton

On the Duality and Growth of Physical Science  
*American Scientist*, Volume 41, 1953 (p. 93)

**Spencer, Herbert** 1820–1903

English social philosopher

...Science is necessary not only for the most successful production, but also for the full appreciation of the fine arts.

*Education: Intellectual, Moral, and Physical*  
Chapter I (p. 70)

A.L. Fowle. New York, New York, USA. 1860

**Sullivan, John William Navin** 1886–1937

Irish mathematician

The measure in which science falls short of art is the measure in which it is incomplete as science.

The Justification of the Scientific Method  
*The Athenaeum*, May 1919 (p. 275)

**Valéry, Paul** 1871–1945

French poet and critic

There is a science of simple things, an art of complicated ones. Science is feasible when the variables are few and can be enumerated; when their combinations are distinct and clear. We are tending toward the condition of science and aspiring to it. The artist works out his own formulas; the interest of science lies in the art of making science.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

Moralités

Analects (p. 64)

Princeton University Press. Princeton, New Jersey, USA. 1971

**Waddington, Conrad Hal** 1905–75

British biologist and paleontologist

The best of modern art is compatible only with true science, and the bogus science requires a fake art to keep it company.

*The Scientific Attitude*

Science Is Not Neutral (p. 27)

Penguin Books, Middlesex, England. 1941

**Whewell, William** 1794–1866

English philosopher and historian

Art and Science differ. The object of Science is Knowledge; the objects of Art are Works. In Art, truth is a means to an end; in Science, it is the only end. Hence the Practical Arts are not to be classed among the Sciences.

*The Philosophy of the Inductive Sciences Founded Upon Their History*  
(Volume 2)

Aphorisms Concerning Science, Aphorism XXV (p. 471)

John W. Parker. London, England. 1847

**Wordsworth, William** 1770–1850

English poet

Enough of Science and of Art;

Close up these barren leaves;

Come forth, and bring with you a heart

That watches and receives.

*The Complete Poetical Works of William Wordsworth*

The Tables Turned, Stanza 8

Crowell. New York, New York, USA. 1888

**SCIENCE AND CIVILIZATION****Ackerman, Diane** 1948–

American writer

When we think of science, we often picture arcane quests after minutiae, or efforts to explain underlying principles. But it's amazing that in a civilization as complex as ours, we are still engaged in Adam's task, the naming of animals.

*The Rarest of the Rare: Vanishing Animals, Timeless Worlds*

Insect Love (p. 160)

Vintage Books. New York, New York, USA. 1997

**Compton, Arthur H.** 1892–1962

American physicist

I verily believe that in the advancement of science lies the hope of our civilization.

*Les Prix Nobel. The Nobel Prizes in 1927*

Nobel banquet speech for award received in 1927

Nobel Foundation. Stockholm, Sweden. 1928

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

Without the impersonal guidance and the efficient control provided by science civilization will either stagnate or collapse, and human nature cannot make progress towards realizing its possible evolutionary destiny.

*What Dare I Think?: The Challenge of Modern Science to Human Action and Belief, Including the Henry La Barre Jayne Foundation Lectures*

Chapter V (p. 177)

Harper & Brothers. New York, New York, USA. 1931

Science has two main functions in civilization. One is to give man a picture of the world phenomena, the most accurate and complete picture possible. The other is to provide him with the means of controlling his environment and his destiny.

*What Dare I Think?: The Challenge of Modern Science to Human Action and Belief, Including the Henry La Barre Jayne Foundation Lectures*

Chapter IV (pp. 127–128)

Harper & Brothers. New York, New York, USA. 1931

Modern civilisation rests upon physical science; take away her gifts to our own country, and our position among the leading nations of the world is gone to-morrow; for it is physical science only that makes intelligence and moral energy stronger than brute force.

*Collected Essays* (Volume 8)

*Discourses, Biological and Geological*

A Lobster; or, The Study of Zoology (p. 226)

Macmillan & Company Ltd. London, England. 1904

### **Lovell, Sir Alfred Charles Bernard** 1913–

English physicist, radio astronomer, and author

The pursuit of the good and evil are now linked in astronomy as in almost all science.... The fate of human civilization will depend on whether the rockets of the future carry the astronomer's telescope or a hydrogen bomb.

*The Individual and the Universe* (p. 72)

Oxford University Press. London, England. 1959

### **Metropolis, Nicholas C.** 1915–99

Mathematician

Science is the locomotive that drives our civilization.

In Sigfried S. Hecker and Gian-Carlo Rota (eds.)

*Essays on the Future: In Honor of Nick Metropolis*

Belated Thoughts (p. xv)

Birkhäuser. Boston, Massachusetts, USA. 2000

### **Ortega y Gasset, José** 1883–1955

Spanish philosopher

...experimental science has progressed thanks in great part to the work of men astoundingly mediocre, and even less than mediocre. That is to say, modern science, the root and symbol of our actual civilisation, finds a place for the intellectually commonplace man and allows him to work therein with success.... A fair amount of the things that have to be done in physics or in biology is mechanical work of the mind which can be done by anyone or almost anyone. For the purpose of innumerable investigations it is possible to divide science into small sections, to enclose oneself in one of these, and leave out of consideration all the rest.

*The Revolt of the Masses*

Chapter 12 (p. 110, 111)

W.W. Norton & Company, Inc. New York, New York, USA. 1960

### **Parson, H. N.**

No biographical data available

A successful blending of the sciences and the humanities is necessary for the health of our civilization.

*Science Is Human*

Science Is Human (p. 31)

University of Otago Press. Dunedin, New Zealand. 1972

### **Sagan, Carl** 1934–96

American astronomer and science writer

The very method of mathematical reasoning that Isaac Newton introduced to explain the motion of the planets

around the Sun has led to most of the technology of our modern world. The Industrial Revolution, for all its shortcomings, is still the global model of how an agricultural nation can emerge from poverty. These debates have bread-and-butter consequences.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 4 (p. 56)

Random House, Inc. New York, New York, USA. 1994

## SCIENCE AND MORALS

### **Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

It is not the business of science to inherit the earth, but to inherit the moral imagination; because without that man and beliefs and science will perish together.

*The Ascent of Man*

Chapter 13 (p. 432)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

### **Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

...when any part of the general public is drawn into a debate on physical science, we may be certain that it has already become a debate on moral science.

*All Is Grist: A Book of Essays*

On Gossip about Heredity (p. 96)

Methuen & Company Ltd. London, England. 1931

### **Compton, Karl Taylor** 1887–1954

American educator and physicist

I would emphasize the fact that scientific discovery is, per se, neither good nor bad. It simply produces knowledge and with knowledge, opportunity and responsibility. I think it fair to say that the advance of science carries with it powerful demands on morality if the results are to be beneficial rather than harmful.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

During the Years 1930–1949 (p. 5)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

### **Dewey, John** 1859–1952

American philosopher and educator

Science through its physical technological consequences is now determining the relations which human beings, severally and in groups, sustain to one another. If it is incapable of developing moral techniques which will also determine these relations, the split in modern culture goes so deep that not only democracy but all civilized values are doomed.

*Freedom and Culture*

Chapter Six (p. 118)

Prometheus Books. Buffalo, New York, USA. 1989

### **Diderot, Denis** 1713–84

French encyclopedist and philosopher of materialism

The moral universe is so closely linked to the physical universe that it is scarcely likely that they are not one and the same machine.

*Éléments de Physiologie* (pp. xiii–xiv)  
Librairie M. Didier. Paris, France. 1964

**Ferré, Nels F. S.** 1908–71  
Swedish-American theologian

Science can be and is being made into an escapist philosophy — into a dodge of moral disciplines and spiritual responsibilities.

*Faith and Reason*  
Chapter II (p. 83)  
Harper & Brothers. New York, New York, USA. 1946

**Friedenberg, Edgar Z.** 1921–2001  
Educator, education critic, and sociologist

...only science can hope to keep technology in some sort of moral order.

*The Vanishing Adolescent*  
The Impact of the School, the Clarification of Experience (p. 50)  
Beacon Press. Boston, Massachusetts. 1964

**Gould, Stephen Jay** 1941–2002  
American paleontologist, evolutionary biologist, and historian of science

I do not know when the technical and popular prose of science became separated, although I accept the inevitability of such a division as knowledge became increasingly more precise, detailed, and specialized. We have now reached the point where most technical literature not only falls outside the possibility of public comprehension but also (as we would all admit in honest moments) outside our own competence in scientific disciplines far removed from our personal expertise. I trust that we all regard this situation as saddening, even though we accept its necessity.

Take Another Look  
*Science*, Volume 286, Number 5441, October 29, 1999 (p. 899)

**Jefferson, Thomas** 1743–1826  
3<sup>rd</sup> president of the United States

...if science produces no better fruits than tyranny, murder, rapine and destitution of national morality, I would rather wish our country to be ignorant, honest and estimable, as our neighboring savages are.

*The Writings of Thomas Jefferson* (Volume 6)  
Letter to John Adams, 1812 (p. 37)  
Deby & Jackson. New York, New York, USA. 1859

**Kruyt, Hugo Rudolph** 1882–1959  
Dutch colloid chemist

Clearer than ever we understand that knowledge is not all, that we need morals and brotherhood to avoid science becoming a curse.

In John P. Dickinson

*International Council of Scientific Unions*  
First General Assembly Following the Second World War, Science and Scientific Researchers in Modern Society (p. 165)

**Lerner, Max** 1902–92  
American educator and author

Science itself is a humanist in the sense that it doesn't discriminate between human beings, but it is also morally neutral. It is no better or worse than the ethos with and for which it is used.

Manipulating Life  
*New York Post*, January 24, 1968

**Masters, William H.** 1915–2001  
American gynecologist and researcher

Science by itself has no moral dimension. But it does seek to establish truth. And upon this truth morality can be built.

Two Sex Researchers on the Firing Line  
*Life*, 24 June 1966 (p. 49)

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

Scientists aren't responsible for the facts that are in nature. It's their job to find the facts. There's no sin connected with it — no morals. If anyone should have a sense of sin, it's God. He put the facts there.

In Lincoln Barnett  
J. Robert Oppenheimer  
*Life*, October 10, 1949 (p. 133)

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

There can no more be immoral science than there can be scientific morals.

*The Foundations of Science*  
The Values of Science, Introduction (p. 206)  
The Science Press. New York, New York, USA. 1913

**Snow, Charles Percy** 1905–80  
English novelist and scientist

...there is a moral component right in the grain of science itself...

*The Two Cultures: And a Second Look*  
Chapter I (p. 13)  
At The University Press. Cambridge, England. 1964

**Toynbee, Arnold J.** 1852–83  
English historian

Our western science is a child of moral virtues; and it must now become the father of further moral virtues if its extraordinary material triumphs in our time are not to bring human history to an abrupt, unpleasant and discreditable end.

A Turning Point in Man's Destiny  
*The New York Times Magazine*, December 26, 1954 (p. 5)

**Wallace, Henry A.** 1888–1935  
33<sup>rd</sup> vice-president of the United States

I can understand the impulse which prompts scientists to defend science against the attacks of the uninformed. Science has achieved so many miracles for society, saved so many lives, made possible so extraordinary an advance in material living standards for so many millions of people, that it is disquieting to think that all the consequences of science can ever be other than good. Yet I don't see what basis we have for assuming that science can and does have only beneficial consequences. Is the product of man's curiosity inevitably good?...It may be disturbing to realize it, but the truth seems to be that science proceeds without moral obligations; it is neither moral nor immoral, but in essence amoral.

Scientists in an Unscientific Society  
*Scientific Monthly*, Volume 150, 1934 (p. 285)

## SCIENCE AND PHILOSOPHY

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

The great and radical difference of capacities, as to philosophy and the sciences, lies here: that some are stronger and fitter to observe the differences of things; others their correspondencies: for a steady and sharp genius can fix it's contemplations, and dwell and fasten upon all the subtlety of differences, while a sublime and ready genius perceives and compares the smallest and most general agreements of things; but both kinds easily fall into excess, by grasping either at the dividing scale, or shadows of things. The former is so taken up with the particles of things, as almost to neglect their structure, whilst the other views their fabrication with such astonishment, as not to enter into the simplicity of nature.

In George Adams  
*Lectures on Natural and Experimental Philosophy* (Volume 1)  
Lecture IV (p. 127)  
Printed by R. Hindmarsh. London, England. 1794

**Burroughs, John** 1837–1921  
American naturalist and writer

Science displeases literature when it dehumanizes nature and shows us irrefragable laws when we had looked for humanistic divinities.

*The Breath of Life*  
Chapter X (p. 243)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

To mix science up with philosophy is only to produce a philosophy that has lost all its ideal value and a science that has lost all its practical value.

*All Things Considered*  
Science and Religion (p. 187)  
John Lane Company. New York, New York, USA. 1908

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

Science is not a technique or a body of knowledge, though it uses both. It is rather an attitude of inquiry, or observation and reasoning, with respect to the world. It can be developed, not by memorizing facts or juggling formulas to get an answer, but only by actual practice of scientific observation and reasoning.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 44)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**de Casseres, Benjamin** 1873–1945  
American journalist and author

My studies in speculative philosophy, metaphysics, and science are all summed up in the image of a mouse called man, running in and out of every hole in the cosmos hunting for the absolute cheese.

*Harper's Weekly*, Volume 19, Number 3164, June 28, 1976

**Durant, William James** 1885–1981  
American historian and essayist

Philosophy...is the front trench in the siege of truth. Science is the captured territory.

*The Story of Philosophy*  
Introduction (p. 2)  
Simon & Schuster. New York, New York, USA. 1953

Science without philosophy, facts without perspective and valuation, cannot save us from havoc and despair. Science gives us knowledge, but only philosophy can give us wisdom.

*The Story of Philosophy*  
Introduction (p. 3)  
Simon & Schuster. New York, New York, USA. 1953

Science is analytical description, philosophy is synthetic interpretation. Science wishes to resolve the whole into the known.

*The Story of Philosophy*  
Introduction (p. 2)  
Simon & Schuster. New York, New York, USA. 1953

**Eddy, Mary Baker** 1821–1910  
American religious writer

Jesus of Nazareth was the most scientific man that ever trod the globe. He plunged beneath the material surface of things, and found the spiritual cause.

*Science and Health with Key to the Scriptures*  
Chapter X (p. 313)  
Joseph Armstrong. Boston, Massachusetts, USA. 1906

**Fischer, Martin H.** 1879–1962  
German-American physician

Not fact-finding, but attainment to philosophy, is the aim of science.

*Fischerisms* (p. 7)

C.C. Thomas. Springfield, Illinois, USA. 1944

### Gornick, Vivian

American essayist

Science — like art, religion, political theory, or psychoanalysis — is work that holds out the promise of philosophical understanding, excites in us the belief that we can “make sense of it all.”

*Women in Science: Portraits from a World in Transition*

Part One (p. 66)

Simon & Schuster. New York, New York, USA. 1983

### Huxley, Julian 1887–1975

English biologist, philosopher, and author

The attempt to understand this universe, including the nature of man, is the task of science; and as she makes progress with this task, so will she become more and more an indispensable part of philosophy and religion — imagination’s touchstone, thought’s background, action’s base.

Searching for the Elixir of Life

*The Century Illustrated Monthly Magazine*, Volume 103, Number 4, February 1922

### Jeans, Sir James Hopwood 1877–1946

English physicist and mathematician

The philosophy of any period is always largely interwoven with the science of the period, so that any fundamental change in science must produce reactions in philosophy.

*Physics and Philosophy*

Chapter I (p. 2)

Dover Publications, Inc. New York, New York, USA. 1981

In whatever ways we define science and philosophy their territories are contiguous; wherever science leaves off — and in many places its boundary is ill-defined — there philosophy begins.

*Physics and Philosophy*

Chapter I (p. 17)

Dover Publications, Inc. New York, New York, USA. 1981

### Jones, Steve 1944–

English genetics professor

...philosophy is to science as pornography is to sex.

In Mary Midgley

Can Science Save Its Soul?

*New Scientist*, 1 August 1992 (p. 25)

### Keats, John 1795–1821

English Romantic lyric poet

Do not all charms fly

At the mere touch of cold philosophy?

There was an awful rainbow once in heaven:

We know her woof, her texture; she is given

In the dull catalogue of common things.

Philosophy will clip an Angel’s wings,

Conquer all mysteries by rule and line,

Empty the haunted air, and gnom’ed mine —

Unweave a rainbow...

*The Complete Poetical Works and Letters of John Keats*

Lamia, Part II, l. 229–237

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

### Mercier, André 1913–99

Swiss physicist

Philosophy does not “solve problems”, whereas science does. Philosophy, in its relations to science, gathers up the problems of science, which are no longer problems since they have found solutions, and seeks to order them in such a way that the structure of knowledge does, in fact, appear.

Fifty Years of the Theory of Relativity

*Nature*, Volume 175, Number 4465, May 28, 1955 (p. 919)

### Pope Pius XII 1876–1958

Bishop of Rome

Science descends ever more deeply into the hidden recesses of things, but it must halt at a certain point when questions arise which cannot be settled by means of sense observations. At that point the scientist needs a light which is capable of revealing to him truth which entirely escapes his senses. This light is philosophy.

In Philip G. Fothergill

*Life and Its Origin*

Pontifical Academy of Science, Meeting 1955 (p. 12)

### Popper, Karl R. 1902–94

Austrian/British philosopher of science

All science and all philosophy are enlightened common sense.

*Objective Knowledge: An Evolutionary Approach*

Chapter 2 (p. 34)

Clarendon Press. Oxford, England. 1972

### Renan, Ernest 1823–92

French philosopher and Orientalist

Socrates founded philosophy, and Aristotle science. There was philosophy before Socrates, and science before Aristotle; and since Socrates and since Aristotle, philosophy and science have made immense progress: but all has all been built upon the foundations they laid.

*The Life of Jesus*

Chapter 28 (p. 383)

Modern Library. New York, New York, USA. 1955

### Ritchie, Arthur David 1891–1967

Scottish philosopher and science history writer

Philosophers who write about Science and scientists who write about Philosophy are too often preoccupied



with the scientific theories and discoveries of the moment to the detriment of both their Science and their Philosophy.

*Scientific Method: An Inquiry into the Character and Validity of Natural Laws*

Preface (p. v)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1923

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

The man who has no tincture of philosophy goes through life imprisoned in the prejudices.... To such a man the world tends to become definite, finite, obvious; common objects rouse no questions, and unfamiliar possibilities are contemptuously rejected.

*The Problems of Philosophy*

Chapter XV (pp. 156–157)

Oxford University Press, Inc. London, England. 1959

It seems to me that science has a much greater likelihood of being true in the main than any philosophy hitherto advanced (I do not, of course, except my own). In science there are many matters about which people are agreed; in philosophy there are none. Therefore, although each proposition in a science may be false, and it is practically certain that there are some that are false, yet we shall be wise to build our philosophy upon science, because the risk of error in philosophy is pretty sure to be greater than in science. If we could hope for certainty in philosophy, the matter would be otherwise, but so far as I can see such a hope would be a chimerical.

*The Philosophy of Logical Atomism*

Logical Atomism

University of Minnesota Press. Minneapolis, Minnesota, USA. 1959

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

In our science and philosophy, even, there is commonly no true and absolute account of things. The spirit of sect and bigotry has planted its hoof amid the stars. You have only to discuss the problem, whether the stars are inhabited or not, in order to discover it.

*The Writings of Henry David Thoreau* (Volume 4)

Life Without Principle (p. 469)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Weyl, Hermann** 1885–1955

German mathematician

A scientist who writes on philosophy faces conflicts of conscience from which he will seldom extricate himself whole and unscathed; the open horizon and depth of philosophical thoughts are not easily reconciled with that objective clarity and determinacy for which he has been trained in the school of science.

*Philosophy of Mathematics and Natural Science*

Preface (p. v)

Princeton University Press. Princeton, New Jersey, USA. 1949

## SCIENCE AND POETRY

**Beston, Henry** 1888–1968

American writer

Poetry is as necessary to comprehension as science. It is as impossible to live without reverence as it is without joy.

*The Outermost House*

Chapter X (p. 221)

Rinehart & Company. New York, New York, USA. 1928

**Clifford, William Kingdon** 1845–79

English philosopher and mathematician

It is an open secret to the few who know it, but a mystery and a stumbling-block to the many, that Science and Poetry are own sisters; inasmuch that in those branches of scientific inquiry which are most abstract, most formal, and most remote from the grasp of the ordinary sensible imagination, a higher power of imagination akin to the creative insight of the poet is most needed and most fruitful of lasting work.

In Leslie Stephen and Frederick Pollock (eds.)

*Lectures and Essays* (Volume 1)

Introduction (p. 1)

Macmillan & Company. London, England. 1886

**Davis, Joel** 1948–

No biographical data available

Poetry and science are closer than most people realize. Many poets and scientists already know this, of course. Most of the rest of us are still trapped in dismal stereotypes about both fields of human endeavor. The deep link between the two is vision.

*Alternate Realities*

In a Grain of Sand (p. 3)

Plenum Trade. New York, New York, USA. 1997

**Day-Lewis, C. (Cecil)** 1904–72

Irish-born English author and poet

Science is concerned with finding out and stating the facts: poetry's task is to give you the look, the smell, the taste, the "feel" of those facts.

*Poetry for You*

Chapter I (p. 10)

Basil Blackwell & Mott Ltd. Oxford, England. 1959

Every good poem, in fact, is a bridge built from the known, familiar side of life over into the unknown. Science, too, is always making expeditions into the unknown. But this does not mean that science can supersede poetry. For poetry enlightens us in a different way from science: it speaks directly to our feelings or imagination. The findings of poetry are no more and no less true than science.

*Poetry for You*

Chapter VIII (p. 92)

Basil Blackwell & Mott Ltd. Oxford, England. 1959

**Holton, Gerald** 1922–

Research professor of physics and science history

Poets rush in where scientists fear to tread.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part One, Chapter 6 (p. 132)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Jones, Frederick Wood** 1879–1954

Physician

Whoever wins to a great scientific truth will find a poet before him in the quest.

*Medical Journal of Australia*, 29 August 1931

**Lysaght, Sidney R.** 1860–1941

Irish writer

Science in the first place looks for information, poetry for beauty; and, taking different paths, they meet on the borderland of discovery.

*A Reading of Life*

Chapter II (p. 35)

Macmillan & Company Ltd. London, England. 1936

**Melandri, E.**

No biographical data available

The existence of poetics of science is undeniable.... Barring poetics from science is the same as barring use of the hypothesis.

In Fernand Hallyn

*The Poetic Structure of the World: Copernicus and Kepler*

Introduction (p. 7)

Zone Books. New York, New York, USA. 1990

**Miller, Hugh** 1802–56

Scottish geologist and theologian

Because science flourishes, must poesy decline? The complaint serves but to betray the weakness of the class who urge it.

*Sketch-Book of Popular Geology*

Lecture Second (p. 80)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

**Spencer, Herbert** 1820–1903

English social philosopher

...those who have never entered upon scientific pursuits know not a tithe of the poetry by which they are surrounded.

*Education: Intellectual, Moral and Physical*

A.L. Fowle. New York, New York, USA. 1860

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The poet uses the results of science and philosophy, and generalizes their widest deductions.

*The Writings of Henry David Thoreau* (Volume 1)

A Week on the Concord and Merrimac Rivers

Friday (p. 478)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Tillyard, E. M. W.** 1889–1962

English classical scholar

**Lewis, C. S. (Clive Staples)** 1898–1963

British author, scholar, and popular theologian

Only science can tell you where and when you are likely to meet an elm: only poetry can tell you what meeting an elm is like.

*The Personal Heresy: A Controversy*

Chapter V (p. 110)

Oxford University Press, Inc. London, England. 1939

**von Schlegel, Friedrich** 1772–1829

German philosopher, critic, and writer

Strictly speaking, the idea of a scientific poem is probably as nonsensical as that of a poetic science.

*Dialogue on Poetry and Literary Aphorisms*

Selected Aphorisms from the Lyceum

Aphorism 61 (p. 127)

The Pennsylvania State University Press, University Park. Pennsylvania, USA. 1968

**Wheelock, John Hall** 1886–1978

American poet

The statements of science are hearsay, reports from a world outside the world we know. What the poet tells us has long been known to us all, and forgotten. His knowledge is of our world, the world we are both doomed and privileged to live in, and it is a knowledge of ourselves, of the human condition, the human predicament.

*What Is Poetry?*

Chapter 6

Charles Scribner's Sons. New York, New York, USA. 1963

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Exact science and its practical movements are no checks on the greatest poet but always his encouragement and support. ...there the arms that lifted him first and brace him best...there he returns after all his goings and comings. The sailor and traveller...the anatomist chemist astronomer geologist phrenologist spiritualist mathematician historian and lexicographer are not poets, but they are the lawgivers of poets and their construction underlies the structure of every perfect poem.

*Leaves of Grass*

Preface to the 1855 edition of "Leaves of Grass" (p. 304)

Doubleday, Doran & Company, Inc. New York, New York, USA. 1940

If there shall be love and content between the father and the son and if the greatness of the son is the exuding of the greatness of the father, there shall be love between the poet and the man of demonstrable science. In the beauty of poems are the tuft and final applause of science.

*Leaves of Grass*

Preface to the 1855 edition of "Leaves of Grass" (p.304)  
 Doubleday, Doran & Company, Inc. New York, New York, USA. 1940

**Zee, Anthony**

American physicist

In science, one tries to say what no one else has ever said before. In poetry, one tries to say what everyone else has already said, but better. This explains, in essence, why good poetry is as rare as good science.

*Fearful Symmetry*

Chapter 7 (p. 103)  
 Macmillan Publishing Company, New York, New York, USA. 1986

**SCIENCE AND POLITICS****Born, Max** 1882–1970

German-born English physicist

...the subordination of fundamental research to political and military authorities is detrimental. The scientists themselves have learned by now that the period of unrestricted individualism in research has come to an end. They know that even the most abstract and remote ideas may one day become of great practical importance — like Einstein's law of equivalence of mass and energy. They have begun to organize themselves and to discuss the problem of their responsibility to human society. It should be left to these organizations to find a way to harmonize the security of the nations with the freedom of research and publication without which science must stagnate.

*The Restless Universe*

Postscript (p. 308)  
 Dover Publications, Inc. New York, New York, USA. 1951

**Budworth, D.**

No biographical data available

Science policy is essentially about the allocation of scarce resources, and is therefore a part of politics.... The scarce resource with which science policy should concern itself in the short term is not money, but that portion of the scientific population which is capable of initiating and leading significant work. Such people are always in short supply, even when the total population itself is greater than the available jobs.

Science Policy Should Be About People  
*New Scientist*, Volume 69, Number 993, 25 March 1976 (pp. 684–685)

**Clarke, Arthur C.** 1917–

English science and science fiction writer

The menace of interplanetary imperialism can be overcome only by world-wide technical and political agreements well in advance of the actual event, and these will require continual pressure and guidance from the organizations which have studied the subject.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 8)  
 Harper & Brothers. New York, New York, USA. 1959

**de Maupertuis, Pierre-Louis Moreau** 1698–1759

French mathematician and astronomer

There are sciences over which the will of kings has no immediate influence; it can procure advancement there only in so far as the advantages which it attaches to their study can multiply the number and the efforts of those who apply themselves to them. But there are other sciences which for their progress urgently need the power of sovereigns; they are all those which require greater expenditure than individuals can make or experiments which would not ordinarily be practicable.

*Lettres su le progrès des sciences, Oeuvres de Maupertuis*

Dresden (pp. 6–7)  
 Publisher undetermined

**Johnson, Harry G.** 1923–1979

American economist

Basic science, per se, contributes to culture; it contributes to our social well-being, including national defence and public health; to our economic well-being; and it is an essential element of the education not only of scientists but also of the population as a whole. In deciding how much science the society needs, one must decide how the support of science bears on these other, politically defined, goals of the society.

In National Academy of Sciences

*Basic Research and National Goals: A Report to the Committee on Science and Astronautics*

Federal Support of Basic Research: Some Economic Issues, Summary (p. 5)

U.S. Government Printing Office. Washington, D.C. 1965

**Koestler, Arthur** 1905–83

Hungarian-born English writer

No scientist is admired for failing in the attempt to solve problems that lie beyond his competence. The most he can hope for is the kindly contempt earned by the Utopian politician. If politics is the art of the possible, research is surely the art of the soluble. Both are immensely practical-minded affairs.

The Act of Creation

*New Statesman*, Volume 19, June 1964

**Price, Don K.** 1910–1995

American presidential advisor and educator

...all sciences are considered by their professors as equally significant; by the politicians, as equally incomprehensible; and by the military as equally expensive.

*The Scientific Estate*

Chapter 1 (p. 12)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1965

...it has begun to seem evident to a great many administrators and politicians that science had become something very close to an establishment, in the old and proper sense of that word: a set of institutions supported by tax funds but largely on faith and without direct responsibility to political control.

*The Scientific Estate*

Chapter 1 (p. 12)

Harvard University Press. Cambridge, Massachusetts, USA. 1965

**Rabinowitch, Eugene** 1901–73

Russian-born American biophysicist

Science has assumed such an important role in determining the parameters of national and international life, that participation in national decisions by people whose world picture has been affected by the study and practice of science (even if this picture has its own bias), is indispensable for many major political decisions — to correct the bias of the more traditional molders of national decisions, such as men with legal training.

Open Season on Scientists

*The New Republic*, January 1, 1966 (p. 21)

## SCIENCE AND RELIGION

**Adams, George** 1750–95

English instrument maker

The two kingdoms of nature and grace, as two parallel lines, correspond to each other, follow a like course, but can never be made to touch. An adequate understanding of this distinction in all its branches, would be the consummation of human knowledge.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture VI (p. 242)

Printed by R. Hindmarsh. London, England. 1794

**Adams, Henry Brooks** 1838–1918

American man of letters

The preacher then went on to criticise the attitude of religion towards science. “If there is still a feeling of hostility between them...it is no longer the fault of religion. There have been times when the church seemed afraid, but she is so no longer. Analyze, dissect, use your microscope or your spectrum till the last atom of matter is reached; reflect and refine till the last element of thought is made clear; the church now knows with the certainty of science what she once knew only by the certainty of faith, that you will find enthroned behind all thought and matter only one central idea, — that idea which the church has never ceased to embody, — I AM!

*Democracy, and Esther: Two Novels by Henry Adams*

Esther (p. 212)

Peter Smith. Gloucester, Massachusetts, USA. 1965

**Allport, Gordon** 1897–1967

American psychologist

A narrowly conceived science can never do business with a narrowly conceived religion.

*The Individual and His Religion: A Psychological Interpretation*

Preface (p. vi)

The Macmillan Company. New York, New York, USA. 1956

**Alpher, Ralph Asher** 1921–

American physicist

I...reject the argument put forth by many fundamentalists that science has nothing to do with religion because God is not among the things making up the universe in which we live. Surely if a necessity for a god-concept in the universe ever turns up, that necessity will become evident to the scientist.

Theology of the Big Bang

*Religious Humanism*, Volume 17, Number 1, Winter 1983 (p. 12)

**Appleyard, Bryan** 1951–

English author and journalist

Science was the lethally dispassionate search for truth in the world whatever its meaning might be; religion was the passionate search for meaning whatever the truth might be. Science can lay a claim to a meaning in the sense of establishing causality, and religion could claim truth in the sense of a transcendent order. But science’s meaning does not answer the question Why? And religion’s truth had no scientific relevance.

*Understanding the Present: Science and the Soul of Modern Man*

Chapter 4 (p. 79)

Doubleday. New York, New York, USA. 1992

**Berger, Peter L.** 1929–

American sociologist

Protestant theologians have been increasingly engaged in playing a game whose rules have been dictated by their cognitive antagonists.

*A Rumor of Angels: Modern Society and the Rediscovery*

*of the Supernatural*

Chapter 1 (p. 10)

Doubleday & Company, Inc. Garden City, New York, USA. 1970

**Bernal, John Desmond** 1901–71

Irish-born physicist and x-ray crystallographer

Now the history of scientific advance has shown us clearly that any appeal to Divine Purpose or any supernatural agency, to explain any phenomenon, is in fact only a concealed confession of ignorance, and a bar to genuine research.

*Science and Ethics*

A Marxist Critique (p. 116)

George Allen & Unwin Ltd. London, England. 1942

The role of God in the material world has been reduced stage by stage with the advance of science, so much so that He only survives in the vaguest mathematical form in the minds of older physicists and biologists.

In C.H. Waddington (ed.)

*Science and Ethics*

A Marxist Critique (p. 116)

George Allen &amp; Unwin Ltd. London, England. 1942

**Boutroux, Émile** 1845–1921

French philosopher

In spite of their relations, science and religion remain, and must remain, distinct. If there were no other way of establishing a rational order between things than that of reducing the many to the one, either by assimilation or by elimination, the destiny of religion would appear doubtful.

Translated by Jonathan Nield

*Science and Religion in Contemporary Philosophy*

Conclusion (pp. 399–400)

Duckworth &amp; Company. London, England. 1912

**Buck, Pearl S.** 1892–1973

American author

Science and religion, religion and science, put it as I may they are two sides of the same glass, through which we see darkly until these two, focusing together, reveal the truth.

*A Bridge for Passing*

Chapter III (p. 255)

John Day Company. New York, New York, USA. 1962

**Bultmann, R.**

No biographical data available

...the New Testament provides a world picture which belongs entirely to Jewish or Gnostic mythology and is incredible or even meaningless in a scientific age.

In H.J. Paton

*The Modern Predicament: A Study in the Philosophy of Religion*

Chapter XV, Section 3 (p. 228)

Collier Books. New York, New York, USA. 1962

**Burroughs, John** 1837–1921

American naturalist and writer

The mysteries of religion are of a different order from those of science; they are parts of an arbitrary system of man's own creation; they contradict our reason and our experience, while the mysteries of science are revealed by our reason, and transcend our experience.

Scientific Faith

*The Atlantic Monthly*, July 1915 (p. 33)

The miracles of religion are to be discredited, not because we cannot conceive of them, but because they run counter to all the rest of our knowledge; while the mysteries of science, such as chemical affinity, the conservation of energy, the indivisibility of the atom, the change of the non-living into the living...extend the boundaries of our knowledge, though the modus operandi of the changes remains hidden.

Scientific Faith

*The Atlantic Monthly*, July 1915 (p. 33)**Bush, Vannevar** 1890–1974

American electrical engineer and physicist

To pursue science is not to disparage the things of the spirit. In fact, to pursue science rightly is to furnish a framework on which the spirit may rise.

Speech, MIT, October 5, 1953

**Bushnell, Horace** 1802–76

American Congregational minister

As the science of nature goes toward completion, religion, having all the while been watching for it in close company, will have gotten immense breadth and solidity, from the ideas and facts unfolded in its discoveries, and will be as much enlarged in its confidence and the sentiment of worship, as beholding God's deep system in the world signifies more than looking on its surfaces.

Science and Religion

*Putnam's Magazine*, Volume 1, 1868 (p. 267)**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Science and religion are reconciled in amiable and sensible people but nowhere else.

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 118)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Chadwick, Owen** 1916–

English historian and Christian scholar

Science versus Religion — the antithesis conjures two hypostatized entities of the later nineteenth century: Huxley St. George slaying Samuel smoothest of dragons; a mysterious undefined ghost called Science against a mysterious indefinable ghost called Religion; until by 1900 schoolboys decided not to have faith because Science, whatever that was, disproved Religion, whatever that was.

*The Secularisation of the European Mind in the Nineteenth Century*

Part II, Chapter 7 (p. 161)

Cambridge University Press. Cambridge, England. 1990

**Clark, W. C.**

No biographical data available

**Majone, G.**

No biographical data available

The social uses of science have always had something in common with the social uses of religion. And in the two decades following the Second World War, modern science took on a most religious-looking numinous legitimacy as an unquestioned source of authority on all manner of policy problems.

*Report of the International Institute of Applied Systems Analysis*

The Critical Appraisal of Scientific Inquiries with Policy Implications, Laxenburg, Austria, 1984 (p. 35)

**Compton, Karl Taylor** 1887–1954

American educator and physicist

Science has contributed to the making of religion into a developing dynamic spiritual force.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 19)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Conklin, Edwin Grant** 1863–1952

American zoologist

Science cannot solve the great mysteries of our existence, — why we are, whither we are bound, and what it all means. Faith alone assures us that there is definite purpose in all experience. This knowledge makes life worth living and service a privilege.

In Edward H. Cotton

*Has Science Discovered God?*

A Biologist's Religion (p. 89)

Thomas Y. Crowell Company. New York, New York, USA. 1931

**Coulson, Charles Alfred** 1910–74

English theoretical chemist

...science is one aspect of God's presence, and scientists therefore part of the company of His heralds.

*Science and Christian Belief*

Scientific Method (p. 30)

The University of North Carolina Press. Chapel Hill, North Carolina, USA. 1955

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

If the Church is largely ignored today it is not because science has finally won its age-old battle with religion, but because it has so radically reoriented our society that the biblical perspective of the world now seems largely irrelevant. As one television cynic recently remarked, few of our neighbors possess an ass for us to covet.

*God and the New Physics*

Chapter 1 (p. 2)

Simon & Schuster. New York, New York, USA. 1983

Those who invoke God as an explanation of cosmic organization usually have in mind a supernatural agency, acting on the world in defiance of natural laws. But it is perfectly possible for much, if not all of what we encounter in the universe to be the product of intelligent manipulation of a purely natural kind: within the laws of physics. For example, our galaxy could have been made by a powerful mind who rearranged the primeval gases using carefully placed gravitating bodies, controlled explosions and all the other paraphernalia of a space age astro-engineer.

*God and the New Physics*

Chapter 15 (p. 208)

Simon & Schuster. New York, New York, USA. 1983

In spite of the fact that religion looks backward to revealed truth while science looks forward to new vistas and discoveries, both activities produce a sense of awe and a curious mixture of humility and arrogance in their

practitioners. All great scientists are inspired by the subtlety and beauty of the natural world that they are seeking to understand. Each new subatomic particle, every unexpected object, produces delight and wonderment. In constructing their theories, physicists are frequently guided by arcane concepts of elegance in the belief that the universe is intrinsically beautiful.

*God and the New Physics*

Chapter 17 (p. 220)

Simon & Schuster. New York, New York, USA. 1983

**Dembski, William A.** 1960–

Mathematician and philosopher

Any view of the sciences that leaves Christ out of the picture must be seen as fundamentally deficient.

*Intelligent Design: The Bridge Between Science and Theology*

Part 3, Chapter 7, Section 7.6 (p. 206)

InterVarsity Press. Downers Grove, Illinois, USA. 1999

**Dobzhansky, Theodosius** 1900–75

Russian-American scientist

There are still many people who are happy and comfortable adhering to fundamentalist creeds. This should cause no surprise, since a large majority of these believers are as unfamiliar with scientific findings as were people who lived centuries ago.

*The Biology of Ultimate Concern*

Chapter 5 (p. 95)

The New American Library, Inc. New York, New York, USA. 1967

Science and religion deal with different aspects of existence...[T]hese are the aspect of facts and the aspect of meaning. But there is one stupendous fact...the meaning of which they have ceaselessly tried to discover. This fact is Man.

*The Biology of Ultimate Concern*

Chapter 5 (p. 96)

The New American Library, Inc. New York, New York, USA. 1967

...nothing gives more pleasure to a rather common type of religious person than to point out that science cannot explain this or cannot account for that!

*The Biology of Ultimate Concern*

Chapter 5 (p. 97)

The New American Library, Inc. New York, New York, USA. 1967

**Draper, John William** 1811–82

American scientist, philosopher, and historian

As to Science, she has never sought to ally herself to civil power. She has never attempted to throw odium or inflict social ruin on any human being. She has never subjected any one to mental torment, physical torture, least of all to death, for the purpose of upholding or promoting her ideas. She presents herself unstained by cruelties and crimes. But in the Vatican — we have only to recall the Inquisition — the hands that are now raised in appeals to the Most Merciful are crimsoned.

*History of the Conflict between Religion and Science*

Preface (p. xi)

D. Appleton and Company. New York, New York, USA. 1898

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

Any man who believes in God must realize that no scientific fact, as long as it is true, can contradict God. Otherwise, it would not be true. Therefore, any man who is afraid of science does not possess a strong faith.

*Human Destiny*

Chapter 16 (p. 243)

Longmans, Green & Company. London, England. 1947

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Religion and science...constitute deep-rooted and ancient efforts to find richer experience and deeper meaning than are found in the ordinary biological and social satisfactions. As pointed out by Whitehead, religion and science have similar origins and are evolving toward similar goals.

*A God Within*

Chapter 12. On Being Human (p. 255)

Charles Scribner's Sons. New York, New York, USA. 1972

Both [religion and science] started from crude observations and fanciful concepts, meaningful only within a narrow range of conditions for the people who formulated them of their limited tribal experience. But progressively, continuously, and almost simultaneously, religious and scientific concepts are ridding themselves of their coarse and local components, reaching higher and higher levels of abstraction and purity.

*A God Within*

Chapter 12. On Being Human (p. 255)

Charles Scribner's Sons. New York, New York, USA. 1972

Both the myths of religion and the laws of science, it is now becoming apparent, are not so much descriptions of facts as symbolic expressions of cosmic truths.

*A God Within*

Chapter 12. On Being Human (p. 255)

Charles Scribner's Sons. New York, New York, USA. 1972

**Durant, William James** 1885–1981

American historian and essayist

Those of you who specialize in science will find it hard to understand religion, unless you feel, as Voltaire did, that the harmony of the spheres reveals a cosmic mind, and unless you realize, as Rousseau did, that man does not live by intellect alone.

Commencement Address

Webb School of Claremont, California, June 7, 1958

We are such microscopic particles in so immense a universe that none of us is in a position to understand the world, much less to dogmatize about it. Pascal trembled at the thought of man's bewildered minuteness between

the immensity of the whole and the complexity of each part; "these infinite spaces," he said, "frighten me!" Let us be careful how we pit our pitiful generalizations against the infinite variety, scope, and subtlety of the world.

Commencement Address

Webb School of Claremont, California, June 7, 1958

**Dyson, Freeman J.** 1923–

American physicist and educator

Professional scientists today live under a taboo against mixing science and religion.

*Disturbing the Universe*

Chapter 23 (p. 245)

Basic Books, Inc. New York, New York, USA. 1979

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The starting-point of belief in mystical religion is a conviction of significance or, as I have called it earlier, the sanction of a striving in the consciousness. This must be emphasized because appeal to intuitive conviction of this kind has been the foundation of religion through all ages, and I do not wish to give the impression that we have now found something new and more scientific to substitute. I repudiate the idea of proving the distinctive beliefs of religion either from the data of physical science or by the methods of physical science.

*The Nature of the Physical World*

Chapter XV (p. 333)

The Macmillan Company. New York, New York, USA. 1930

It is curious that the doctrine of the running down of the physical universe is so often looked upon as pessimistic and contrary to the aspirations of religion. Since when has the teaching that "heaven and earth shall pass away" become ecclesiastically unorthodox?

*New Pathways in Science*

Chapter III, Section III (p. 59)

The Macmillan Company. New York, New York, USA. 1935

It is probably true that the recent changes of scientific thought remove some of the obstacles to a reconciliation of religion with science; but this must be carefully distinguished from any proposal to base religion on scientific discovery. For my own part I am wholly opposed to any such attempt.

*Science and the Unseen World*

Chapter VII (pp. 72–73)

The Macmillan Company. New York, New York, USA. 1929

**Einstein, Albert** 1879–1955

German-born physicist

All religions, arts and sciences are branches of the same tree.

*Out of My Later Years* (p. 7)

Thames & Hudson. London, England. 1950

Everyone who is seriously involved in the pursuit of science becomes convinced that a spirit is manifest in the laws of the Universe — a spirit vastly superior to that of man, and one in the face of which we with our modest powers must feel humble. In this way the pursuit of science leads to a religious feeling of a special sort, which is indeed quite different of the religiosity of someone more naive.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side — New Glimpses from His Archives*

Letter dated 20 December, 1935 (p. 33)

Princeton University Press. Princeton, New Jersey, USA. 1979

Scientific research is based on the idea that everything that takes place is determined by laws of nature, and therefore this holds for the actions of people. For this reason, a research scientist will hardly be inclined to believe that events could be influenced by a prayer, i.e., by a wish addressed to a supernatural Being. However, it must be admitted that our actual knowledge of these laws is only imperfect and fragmentary, so that, actually, the belief in the existence of basic all-embracing laws in Nature also rests on a sort of faith. [Belief in basic laws of Nature] has been largely justified so far by the success of scientific research.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 24 January 1936 (pp. 32–34)

Princeton University Press. Princeton, New Jersey, USA. 1979

The basis of all scientific work is the conviction that the world is an ordered and comprehensive entity, which is a religious sentiment. My religious feeling is a humble amazement at the order revealed in the small patch of reality to which our feeble intelligence is equal.

*Cosmic Religion, With Other Opinions and Aphorisms*

On Science (p. 98)

Covici-Fiede. New York, New York, USA. 1931

[E]very one who is seriously involved in the pursuit of science becomes convinced that a spirit is manifest in the laws of the Universe — a spirit vastly superior to that of man, and one in the face of which we with our modest powers must feel humble. In this way the pursuit of science leads to a religious feeling of a special sort, which is indeed quite different from the religiosity of someone more naive.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter dated 24 January 1936 (pp. 32–34)

Princeton University Press. Princeton, New Jersey, USA. 1979

[T]he cosmic religious experience is the strongest and the noblest driving force behind scientific research. No one who does not appreciate the terrific assertions, and, above all, the devotion without which pioneer creations in scientific thought cannot come into being, can judge the strength of the feeling out of which alone such work, turned away as it is from immediate practical life, can

grow. What a deep faith in the rationality of the structure of the world and what a longing to understand even a small glimpse of the reason revealed in the world there must have been in Kepler and Newton to enable them to unravel the mechanism of the heavens in long years of lonely study.

*The New York Times Magazine*, 9 November 1930

Certain it is that a conviction, akin to religious feeling, of the rationality or intelligibility of the world lies behind all scientific work of a higher order... This firm belief, a belief bound up with deep feeling, in a superior mind that reveals itself in the world of experience, represents my conception of God.

*Ideas and Opinions*

On Scientific Truth (p. 261)

Crown Publishers, Inc. New York, New York, USA. 1954

I have never found a better expression than “religious” for this trust in the rational nature of reality and of its peculiar accessibility to the human mind. Where this trust is lacking science degenerates into an uninspired procedure. Let the devil care if the priests make capital out of this. There is no remedy for that.

*Lettres a Maurice Solovine* (pp. 102–103)

Gauthier-Villars. Paris, France. 1956

I am of the opinion that all the finer speculations in the realm of science spring from a deep religious feeling, and that without such feeling they would not be fruitful.

Science and God: A Dialog

*Forum*, Volume 83, June 1930 (p. 373)

Science without religion is lame, religion without science is blind.

*Out of My Later Years*

Science and Religion, II (p. 26)

Thames & Hudson. London, England. 1950

...science not only purifies the religious impulse of the dross of its anthropomorphism but also contributes to a religious spiritualization of our understanding of life.

*Out of My Later Years*

Science and Religion, II (p. 29)

Thames & Hudson. London, England. 1950

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

Century after century, humanity studies itself in the mirror of fashion, and ever the mirror gives back distortions, which for the moment impose themselves upon man’s real image. In one period we believe ourselves governed by immutable laws; in the next, by chance. In one period angels hover over our birth; in the following time we are planetary waifs, the product of a meaningless and ever altering chemistry. We exchange halos in one era for fangs in another. Our religious and philosophical conceptions change so rapidly that the theological and moral exhortations of one decade become the



wastepaper of the next epoch. The ideas for which millions yielded up their lives produce only bored yawns in a later generation.

*The Unexpected Universe*

Chapter Eight, Section 2 (p. 179)

Harcourt, Brace & World, Inc. New York, New York, USA. 1969

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The Religion that is afraid of science dishonors God and commits suicide.

*The Journals and Miscellaneous Notebooks of Ralph Waldo Emerson*  
(Volume 2)

1826–1832, 4 March 1831 (p. 239)

Harvard University Press. Cambridge, Massachusetts, USA. 1970

**Flaubert, Gustave** 1821–90

French novelist

A little science takes your religion from you; a great deal brings you back to it.

*Dictionary of Accepted Ideas*

M. Reinhardt. London, England. 1954

**Fosdick, Harry Emerson** 1878–1969

American clergyman and educator

What modern science is doing for multitudes of people, as anybody who watches American life can see, is not to disprove God's theoretical existence, but to make him "progressively less essential."

*Adventurous Religion*

Will Science Displace God? (p. 136)

Harper & Brothers. New York, New York, USA. 1926

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

The scientific spirit brings about a particular attitude towards worldly matters; before religious matters it pauses for a little, hesitates, and finally there too crosses the threshold. In this process there is no stopping; the greater the number of men to whom the treasures of knowledge become accessible, the more widespread is the falling-away from religious belief...

*The Future of an Illusion*

Chapter VII (p. 38)

W.W. Norton & Company, Inc. New York, New York, USA. 1961

**Froude, James Anthony** 1818–94

English historian and biographer

The superstitions of science scoff at the superstitions of faith.

*The Lives of the Saints*

*Eclectic Review*, February 1852

**Garman, Charles E.** 1862–1932

No biographical data available

Science is thinking God's thoughts after Him just as truly as when we read the scriptures.

*Letters, Lectures, Addresses of Charles Edward Garman; A Memorial Volume, Prepared with the Cooperation of the Class of 1884, Amherst Science and Theism* (p. 231)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1909

**Gilkey, Langdon** 1919–2004

Protestant theologian

It is because science is limited to a certain level of explanation that scientific and religious theories can exist side by side without excluding one another, that one person can hold both to the scientific accounts of origins and to a religious account, to the creation of all things by God...

*Creationism on Trial: Evolution and God at Little Rock*

Chapter 5 (p. 117)

Winston Press. Minneapolis, Minnesota, USA. 1985

**Gillispie, Charles Coulston** 1918–

French writer and editor of philosophy and history of science

If one be clear about the nature of science as a description of the world, declarative but never normative, may not the choice between science and religion be refused? Is it not simply a false problem, arising from a confusion — an ancient confusion going back to the beginning of science — between objects and persona? Science is about nature, after all, not about duties. It is about objects. Christianity is about persons, the relation of the persons of men to the person of God.

*The Edge of Objectivity: An Essay in the History of Scientific Ideas*

Chapter VIII (pp. 350–351)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Goodspeed, Edgar J.** 1871–1962

American scholar

Science needs religion, to prevent it from becoming a curse to mankind instead of a blessing.

*The Four Pillars of Democracy*

Chapter VI (p. 134)

Harper & Brothers. New York, New York, US. 1940

Science sees meaning in every part; religion sees meaning in the whole.

*Four Pillars of Democracy*

Chapter V (p. 106)

Harper & Brothers. New York, New York, USA. 1940

...religion needs science, to protect it from religion's greatest danger, superstition.

*Four Pillars of Democracy*

Chapter V (p. 115)

Harper & Brothers. New York, New York, USA. 1940

**Grinnel, Frederick**

...modern science constitutes a method for understanding and modifying the world but has no inherent direction, whereas modern religion describes a messianic world view but lacks a useful method to bring about this state of affairs.

Complementarity: An Approach to Understanding the Relationship Between Science and Religion  
*Perspectives in Biology and Medicine*, Volume 29, Number 2, Winter 1986 (p. 293)

**Gull, Sir William Withey** 1816–90  
 English physician

Realize, if you can, what a paralyzing influence on all scientific inquiry the ancient belief must have had which attributed the operations of nature to the caprice not of one divinity only, but of many. There still remains vestiges of this in most of our minds, and the more distinct in proportion to our weakness and ignorance.

*British Medical Journal*, Volume 2, 1874 (p. 425)

**Haldane, John Burdon Sanderson** 1892–1964  
 English biologist

The wise man regulates his conduct by the theories both of religion and science. But he regards these theories not as statements of ultimate fact but as art-forms.

*Possible Worlds and Other Papers*  
 Chapter XXXI (p. 252)

Harper & Brothers. New York, New York, USA. 1928

**Hardin, Garrett** 1915–2003  
 American ecologist and microbiologist

We are terribly clever people, we moderns: we bend Nature to our will in countless ways. We move mountains, we make caves, fly at speeds no other organism can achieve and tap the power of the atom. We are terribly clever. The essentially religious feeling of subserviency to a power greater than ourselves comes hard to us clever people. But by our intelligence we are now beginning to make out the limits of our cleverness, the impotence principles that say what can and cannot be. In an operational sense, we are experiencing a return to a religious orientation toward the world.

*Nature and Man's Fate*

The Search for Truth

The New American Library. New York, New York, USA. 1961

**Heisenberg, Werner Karl** 1901–76  
 German physicist and philosopher

In the history of science, ever since the famous trial of Galileo, it has repeatedly been claimed that scientific truth cannot be reconciled with the religious interpretation of the world. Although I am now convinced that scientific truth is unassailable in its own field, I have never found it possible to dismiss the content of religious thinking as simply part of an outmoded phase in the consciousness of mankind, a part we shall have to give up from now on. Thus in the course of my life I have repeatedly been compelled to ponder on the relationship of these two regions of thought, for I have never been able to doubt the reality of that to which they point.

*Across the Frontiers*  
 Chapter XVI (p. 213)  
 Harper & Row, Publishers. New York, New York, USA. 1974

If we are honest — and scientists have to be — we must admit that religion is a jumble of false assertions, with no basis in reality. The very idea of God is a product of human imagination.

*Physics and Beyond: Encounters and Conversations*

Chapter 7 (p. 85)

Harper & Row, Publishers. New York, New York, USA. 1972

**Hertz, Rabbi Richard**

No biographical data available

I find no conflict between science and religion. Science teaches what is. Religion teaches what ought to be. Science describes. Religion prescribes. Science analyzes what we can see. Religion deals with what is unseen. Each can help the other.

*The American Jew in Search of Himself*

Chapter 4 (p. 42)

Bloch Publishing Company. New York, New York, USA. 1962

**Hillis, W. Daniel** 1956–

American engineer, inventor, and author

...I remain convinced that neither religion nor science has everything figured out.

*The Pattern on the Stone: The Simple Ideas that Make Computers Work*  
 (p. 152)

Basic Books, Inc. New York, New York, USA. 1998

**Hooykaas, Reijer**

Dutch historian of science

Metaphorically speaking, whereas the bodily ingredients of science may have been Greek, its vitamins and hormones were biblical.

*Religion and the Rise of Modern Science*

Epilogue (p. 162)

William B. Eerdmans Publishing Company. Grand Rapids, Michigan, USA. 1972

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

...it is no longer possible to maintain that science and religion must operate in thought-tight compartments or concern separate sectors of life; they are both relevant to the whole of human existence.

In Teilhard de Chardin

*The Phenomenon of Man*

Introduction (p. 26)

Harper & Row, Publishers. New York, New York, USA. 1959

Like the meridians as they approach the poles, science, philosophy and religion are bound to converge as they draw nearer to the whole. I say “converge” advisedly, but without merging, and without ceasing, to the very end, to assail the real from different angles and on different planes.

In Teilhard de Chardin  
*The Phenomenon of Man*  
 Introduction (p. 30)  
 Harper & Row, Publishers. New York, New York, USA. 1959

**Huxley, Thomas Henry** 1825–95  
 English biologist

True science and true religion...are twin-sisters, and the separation of either from the other is sure to prove the death of both. Science prospers exactly in proportion as it is religious; and religion flourishes in exact proportion to the scientific depth and firmness of its basis. The great deeds of philosophers have been less the fruit of their intellect than of the direction of that intellect by an imminently religious tone of mind. Truth has yielded herself rather to their patience, their love, their single-heartedness, and their self-denial, than to their logical acumen.

In Herbert Spencer  
*Education: Intellectual, Moral, and Physical*  
 Chapter I (p. 81)  
 A.L. Fowle. New York, New York, USA. 1860

...the materialistic position that there is nothing in the world but matter, force, and necessity, is as utterly devoid of justification as the most baseless of theological dogmas.

*Collected Essays* (Volume 1)  
 On the Physical Basis of Life (p. 162)  
 Macmillan & Company Ltd. London, England. 1904

Elijah's great question, "Will you serve God or Baal? Choose ye," is uttered audibly enough in the ears of every one of us as we come to manhood. Let every man who tries to answer it seriously ask himself whether he can be satisfied with the Baal of authority, and with all the good things his worshippers are promised in this world and the next. If he can, let him, if he be so inclined, amuse himself with such scientific implements as authority tells him are safe and will not cut his fingers; but let him not imagine he is, or can be, both a true son of the Church and a loyal soldier of science.

*Collected Essays* (Volume 2)  
*Darwiniana*  
 Mr. Darwin's Critics (p. 149)  
 Macmillan & Company Ltd. London, England. 1904

**Inge, William Ralph** 1860–1954  
 English religious leader and author

No scientific discovery is without its religious and moral implications.

*Outspoken Essays* (Second Series)  
 Confessio Fidei (p. 56)  
 Longmans, Green & Company. London, England. 1922

**Jastrow, Robert** 1925–  
 American space scientist

For the scientist who has lived by his faith in the power of reason, the story ends like a bad dream. He has scaled

the mountains of ignorance; he is about to conquer the highest peak; as he pulls himself over the final rock, he is greeted by a band of theologians who have been sitting there for centuries.

*God and the Astronomers*  
 Chapter 6 (p. 116)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1978

### Joint Statement of Religious Leaders

The purpose of science is to develop, without prejudice or preconception of any kind, a knowledge of the facts, the laws, and the processes of nature. The even more important task of religion, on the other hand, is to develop the consciences, the ideals, and the aspirations of mankind.

In Robert Andrews Millikan  
*Science and Life*  
 A Joint Statement upon the Relations of Science and Religion (p. 86)  
 The Pilgrim Press. Boston, Massachusetts, USA. 1924

**Kaempffert, Waldemar** 1877–1956  
 American science editor and museum director

Religion may preach the brotherhood of man; science practices it.

In Edward R. Murrow  
*This I Believe*  
 2, Michael Faraday (p. 196)  
 Simon & Schuster. New York, New York, USA. 1952

**King, Jr., Martin Luther** 1929–68  
 American civil rights leader and clergyman

Science investigates; religion interprets. Science gives man knowledge which is power; religion gives man wisdom which is control.

*Strength to Love*  
 Chapter I (p. 3)  
 Harper & Row, Publishers. New York, New York, USA. 1963

**Lewis, C. S. (Clive Staples)** 1898–1963  
 British author, scholar, and popular theologian

Keep pressing home on him the ordinariness of things. Above all, do not attempt to use science (I mean, the real sciences) as a defense against Christianity. They will positively encourage him to think about realities he can't touch and see. There have been sad cases among the modern physicists.

*The Screwtape Letters: Letters from from a Senior to a Junior Devil* (p. 4)  
 Harper & Row, Publishers. New York, New York, USA. 2001

**Lewis, Gilbert Newton** 1875–1946  
 American chemist

...in the struggle of life with the facts of existence, Science is a bringer of aid; in the struggle of the soul with the mystery of existence, Science is the bringer of light.

On the Dread and Dislike of Science  
*Fortnightly Review*, Volume 29, 1878

**Lynch, Gary**

No biographical data available

What you're really seeking are constraints.... You're seeking things that box you in. That's what separates science from most other human endeavors. Religion is not something where people sit down and say, "Well, if there were a god then".... But science is a constant search for that, for those things that hem you in.

In George Johnson

*In the Palaces of Memory: How We Build the Worlds Inside Our Heads Mucking Around in the Wetware* (p. 91)  
Alfred A. Knopf. New York, New York, USA. 1991

**Marguerite of Valois** 1553–1615

Queen of France and Navarre

Science conducts us, step by step, through the whole range of creation, until we arrive, at length, at God.

*Memoirs of Marguerite de Valois*

Letter XII, 1628 (p. 80)

P.F. Collier & Son, Company. New York, New York, USA. 1910

**Mather, Kirtley F.** 1888–1978

American geologist

The faith by which a man lives must be in accord with the facts which men know. Only that religion, which is in harmony with the current scientific description of man and the universe, can maintain itself effectively in any age.

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (p. 6)

Thomas Y. Crowell Company, Publishers. New York, New York, USA. 1931

**McCabe, Joseph** 1867–1955

English rationalist writer and ex-Franciscan priest

The theist and the scientist are rival interpreters of nature, The one retreats as the other advances.

*The Existence of God*

Chapter V (p. 80)

Watts & Company. London, England. 1933

**McKenzie, John L.** d. 1991

American Jesuit theologian and Catholic cardinal

Happily, we have survived into a day when science and theology no longer speak to each other in the language of fishmongers.

*The Two-Edged Sword: An Interpretation of the Old Testament*

Chapter V. Cosmic Origins (p. 74)

The Bruce Publishing Company. Milwaukee, Minnesota, USA. 1968

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

To me the scientific point of view is completely satisfying, and it has been so as long as I can remember. Not once in this life have I ever been inclined to seek a rock

and a refuge elsewhere. It leaves a good many dark spots in the universe, to be sure, but not a hundredth time as many as theology. We may trust it, soon or late, to throw light upon many of them, and those that remain dark will be beyond illumination by any other agency. It also fails on occasion to console, but so does theology...

In Charles A. Fecher

*Mencken: A Study of His Thought* (p. 84)

Alfred A. Knopf. New York, New York, USA. 1978

The notion that science does not concern itself with first causes — that it leaves the field to theology or metaphysics, and confines itself to mere effects — this notion has no support in the plain facts. If it could, science would explain the origin of life on earth at once — and there is every reason to believe that it will do so on some not too remote tomorrow. To argue that gaps in knowledge which will confront the seeker must be filled, not by patient inquiry, but by intuition or revelation, is simply to give ignorance a gratuitous and preposterous dignity.

*Treatise on the Gods*

Chapter 5 (p. 239)

Vintage Books. New York, New York, USA. 1963

The essence of science is that it is always willing to abandon a given idea, however fundamental it may seem to be, for a better one; the essence of theology is that it holds its truths to be eternal and immutable. To be sure, theology is always yielding a little to the progress of knowledge, and only a Holy Roller in the mountains of Tennessee would dare to preach today what the popes preached in the Thirteenth Century, but this yielding is always done grudgingly, and thus lingers a good while behind the event.

*Minority Report: H.L. Mencken's Notebooks*

No. 232 (p. 166)

Alfred A. Knopf. New York, New York, USA. 1956

The effort to reconcile science and religion is almost always made, not by theologians, but by scientists unable to shake off altogether the piety absorbed with their mother's milk.

*Minority Report: H.L. Mencken's Notebooks*

No. 232 (p. 166)

Alfred A. Knopf. New York, New York, USA. 1956

**Mernissi, Fatima** 1940–

Moroccan writer, feminist, and sociologist

Awareness of the stars and their light pervades the Koran, which reflects the brightness of the heavenly bodies in many verses. The blossoming of mathematics and astronomy was a natural consequence of this awareness. Understanding the cosmos and the movements of the stars means understanding the marvels created by Allah. There would be no persecuted Galileo in Islam, because Islam, unlike Christianity, did not force people to believe in a "fixed" heaven.

Translated by Mary Jo Lakeland

*Islam and Democracy: Fear of the Modern World*  
Chapter 9 (p. 133)  
Perseus Publishing, New York, New York, USA. 1992

**Miller, Kenneth R.** 1948–  
American biology professor and author

To a believer, God's great gift was to provide us with a means to understand, to master, and to do good using both the strengths and weaknesses of human nature.

Where does science sit with all of this? I would argue that any scientist who believes in God possesses the faith that we are given our unique imaginative powers not only to find God, but also to discover as much of His universe as we could. In other words, to a religious person, science can be a pathway towards God, not away from Him, an additional and sometimes even an amazing grace!

*Finding Darwin's God*  
Chapter 9 (pp. 280–281)  
HarperCollins Publishers, Inc. New York, New York, USA. 1999

**Millikan, Robert Andrews** 1868–1953  
American physicist

Modern science, of the real sort, is slowly learning to walk humbly with its God, and in learning that lesson it is contributing something to religion.

*Evolution in Science and Religion*  
Chapter III (pp. 94–95)  
Yale University Press. New Haven, Connecticut, USA. 1927

The purpose of science is to develop, without prejudice or preconception of any kind, a knowledge of the facts, the laws and the processes of nature. The even more important task of religion, on the other hand, is to develop the consciences, the ideals and the aspirations of mankind. Each of these two activities represents a deep and vital function of the soul of man, and both are necessary for the life, the progress and the happiness of the human race.

Science Serves God  
*Time*, June 4, 1923

It is a sublime conception of God which is furnished by science, and one wholly consonant with the highest ideals of religion, when it represents Him as revealing Himself through countless ages in the development of the earth as an abode for man and in the age long inbreathing of life into its constituent matter, culminating in man with his spiritual nature and all his Godlike powers.

Science Serves God  
*Time*, June 4, 1923

**Moore, Benjamin** 1748–1816  
Episcopal writer and professor of rhetoric

When new scientific facts are suddenly thrown in amongst old pre-conceived ideas of divinity, there may at first appear discords, and zealous champions of natural sci-

ence and of religious knowledge fly to arms and indulge in acrimonious polemics; but as time advances and things that are crude and adventitious are thrown away one each side, it is discovered that science has added a new beauty to religion, or rather revealed a beauty that was there all the while, but concealed by misconceptions, or by lack of knowledge.

*The Origin and Nature of Life*  
Chapter I (p. 8)  
Henry Holt & Company. New York, New York, USA. No date

**Moore, John A.**  
American writer and professor of genetics and biology

A fundamental difference between religious and scientific thought is that the received beliefs in religion are ultimately based on revelations or pronouncements, usually by some long dead prophet or priest. . . . Dogma is interpreted by a caste of priests and is accepted by the multitude on faith or under duress. In contrast, the statements of science are derived from the data of observations and experiment, and from the manipulation of these data according to logical and often mathematical procedures.

*Science as a Way of Knowing: The Foundations of Modern Biology*  
Chapter 4 (p. 59)  
Harvard University Press. Cambridge, Massachusetts, USA. 1993

**Morrow, Lance** 1942–  
American writer and professor of journalism

Sometime after the Enlightenment, science and religion came to a gentleman's agreement. Science was for the real world: machines, manufactured things, medicines, guns, moon rockets. Religion was for everything else, the immeasurable: morals, sacraments, poetry, insanity, death, and some residual forms of politics and statesmanship. Religion became, in both senses of the word, immaterial.

*Fishing in the Tiber: Essays*  
God and Science (p. 195)  
Henry Holt & Company. New York, New York, USA. 1988

Science and religion were apples and oranges. So the pact said: render unto apples the things that are Caesar's, and unto oranges the things that are God's. Just as the Maya kept two calendars, one profane and one priestly, so Western science and religion fell into two different conceptions of the universe, two different vocabularies.

*Fishing in the Tiber: Essays*  
God and Science (p. 195)  
Henry Holt & Company. New York, New York, USA. 1988

**Nemerov, Howard** 1920–91  
American poet, novelist, and critic

Religion and science both profess peace (and the sincerity of the professors is not being doubted), but each always turns out to have a dominant part in any war that is going or contemplated.

*Figures of Thought: Speculations on the Meaning of Poetry and Other Essays*

On the Resemblances Between Science and Religion  
David R. Godine. Boston Massachusetts, USA. 1979

**Paley, William** 1743–1805  
English theologian

There cannot be design without a designer; contrivance without a contriver; order without choice; arrangement, without any thing capable of arranging; subserviency and relation to a purpose, without that which could intend a purpose; means suitable to an end, without the end ever having been contemplated, or the means accommodated to it. Arrangement, disposition of parts, subserviency of means to an end, relation of instruments to an use, imply the presence of intelligence and mind.

*The Works of William Paley. D.D.*

Natural Theology

Chapter II, Section III (p. 22)

Ward, Lock & Company. London, England. No date

**Planck, Max** 1858–1947  
German physicist

There can never be any real opposition between religion and science; for the one is the compliment of the other.

*Where Is Science Going?*

Chapter V (p. 168)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

Religion belongs to that realm that is inviolable before the law of causation and therefore closed to science.

*Where Is Science Going?*

Chapter V (p. 168)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

Religion and natural science...are in agreement, first of all, on the point that there exists a rational world order independent from man, and secondly, on the view that the character of this world order can never be directly known but can only be indirectly recognized or suspected. Religion employs in this connection its own characteristic symbols, while natural science uses measurements founded on sense experiences.

*Scientific Autobiography and Other Papers*

Religion and Natural Science, Part IV (pp. 182–183)

Philosophical Library. New York, New York, USA. 1949

Religion and natural science are fighting a joint battle in an incessant, never relaxing crusade against skepticism and against dogmatism, against disbelief and against superstition, and the rallying cry in this crusade has always been, and always will be, "On to God."

*Scientific Autobiography and Other Papers*

Religion and Natural Science, Part IV (p. 187)

Philosophical Library. New York, New York, USA. 1949

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

Admittedly, religious conversion commits our whole person and changes our whole being in a way that an expansion of natural knowledge does not do. But once the dynamics of knowing are recognized as the dominant principle of knowledge, the difference appears only as one of degree...it establishe[s] a continuous ascent from our less personal knowing of inanimate matter to our convivial knowing of living beings and beyond this to knowing our responsible fellow men. Such I believe is the true transition from the sciences to the humanities and also from our knowing the laws of nature to our knowing the person of God.

Faith and Reason

*Journal of Religion*, Volume 41, Number 4, October 1961 (p. 244, 245)

**Polkinghorne, John** 1930–

British physicist, Episcopal priest, and writer

Only in the media, and in the popular and polemical scientific writing, does there persist the myth of the light of pure scientific truth confronting the darkness of obscurantist religious error. Indeed, when one reads writers like Richard Dawkins or Daniel Dennett, one sees that nowadays the danger of a facile triumphalism is very much a problem for the secular academy rather than the Christian Church.

*Quarks, Chaos, and Christianity* (p. 5)

Abingdon Press. Nashville, Tennessee, USA. 2005

**Pope John Paul II** 1920–2005

Bishop of Rome

Science can purify religion from error and superstition. Religion can purify science from idolatry and false absolutes.

In James Reston

*Galileo, a Life* (p. 461)

HarperCollins Publishers, Inc. New York, New York, USA. 1994

**Pope Pius XII** 1876–1958

Bishop of Rome

The more true science advances, the more it discovers God, almost, as though he were standing, vigilant behind every door which science opens.

Address, November 22, 1951

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Science is most significant as one of the greatest spiritual adventures that man has yet known.

In John Oulton Wisdom

*Foundations of Inference in Natural Science* (p. v)

Methuen & Company Ltd. London, England. 1952

**Raven, Charles E.** 1885–1964

English writer of theology and science

To mention Science and Religion in the same sentence is...to affirm an antithesis and suggest a conflict.

*Science, Religion and the Future*

Chapter 1 (p. 1)

At The University Press. Cambridge, England. 1943

**Raymo, Chet** 1936–

American physicist and science writer

Everything we have learned in science since the time of Galileo suggests that the nebulas and galaxies are oblivious to our fates. Everything we have learned suggests that our souls and bodies are inseparable. Everything we have learned suggests that the grave is our destiny. Therefore, if the promise of eternal life is to have maximum drawing power, it is essential for Church and guru to undermine the legitimacy of science.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Four (pp. 66–67)

Walker & Company. New York, New York, USA. 1998

**Reichenbach, Hans** 1891–1953

German philosopher of science

The belief in science has replaced in large measure, the belief in God. Even where religion was regarded as compatible with science, it was modified by the mentality of the believer in scientific truth.

*The Rise of Scientific Philosophy*

Chapter 3 (p. 44)

University of California Press. Berkeley, California, USA. 1951

**Rice, Laban Lacy** 1870–1973

American educator

Science does not regard its currently established truths as final: religion everywhere and in all centuries has followed the trend toward crystallization of belief.

*The Universe: Its Origin, Nature and Destiny*

Chapter I (p. 15)

Exposition Press. New York, New York, USA. 1951

**Roelofs, Howard Dykema** 1893–1974

Professor of philosophy

Religion can produce on occasion what science never does, namely, saints. Today we have science and scientists aplenty. We lack saints.

In Herbert J. Muller

*Science and Criticism: The Humanistic Tradition in Contemporary Thought*

Chapter III (p. 59)

G. Braziller. New York, New York, USA. 1943

**Sagan, Carl** 1934–96

American astronomer and author

How is it that hardly any major religion has looked at science and concluded, “This is better than we thought! The

Universe is much bigger than our prophets said, grander, more subtle, more elegant?”

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 4 (p. 52)

Random House, Inc. New York, New York, USA. 1994

If you lived two or three millennia ago, there was no shame in holding that the Universe was made for us. It was an appealing thesis consistent with everything we knew; it was what the most learned among us taught without qualification. But we have found out much since then. Defending such a position today amounts to willful disregard of the evidence, and a flight from self-knowledge.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 4 (p. 52)

Random House, Inc. New York, New York, USA. 1994

Heroes who try to explain the world in terms of matter and energy may have arisen many times in many cultures, only to be obliterated by the priests and philosophers in charge of the conventional wisdom....

*The Demon-Haunted World: Science as a Candle in the Dark* (p. 310)

Random House, Inc. New York, New York, USA. 1995

If you want to know when the next eclipse of the Sun will be, you might try magicians or mystics, but you’ll do much better with scientists.

*The Demon-Haunted World: Science as a Candle in the Dark* (p. 30)

Random House, Inc. New York, New York, USA. 1995

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

Let the Churches ask themselves why there is no revolt against the dogmas of mathematics though there is one against the dogmas of religions. It is not that the mathematical dogmas are more comprehensible.... It is not that science is free from legends, witchcraft, miracles, biographic boostings of quacks as heroes and saints, and of barren scoundrels as explorers and discoverers.... But no student of science has yet been taught that specific gravity consists in the belief that Archimedes jumped out of the bath and ran naked through the streets of Syracuse shouting Eureka, Eureka, or that the law of inverse squares must be discarded if anyone can prove that Newton was never in an orchard in his life.

*Back to Methuselah*

Preface (pp. lxxvii–lxxviii)

Constable & Company Ltd. London, England. 1921

**Sperry, Roger Wolcott** 1913–94

Neuropsychologist

Probably the widest, deepest rift in contemporary culture and the source of its most profound conflict is that separating the two major opposing views of existence upheld by science and by orthodox religions, respectively. Together they represent two totally different kinds of “truth”, the former asking us to accept impersonal

mass-energy accounts of the cosmos, the latter requiring faith in varied spiritual explanations.

The New Mentalist Paradigm and Ultimate Concern  
*Perspectives in Biology and Medicine*, Volume 29, Number 3, Part I,  
Spring 1986 (p. 415)

**Stace, Walter Terence** 1886–1967  
English philosopher and educator

...no scientific argument — by which I mean an argument drawn from the phenomena of nature — can ever have the slightest tendency either to prove or disprove the existence of God...science is irrelevant to religion.

*Religion and the Modern Mind*

Chapter 5 (p. 76)

J.B. Lippincott Company, Philadelphia, Pennsylvania, USA. 1952

**Stapledon, Olaf** 1886–1950  
English author

Within the chapel, the great Bible was decorously removed and the windows thrown open, to dispel somewhat the odour of sanctity. For though the early and spiritistic interpretations of relativity and quantum theory had by now accustomed men of science to pay their respects to the religions, many of them were still liable to a certain asphyxia when they were actually within the precincts of sanctity. *Last and First Men*

Chapter II (p. 29)

Jeremy P. Tarcher, Inc. Los Angeles, California, USA. 1988

When the scientists had settled themselves upon the archaic and unyielding benches, the President explained that the chapel authorities had kindly permitted this meeting because they realized that, since men of science had gradually discovered the spiritual foundation of physics, science and religion must henceforth be close allies. Moreover the purpose of this meeting was to discuss one of those supreme mysteries which it was the glory of science to discover and religion to transfigure.

*Last and First Men*

Chapter II (p. 29)

Jeremy P. Tarcher, Inc. Los Angeles, California, USA. 1988

**Streeter, B. H. (Burnett Hillman)** 1874–1937  
English theologian and New Testament scholar

Science is the great cleanser of the human thinking; it makes impossible any religion but the highest.

*Reality*

Chapter IX (p. 272)

Publisher undetermined

**Teilhard de Chardin, Pierre** 1881–1955  
French Jesuit, paleontologist, and biologist

Religion and science are the two conjugated faces of phases of one and the same act of complete knowledge — the only one which can embrace the past and future of evolution so as to contemplate, measure and fulfill them.

*The Phenomenon of Man*

Chapter Three, Chapter III, Section 2 (pp. 284–285)

Harper & Brothers, New York, New York, USA. 1959

**Temple, Frederick** 1821–1902  
Anglican prelate and archbishop of Canterbury

Science and Religion seem very often to be the most determined foes to each other that can be found. The scientific man often asserts that he cannot find God in Science; and the religious man often asserts that he cannot find Science in God.

*The Relations Between Religion and Science* (p. 4)

Macmillan & Company, New York, New York, USA. 1884

Science postulates uniformity; Religion postulates liberty.

*The Relations Between Religion and Science* (p. 70)

Macmillan & Company, New York, New York, USA. 1884

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

When we are thrilled with the wonder of the world, the heights and depths of things, the beauty of it all, we approach the door of natural religion. And when the Nature-feeling is not superficial but informed with knowledge, with no gain of the hard-won analysis unused, we may reach the threshold. And when we feel that our scientific cosmology leaves Isis still veiled, and when our attempts at philosophical interpretation give us a reasoned conviction of a meaning behind the process, we may perhaps enter in.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 42)

William & Norgate, London, England. 1920

Religious interpretation and scientific description must not be inconsistent, but they are incommensurable.

*The Outline of Science* (Volume 4)

Chapter XXXVIII (p. 1177)

G.P. Putnam's Sons, New York, New York, USA. 1937

**Tillich, Paul** 1886–1965  
German-born American theologian

The distinction between the truth of faith and the truth of science leads to a warning, directed to theologians, not to use recent scientific discoveries to confirm the truth of faith. Microphysics have undercut some scientific hypotheses concerning the calculability of the universe. The theory of quantum and the principle of indeterminacy have had this effect. Immediately religious writers use these insights for the confirmation of their own ideas of human freedom, divine creativity, and miracles. But there is no justification for such a procedure at all, neither from the point of view of physics nor from the point of view of religion. The physical theories referred to have no direct relation to the infinitely complex phenomenon of human freedom, and the emission of power in quantum has no direct relation to the meaning of miracles...



The truth of faith cannot be confirmed by latest physical or biological or psychological discoveries — as it cannot be denied by them.

*Dynamics of Faith*

Chapter V, Section 2 (p. 85)

Harper & Brothers. New York, New York, USA. 1957

...theology cannot rest on scientific theory. But it must relate its understanding of man to an understanding of universal nature, for man is a part of nature and statements about nature underlie every statement about him.

In Theodosius Dobzhansky

*The Biology of Ultimate Concern*

Chapter 6 (pp. 109–110)

The New American Library, Inc. New York, New York, USA. 1967

**Toynbee, Arnold J.** 1852–83

English historian

Theology, not religion, is the antithesis to science.

*Toynbee's Industrial Revolution*

Notes and Jottings (p. 243)

A.M. Kelley. New York, New York, USA. 1969

Before the close of the seventeenth century our forefathers consciously took their treasure out of religion and reinvested it in natural science...

A Turning Point in Man's Destiny

*The New York Times Magazine*, December 26, 1954 (p. 5)

**Tyndall, John** 1820–93

Irish-born English physicist

We claim, and we shall wrest from theology, the entire domain of cosmological theory.

The Belfast Address

The Position of Science

**Valéry, Paul** 1871–1945

French poet and critic

Without religions the sciences would never have existed. For the human brain would not have trained itself to range beyond the immediate, ever — present “facts” of appearance which, for it, constitute reality.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

Analects, XLVIII (p. 285)

Princeton University Press. Princeton, New Jersey, USA. 1971

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

There can be no scientific dispute with respect to faith, for science and faith exclude one another.

Translated by Lelland J. Rather

*Disease, Life, and Man, Selected Essays*

On Man (p. 68)

Stanford University Press. Stanford, California, USA. 1958

The task of science... is not to attack the objects of faith, but to establish the limits beyond which knowledge

cannot go and to found a unified self-consciousness within these limits.

Translated by Lelland J. Rather

*Disease, Life, and Man, Selected Essays*

On Man (p. 69)

Stanford University Press. Stanford, California, USA. 1958

...belief has no place as far as science reaches, and may be first permitted to take root where science stops.

Translated by Lelland J. Rather

*Disease, Life, and Man, Selected Essays*

On Man (p. 69)

Stanford University Press. Stanford, California, USA. 1958

**Whaling, Thornton** 1858–1938

American Presbyterian writer

There can be no real conflict between natural science and true religion because their spheres are entirely distinct and separate. ... Conflicts between these two are always the result of misinterpretation and misrepresentation of one or the other or both, and history abounds with illustrations of all these forms of confusing contradictions. Science and religion, while thus separate, have various relationships which make each the servant of the other.

*Science and Religion Today* (pp. 51–52)

The University of North Carolina Press. Chapel Hill, North Carolina. 1929

Dean Inge [English religious leader] remarks, “We may hope for a time when the science of a religious man will be scientific and religion of a scientific man religious.”

*Science and Religion Today* (pp. 51–52)

The University of North Carolina Press. Chapel Hill, North Carolina. 1929

**Whewell, William** 1794–1866

English philosopher and historian

All speculations on subjects in which Science and Religion bear upon each other are liable to one of the two opposite charges[:] that the speculator sets Philosophy and Religion at variance; or that he warps Philosophy into a conformity with Religion.

*Of the Plurality of Worlds*

Preface (p. iv)

John W. Parker & Son. London, England. 1853

**White, Andrew Dickson** 1832–1918

American author, educator, and diplomat

In all modern history, interference with science in the supposed interests of religion...has resulted in the direst evils both to religion and science; and, on the other hand all untrammelled scientific investigation, no matter how dangerous to religion some of its stages may have seemed...has invariably resulted in the highest good both of religion and of science.

*A History of the Warfare of Science with Theology in Christendom*

Introduction (p. viii)

Macmillan & Company Ltd. London, England. 1896

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

When we consider what religion is for mankind, and what science is, it is no exaggeration to say that the future course of history depends upon the decision of this generation as to the relations between them.

*Science and the Modern World*

Chapter XII (p. 181)

The Macmillan Company. New York, New York, USA. 1929

Religion will not gain its old power until it can face change in the same spirit as does science. Its principles may be eternal, but the expression of these principles requires continual development.

*Science and the Modern World*

Chapter XII (p. 189)

The Macmillan Company. New York, New York, USA. 1929

Science suggests a cosmology; and whatever suggests a cosmology suggests a religion.

*Religion in the Making*

Truth and Criticism (p. 136)

New American Library. New York, New York, USA. 1960

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Science is the record of dead religions.

*Phrases and Philosophies for the Use of the Young*

L. Smithers. London, England. 1903

Press. Minneapolis, Minnesota, USA. 1996

**SCIENCE AND SOCIETY****Asimov, Isaac** 1920–92

American author and biochemist

Science with all its faults has brought education and the arts to more people — a larger percentage — than has ever existed before science. In that respect it is science that is the great humanizer. And, if we are going to solve the problems that science has brought us, it will be done by science and in no other way.

Essay 400 — A Way of Thinking

*The Magazine of Fantasy and Science Fiction*, December 1994

...science must not be viewed as a mysterious black box out of which came toys and goodies, for that way laymen would view scientists as a kind of lab-coated priesthood — and, eventually, fear and hate them.

Essay 400 — A Way of Thinking

*The Magazine of Fantasy and Science Fiction*,

December 1994

**Barry, Dave** 1947–

American humor columnist

...a recent survey, conducted by the National Science Foundation...showed that the average American does not understand basic scientific principles. Naturally, the news

media reported this finding as though it was shocking, which is silly. This is, after all, a nation that has produced tournament bass fishing and the Home Shopping Channel; we should be shocked that the average American still knows how to walk erect.

In a World of Scientists, No One Really Knows Much of Anything

*Dave's World*, July 8, 1996**Bauer, Henry H.** 1931–

American chemist

The point is that no amount of knowledge of or about science in itself causes individuals or groups to make good decisions about the many quandaries of life: humans readily subjugate their knowledge to their wishes, believing and doing what they want, all scientific facts and knowledge notwithstanding.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 1 (p. 13)

University of Illinois Press. Urbana, Illinois, USA. 1992

What is the social value of science? Why should we support it with taxes? Answer: It can keep people honest. Emperors and popes used to insist that people subscribe to lies about the Earth, about the relationships among different sorts of people, and about a lot of other things. They cannot lie to that extent anymore. Science can put and keep politicians and prophets in their proper place, at least over some things.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 146)

University of Illinois Press. Urbana, Illinois, USA. 1992

Scientific research is an investment in the future; trying to make it pay off quickly is as counterproductive as is, in the economic sphere, skimming wealth from corporations through leveraged buy-outs instead of investing for the long haul. Science is part of humanity's cultural heritage. Being educated in science is as important as being educated in philosophy, or psychology, or foreign languages because without it one is ignorant, a primitive savage rather than a civilized human being. And to be scientifically literate is to understand that.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 147)

University of Illinois Press. Urbana, Illinois, USA. 1992

Studying science is excellent training for the mind, much better than the classically prescribed study of Latin. When you study science in the right way, you learn about reality therapy; and that is worth applying to other things than science.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 7 (p. 147)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Bernstein, Jeremy** 1929–

American physicist, educator, and writer

We live in a complex, dangerous, and fascinating world. Science has played a role in creating the dangers, and one hopes that it will aid in creating ways of dealing with these dangers. But most of these problems cannot, and will not, be dealt with by scientists alone. We need all the help we can get, and this help has got to come from a scientifically literate general public. Ignorance of science and technology is becoming the ultimate self-indulgent luxury.

*Cranks, Quarks, and the Cosmos: Writings on Science*  
Chapter 16 (p. 202)  
Basic Books, Inc. New York, New York, USA. 1993

...the first reason for teaching science to non scientists is that many of these nonscientists have a genuine desire to learn about science, and this, after all, is the best reason for teaching anything to anyone.

*Cranks, Quarks, and the Cosmos: Writings on Science*  
Chapter 16 (p. 196)  
Basic Books, Inc. New York, New York, USA. 1993

**Brin, David** 1950–  
American scientist and author

We Americans have refined self-righteousness to a high art, cherishing the romantic image of smart outsiders against the establishment. New Age types see themselves as brave truth-seekers, opposed by a rigid technological priesthood. No matter that this priesthood is dedicated to self-criticism, and to sharing whatever they learn. Science represents this era's "establishment," and is therefore automatically suspect.

*Otherness*  
What to Say to a UFO  
Bantam Dell Doubleday Publishing Group. New York, New York, USA. 1994

**Calvin, William H.** 1939–  
Theoretical neurophysiologist

Science doesn't merely empower us, as in seeding better technologies; it also helps prevent trouble in the first place. Knowledge can be like a vaccine, immunizing you against false fears and bad moves.

*How Brains Think: Evolving Intelligence, Then and Now*  
Chapter 3 (p. 41)  
Basic Books, Inc. New York, New York, USA. 1996

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

One of the factors, ironically enough, which has contributed to popular willingness to accept the incredible is the success of modern science. Because so many technical marvels have been achieved, the public believes that the scientist is a magician who can make anything happen. It does not know where to draw the line between the possible, the plausible, the improbable and the frankly absurd. Admittedly this is often extremely difficult, and even the

experts sometimes fall flat on their faces. But usually, all that is needed is a little common sense.

*Voices from the Sky: A Preview of the Coming Space Age*  
The Lunatic Fringe  
Harper & Row, Publishers. New York, New York, USA. 1965

**Compton, Karl Taylor** 1887–1954  
American educator and physicist

There is "something new under the sun" in that modern science has given mankind, for the first time in the history of the human race, a way of securing a more abundant life which does not simply consist in taking it away from someone else. Science really creates wealth and opportunity where they did not exist before.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 2)  
Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Cori, Carl** 1896–1984  
American biochemist

Art and science can best grow and develop in a society which cherishes freedom and which shows respect for the needs, the happiness and the dignity of human beings.

*Les Prix Nobel. The Nobel Prizes in 1947*  
Nobel banquet speech for award received in 1947  
Nobel Foundation. Stockholm, Sweden. 1948

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

The average adult can usually enjoy something only if it relates to what he knows already, and what he knows about science is in many cases pitifully inadequate.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 7 (p. 80)  
Basic Books, Inc. New York, New York, USA. 1988

**Dawkins, Richard** 1941–  
British ethologist, evolutionary biologist, and popular science writer

People certainly blame science for nuclear weapons and similar horrors. It's been said before but needs to be said again: if you want to do evil, science provides the most powerful weapons to do evil; but equally, if you want to do good, science puts into your hands the most powerful tools to do so. The trick is to want the right things, then science will provide you with the most effective methods of achieving them.

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12<sup>th</sup>, 1996

It has become almost a cliché to remark that nobody boasts of ignorance of literature, but it is socially acceptable to boast ignorance of science and proudly claim incompetence in mathematics.

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12<sup>th</sup>, 1996

Science provokes more hostility than ever, sometimes with good reason, often from people who know nothing about it and use their hostility as an excuse not to learn. Depressingly many people still fall for the discredited cliché that scientific explanation corrodes poetic sensibility.

*Science and Sensibility*

Queen Elizabeth Hall Lecture, London, 24<sup>th</sup> March 1998

## Editorial

The scientific illiteracy of politicians, their simple lack of “feel” for what science is and what it can do, prevents them from exploring the deeper questions, among the most important facing humankind: how can science be conducted so that, on the one hand, the thinkers have the freedom to think, for that is the *sine qua non*; and how, on the other hand, can the products of unfettered thought be harnessed for the needs of society?

Who Cares About Science?

*New Scientist*, 17 October 1985 (p. 18)

## Eisenhower, Dwight David 1890–1969

34<sup>th</sup> president of the United States

Science, great as it is, remains always the servant and the handmaiden of freedom. And a free science will ever be one of the most effective tools through which man will eventually bring to realization his age-old aspiration for an abundant life, with peace and justice for all.

In Dael Wolfe (ed.)

*Symposium on Basic Research*

Casper Auditorium of the Rockefeller Institute, May, 1959

Science: Handmaiden of Freedom (p. 142)

American Association of the Advancement of Science. Washington, D.C. 1959

## Feyerabend, Paul K. 1924–94

Austrian-born American philosopher of science

[Because] there is trouble in the third world... [it is argued that] the attempt to judge cosmologies by their content may have to be given up. Such a development, far from being undesirable, changes science from a stern and demanding mistress into an attractive and yielding courtesan who tries to anticipate every wish of her lover. Of course, it is up to us to choose either a dragon or a pussy cat for our company. I do not think I need to explain my own preferences.

*Realism, Rationalism and Scientific Method*

Consolations for the Specialist (p. 161)

Cambridge University Press. Cambridge, England. 1985

## Feynman, Richard P. 1918–88

American theoretical physicist

...the things that appear in the newspaper and that seem to excite the adult imagination are always those things which they cannot possibly understand, because they haven't learned anything at all of the much more interesting well-

known [to scientists] things that people have found out before. It's not the case with children, thank goodness, for a while — at least until they become adults.

In Jeffrey Robbins, ed.

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 4 (p. 102)

Perseus Books. Cambridge, Massachusetts, USA. 1999

Another value of science is the fun called intellectual enjoyment which some people get from reading and learning and thinking about it, and which others get from working in it. This is an important point, one which is not considered enough by those who tell us it is our social responsibility to reflect on the impact of science on society. Is this mere personal enjoyment of value to society as a whole? No! But it is also a responsibility to consider the aim of society itself. Is it to arrange matters so that people can enjoy things? If so, then the enjoyment of science is as important as anything else.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 6 (p. 143)

Perseus Books. Cambridge, Massachusetts, USA. 1999

I don't believe in the idea that there are a few peculiar people capable of understanding math, and the rest of the world is normal. Math is a human discovery, and it's no more complicated than humans can understand. I had a calculus book once that said, “What one fool can do, another can.” What we've been able to work out about nature may look abstract and threatening to someone who hasn't studied it, but it was fools who did it, and in the next generation, all the fools will understand it.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 9 (p. 144)

Perseus Books. Cambridge, Massachusetts, USA. 1999

When we read about this in the newspaper, it says “Scientists say this discovery may have importance in the search for a cure for cancer.” The paper is only interested in the use of the idea, not the idea itself. Hardly anyone can understand the importance of an idea, it is so remarkable. Except that, possibly, some children catch on. And when a child catches on to an idea like that, we have a scientist.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 6 (p. 145)

Perseus Books. Cambridge, Massachusetts, USA. 1999

[I]f a thing is not scientific, if it cannot be subjected to the test of observation, this does not mean that it is dead, or wrong, or stupid. We are not trying to argue that science is somehow good and other things are somehow not

good. Scientists take all those things that can be analyzed by observation, and thus the things called science are found out. But there are some things left out, for which the method does not work. This does not mean that those things are unimportant. They are, in fact, in many ways the most important.

*The Meaning of It All: Thoughts of a Citizen Scientist*  
Chapter 1 (p. 16)  
Perseus Books. Reading, Massachusetts, USA. 1998

It is odd, but on the infrequent occasions when I have been called upon in a formal place to play the bongo drums, the introducer never seems to find it necessary to mention that I also do theoretical physics.

*The Character of Physical Law*  
Chapter 1 (p. 13)  
British Broadcasting Company. London, England. 1965

### **Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

There are the elements, which seem to mock at all human control: the earth, which quakes and is torn apart and buries all human life and its works; water, which deluges and drowns everything in a turmoil; storms, which blow everything before them; there are diseases, which we have only recently recognized as attacks by other organisms; and finally there is the painful riddle of death, against which no medicine has yet been found, nor probably will be. With these forces nature rises up against us, majestic, cruel and inexorable; she brings...to our mind once more our weakness and helplessness, which we thought to escape through the work of civilization.

*The Future of an Illusion*  
Chapter III (pp. 15–16)  
W.W. Norton & Company, Inc. New York, New York, USA. 1961

### **Gleick, James** 1954–

American author, journalist, and essayist

Einstein's relativity did not speak to human values. Those were, or were not, relative for reasons unrelated to the physics of objects moving at near-light speed. Borrowing metaphors from the technical sciences could be a dangerous practice.

*Genius: The Life and Science of Richard Feynman*  
Epilogue (p. 430)  
Pantheon Books. New York, New York, USA. 1992

### **Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Science, since people must do it, is a socially embedded activity. It progresses by hunch, vision, and intuition. Much of its change through time does not record a closer approach to absolute truth, but the alteration of cultural contexts that influence it so strongly. Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are

not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.

*The Mismeasure of Man*  
Chapter One (pp. 53–54)  
W.W. Norton & Company, Inc. New York, New York, USA. 1996

...I believe that science must be understood as a social phenomenon, a gutsy, human enterprise, not the work of robots programmed to collect pure information.... Science, since people must do it, is a socially embedded activity. It progresses by hunch, vision, and intuition. Much of its change through time does not record a closer approach to absolute truth, but the alteration of cultural contexts that influence it so strongly. Facts are not pure and unsullied bits of information; culture also influences what we see and how we see it. Theories, moreover, are not inexorable inductions from facts. The most creative theories are often imaginative visions imposed upon facts; the source of imagination is also strongly cultural.

*The Mismeasure of Man*  
Chapter One (p. 53)  
W.W. Norton & Company, Inc. New York, New York, USA. 1996

Science is accessible to all thinking people because it applies universal tools of intellect to its distinctive material. The understanding of science — one need hardly repeat the litany — becomes ever more crucial in a world of biotechnology, computers, and bombs.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*  
Chapter 1 (p. 7)  
Harvard University Press. Cambridge, Massachusetts, USA. 1987

### **Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

...a science is said to be useful if its development tends to accentuate the existing inequalities in the distribution of wealth, or more directly promotes the destruction of human life.

*A Mathematician's Apology*  
Chapter 22 (p. 120)  
Cambridge University Press. Cambridge, England. 1967

### **Haskins, C. P.**

No biographical data available

Science provides a challenge to effort for the individual youth that is far greater than the challenge of militarism. It provides a unity of thought which is far wider, for it transcends all national boundaries. It provides a wider battleground, for the goal of militarism is the conquering of man, but that of science is the understanding and the subjugation of all the rest of our natural environment. And finally, it is an infinitely broader training than totalitarian training can possibly be, for it requires, in addition to great courage, stamina, and drive, the qualities of intellectualism and gentleness.

*Science Philosophy and Religion*

Scientific Thought and a Democratic Ideology (p. 235)

The Conference on Science, Philosophy and Religion in Their Relation to a Democratic Way of Life, Inc. New York, New York, USA. 1941

**Hoffmann, Roald** 1937–

Polish-born American chemist

...the overall effect of science is inexorably democratizing, in the deepest sense of the word — by making available to a wider range of people the necessities and comforts that in a previous age were reserved for a privileged elite.

*The Same and Not the Same*

Part Eight, Chapter 40 (p. 212)

Columbia University Press. New York, New York, USA. 1995

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

I am a little afraid that science is breeding us down too fast into coral-insects. A man like Newton or Leibnitz or Haller used to paint a picture of outward or inward nature with a free hand, and stand back and look at it as a whole and feel like an archangel; but nowadays you have a Society, and they come together and make a great mosaic, each man bringing his little bit and sticking it in its place, but so taken up with his petty fragment that he never thinks of looking at the picture the little bits make when they are put together.

*The Poet at the Breakfast-Table*

Chapter III (p. 79)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Holton, Gerald** 1922–

Research professor of physics and science history

Was not the universe of Dante and Milton so powerful and “gloriously romantic” precisely because it incorporated, and thereby rendered meaningful, the contemporary scientific cosmology alongside the moral and aesthetic conceptions? Leaving aside the question of whether Dante’s and Milton’s contemporaries by and large were living in a rich and fragrant world of gladness, love, and beauty, it is fair to speculate that if our new cosmos is felt to be cold, inglorious, and unromantic, it is not the new cosmology which may be at fault, but the absence of new Dantes and Miltons.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part One, Chapter 2 (p. 53)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

But making science again a part of every intelligent person’s educational resource is the minimum requirement — not because science is more important than other field, but because it is an integral part of a sound contemporary worldview.

*Einstein, History, and Other Passions: The Rebellion Against Science at the End of the Twentieth Century*

Part One, Chapter 2 (p. 53)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**King, Jr., Martin Luther** 1929–68

American civil rights leader and clergyman

The means by which we live have outdistanced the ends for which we live. Our scientific power has outrun our spiritual power. We have guided missiles and misguided men.

*Strength to Love*

Chapter VII (p. 57)

Harper &amp; Row, Publishers. New York, New York, USA. 1963

**Lederman, Leon** 1922–

American high-energy physicist

In his “Defense of Poetry,” the English romantic poet Percy Bysshe Shelley contended that one of the sacred tasks of the artist is to “absorb the new knowledge of the sciences and assimilate it to human needs, color it with human passions, transform it into the blood and bone of human nature.” Not many romantic poets rushed to accept Shelley’s challenge, which may explain the present sorry state of our nation and planet. If we had Byron and Keats and Shelley and their French, Italian, and Urdu equivalents explaining science, the science literacy of the general public would be far higher than it is now.

*The God Particle: If the Universe Is the Answer, What Is the Question*

Chapter 9 (p. 382)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

Money can’t buy ideas, that’s for sure, but lack of it can prevent one having them.

*The Cost-Benefit Analysis of Pure Research**Hospital Practice*, Sept 1973

I am afraid we shall have to regard the funding of “pure” research as a tax levied upon society that is not dissimilar in kind from that which maintains art galleries and opera houses — a “civilization tax”, perhaps.

*The Cost-Benefit Analysis of Pure Research**Hospital Practice*, Sept 1973

It is the great glory and also the great threat of science that anything which is possible in principle — which does not flout a bedrock law of physics — can be done if the intention to do it is sufficiently resolute and long sustained.

*Four Score Years and Ten—And Still Counting**Guardian*, December 13, 1984**Paulos, John Allen** 1945–

American mathematician

In general, almost any mathematically expressed scientific fact can be transformed into a consumer caveat (or lure) that will terrify (or attract) people.

*A Mathematician Reads the Newspaper*

Asbestos Removal Closes NYC Schools (p. 142)  
Basic Books, Inc. New York, New York, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Some men are so impressed by what science knows that they forget what it does not know; others are so much more interested in what it does not know than in what it does that they belittle its achievements.

*Unpopular Essays*

Philosophy for Laymen (p. 40)

George Allen & Unwin Ltd. London, England. 1950

Can a society in which thought and technique are scientific persist for a long period, as, for example, ancient Egypt persisted, or does it necessarily contain within itself forces which must bring either decay or explosion?

Lloyd Roberts lecture

Can a Scientific Community be Stable, Royal Society of Medicine, London, November 29, 1949

**Sagan, Carl** 1934–96

American astronomer and author

Many of the dangers we face indeed arise from science and technology — but, more fundamentally, because we have become powerful without becoming commensurately wise. The world-altering powers that technology has delivered into our hands now require a degree of consideration and foresight that has never before been asked of us.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 22 (p. 384)

Random House, Inc. New York, New York, USA. 1994

Surely...any powerful tool, those in power will try to use...or even monopolize.... Surely scientists, being people, grow up in a society and reflect the prejudices of that society. How could it be otherwise? Some scientists have been nationalists; some have been racists; some have been sexists. But that doesn't undermine the validity of science. It's just a consequence of being human.

Wonder and Skepticism

*Skeptical Inquirer*, January/February 1995 (p. 24)

There is a reward structure in science that is very interesting: Our highest honors go to those who disprove the findings of the most revered among us... [I]t's exactly the opposite [in economics, politics, or religion]: There we reward those who reassure us that what we've been told is right, that we need not concern ourselves about it. This difference, I believe, is at least a basic reason why we've made so much progress in science, and so little in some other areas.

Wonder and Skepticism

*Skeptical Inquirer*, January/February 1995 (p. 24)

The scientific world view works so well, explains so much and resonates so harmoniously with the most advanced parts of our brains that in time, I think, virtually every culture on the Earth, left to its own devices, would have discovered science.

*Cosmos*

Chapter VII (p. 176)

Random House, Inc. New York, New York, USA. 1980

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

...— who are we? ... I consider this not only one of the tasks, but the task of science, the only one that really counts.

*Science and Humanism: Physics in Our Time*

The Alleged Break-Down of the Barrier Between Subject and Object (p. 51)

At The University Press. Cambridge, England. 1952

**Silver, Brian L.**

Israeli professor of physical chemistry

Scientific ideas have affected the relationship of man to society, his ideas of God, and his image of himself. Science has influenced the way people write poetry and the way they paint pictures. In the hands of bigots, it has provided a theoretical justification for the sterilization of some human beings and the enslavement of others. Science, as a source of ideas, is a major character in the human drama.

*The Ascent of Science*

Preface (p. xvi)

Solomon Press Book. New York, New York, USA. 1998

**Snow, Charles Percy** 1905–80

English novelist and scientist

Literary intellectuals at one pole — at the other scientists. — .... Between the two a gulf of mutual incomprehension.

*The Two Cultures and the Scientific Revolution*

Chapter I (p. 4)

Cambridge University Press. New York, New York, USA. 1961

**Stenger, Victor J.** 1935–

American physicist

Most humans on this planet use the fruits of science in every phase of their lives. I become very irritated at those who decry science while accepting its every benefit. It is especially ironic how the antiscientists use modern communications to get their messages to the public.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 14 (p. 297)

Prometheus Books. Buffalo, New York, USA. 1990

**Tennyson, Alfred (Lord)** 1809–92

English poet

Science grows and Beauty dwindles.

*Alfred Tennyson's Poetical Works*

Locksley Hall. Sixty Years After, Stanza 123  
Oxford University Press, Inc. London, England. 1953

**Thomas, Lewis** 1913–93  
American physician and biologist

The cloning of humans is on most of the lists of things to worry about from Science, along with behavior control, genetic engineering, transplanted heads, computer poetry and the unrestrained growth of plastic flowers.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
On Cloning Human Beings (pp. 51–52)  
The Viking Press. New York, New York, USA. 1979

**Weinberg, Steven** 1933–  
American nuclear physicist

It is simply a logical fallacy to go from the observation that science is a social process to the conclusion that the final product, our scientific theories, is what it is because of the social and historical forces acting in this process. A party of mountain climbers may argue over the best path to the peak, and these arguments may be conditioned by the history and social structure of the expedition, but in the end either they find a good path to the peak or they do not, and when they get there they know it. (No one would give a book about mountain climbing the title Constructing Everest.)

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
Chapter VI (p. 165)  
Pantheon Books. New York, New York, USA. 1992

It certainly feels to me that we are discovering something real in physics, something that is what it is without any regard to the social and historical conditions that allowed us to discover it.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
Chapter VI (p. 165)  
Pantheon Books. New York, New York, USA. 1992

**Weinberg, Steven** 1933–  
American nuclear physicist

We may need to rely again on the influence of science to preserve a sane world. It is not the certainty of scientific knowledge that fits it for this role, but its uncertainty. Seeing scientists change their minds again and again about matters that can be studied directly in laboratory experiments, how can one take seriously the claims of religious tradition or sacred writings to certain knowledge about matters beyond human experience?

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
Chapter VII (p. 188)  
Pantheon Books. New York, New York, USA. 1992

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science cannot develop unless it is pursued for the sake of pure knowledge and insight. It will not survive unless it is used intensely and wisely for the betterment of humanity and not as an instrument of domination. Human existence depends upon compassion and curiosity. Curiosity without compassion is inhuman; compassion without curiosity is ineffectual.

*Science Yesterday, Today, and Tomorrow*  
Speech, 1993

**Wilson, Edward O.** 1929–  
American biologist and author

The love of complexity without reductionism makes art; the love of complexity with reductionism makes science.

*Consilience: The Unity of Knowledge*  
Chapter 4 (p. 54)  
Alfred A. Knopf. New York, New York, USA. 1998

**Wolpert, Lewis** 1929–  
British embryologist

Mary Shelley's *Dr. Frankenstein*, H. G. Wells's *Dr. Moreau* and Aldous Huxley's *Brave New World*...are evidence of a powerfully emotive anti-science movement. Science is dangerous, so the message goes — it dehumanizes; it takes away free will; it is materialistic and arrogant. It removes magic from the world and makes it prosaic. But note where these ideas come from — not from the evidence of history, but from creative artists who have molded science by their own imagination.

*The Unnatural Nature of Science*  
Introduction (p. x)  
Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Zelinsky, Wilbur** 1921–  
American cultural geographer

Perhaps the greatest discovery of twentieth century science has to do with its own essential nature: That it is, first and always, a social activity, an organized band of human beings who obey the same fundamental rules of organized behavior as do any other complex group of people, not a disembodied flock of angels soaring unswervingly upward toward the elysian fields of truth.

*The Demigod's Dilemma*  
*Annals of the Association of American Geographers*, Volume 65, 1975  
(p. 133)

## SCIENCE AND STATE

**Duprée, Hunter** 1921–  
American historian of science and technology

The mighty edifice of government science dominated the scene in the middle and twentieth century as a Gothic cathedral dominated a thirteenth century landscape. The work of many hands over the years, it universally inspired admiration, wonder and fear.



*Science in the Federal Government*

Chapter XIX (p. 375)

Harvard University Press. Cambridge, Massachusetts. 1957

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

...the separation of state and church must be complemented by the separation of state and science, that most recent, most aggressive, and most dogmatic religious institution.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 18 (p. 295)

Verso. London, England. 1978

**Mellanby, Kenneth** 1908–93

English ecologist and entomologist

...the corridors of power have a strong attraction for even the most devoted investigator, and these corridors seldom lead back to the laboratory.

Disorganisation of Scientific Research

*New Scientist*, Volume 59, Number 86023 August 1973 (p. 436)

**Ramón y Cajal, Santiago** 1852–1934

Spanish neuropathologist

Today's statesmen undoubtedly have limitations, one of which is not realizing that the greatness and might of nations are the products of science, and that justice, order, and good laws are important but secondary factors in prosperity.

*Advice for a Young Investigator*

Chapter 6 (p. 91)

The MIT Press. Cambridge, Massachusetts, USA. 1999

**Rutherford, Ernest** 1871–1937

English physicist

It is essential for men of science to take an interest in the administration of their own affairs or else the professional civil servant will step in — and then the Lord help you.

*Bulletin of the Institute of Physics*, 1950, 1, Number 1, cover

**Wiener, Norbert** 1894–1964

American mathematician

Neither the public nor the big administrator [of science] has too good an understanding of the inner continuity of science, but they have both seen its world-shaking consequences, and they are afraid of it. Both of them wish to decerebrate the scientist, as the Byzantine State emasculated its civil servants. Moreover the great administrator who is not sure of his own intellectual level can aggrandize himself only by cutting his scientific employees down to size.

*I Am a Mathematician*

Epilogue (p. 363)

Doubleday. Garden City, NY 1956

## SCIENCE AND SUPERSTITION

**Einstein, Albert** 1879–1955

German-born physicist

By furthering logical thought and a logical attitude, science can diminish the amount of superstition in the world. There is no doubt that all but the crudest scientific work is based on a firm belief — akin to religious feeling — in the rationality and comprehensibility of the world.

*Cosmic Religion, With Other Opinions and Aphorisms*

On Science (p. 98)

Covici-Fiede. New York, New York, USA. 1931

**Lovecraft, H. P. (Howard Phillips)** 1890–1937

American writer of fantasy, horror, and science fiction

We were not...in any sense childishly superstitious, but scientific study and reflection had taught us that the known universe of three dimensions embraces the merest fraction of the whole cosmos of substance and energy.

*The Shunned House*

Section IV

The Recluse Press. Athol, Massachusetts, USA. 1928

To say that we actually believed in vampires or werewolves would be a carelessly inclusive statement. Rather must it be said that we were not prepared to deny the possibility of certain unfamiliar and unclassified modifications of vital force and attenuated matter; existing very infrequently in three-dimensional space because of its more intimate connection with other spatial units, yet close enough to the boundary of our own to furnish us occasional manifestations which we, for lack of a proper vantage-point, may never hope to understand.

*The Shunned House*

Section IV

The Recluse Press. Athol, Massachusetts, USA. 1928

**Machen, Arthur** 1863–1947

Welsh author

I have told you that I was of skeptical habit; but though I understood little or nothing, I began to dread, vainly proposing to myself the iterated dogmas of science that all life is material, and that in the system of things there is no undiscovered land, even beyond the remotest stars, where the supernatural can find a footing. Yet there struck in on this the thought that matter is as really awful and unknown as spirit, that science itself but dallies on the threshold, scarcely gaining more than a glimpse of the wonders of the inner place.

*The Novel of the Black Seal* (p. 18)

Kessinger Publishing. Whitefish, Montana, USA.

**Pagels, Heinz R.** 1939–88

American physicist and science writer

I like to browse in occult bookshops if for no other reason than to refresh my commitment to science.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 11 (p. 242)

Simon & Schuster. New York, New York, USA. 1988

## SCIENCE AND WOMEN

### Bolton, Henrietta

No biographical data available

As a general rule the scientific woman must be strong enough to stand alone, able to bear the often unjust sarcasm and dislike of men who are jealous of seeing what they consider their own field invaded.

Women in Science

*Popular Science Monthly*, Volume 53, 1898 (p. 511)

### Buckley, Arabella B. 1840–1929

English author

I have promised to introduce you today to the fairy-land of science, — a somewhat bold promise, seeing that most of you probably look upon science as a bundle of dry facts, while fairy-land is all that is beautiful, and full of poetry and imagination. But I thoroughly believe myself, and hope to prove to you, that science is full of beautiful pictures, of real poetry, and of wonder-working fairies...

*The Fairy-Land of Science*

Lecture I (p. 7)

D. Appleton & Company. New York, New York, USA. 1892

### Cannon, Annie Jump 1863–1941

American astronomer

...a life spent in the routine of science need not destroy the attractive human element of a woman's nature.

Williamina Patton Fleming

*Science*, Volume 33, Number 861, June 30, 1911 (p. 988)

### de Lamennais, Félicité Robert 1782–1854

French nobleman and ecclesiastic scholar

I have never met a woman who was competent to follow a course of reasoning the half of a quarter of an hour — *un demi quart d'heure*. She has qualities which are wanting in us, qualities of a particular, inexpressible charm; but, in the matter of reason, logic, the power to connect ideas, to enchain principles of knowledge and perceive their relationships, woman, even the most highly gifted, rarely attains to the height of a man of mediocre capacity.

In H.J. Mozans

*Women in Science*

Chapter III (p. 136)

The MIT Press. Cambridge, Massachusetts, USA. 1974

### de Pizan, Christine 1364–ca. 1430

Venician Medieval writer and analyst

I'll give you some conclusive examples. I repeat — and don't doubt my word — that if it were the custom to send little girls to school and to teach them all sorts of different subjects there, as one does with little boys, they would grasp and learn the difficulties of all the arts and sciences just as easily as the boys do.

Translated by Rosalind Brown-Grant

*The Book of the City of Ladies*

Part I, 26 (p. 57)

Penguin Books. London, England. 1999

### Gildersleeve, Virginia Crocheron 1877–1965

American educator

If we could produce one or two more Madame Curies, that would accomplish far more for the advancement of women than any amount of agitation, argument and legislation.

*Many a Good Crusade: Memoirs of Virginia Crocheron Gildersleeve*

Part I. The Advancement of Women, (p. 104)

The Macmillan Company. New York, New York, USA. 1954

### Kant, Immanuel 1724–1804

German philosopher

All abstract speculations, all knowledge which is dry, however useful it may be, must be abandoned to the laborious and solid mind of man.... For this reason women will never learn geometry.

In H.J. Mozans

*Women in Science*

Chapter III (p. 136)

The MIT Press. Cambridge, Massachusetts, USA. 1974

### Kass-Simon, G.

American neurobiologist

### Farnes, Patricia 1931–85

American health care writer

For women in science to be remembered, not only must their work be thought right, but usually it must have such impact upon scientific thought that exclusion is impossible. If women scientists are wrong, or if they narrowly miss the mark, or if they propound ideas that are ultimately superseded, not only are their ideas quickly forgotten, but as often as not, the women are ostracized by their contemporaries or treated with derision.

*Women of Science: Righting the Record*

Introduction (p. xiii)

Indiana University Press. Bloomington, Indiana, USA. 1990

### Lamy, Étienne 1845–1919

French essayist, politician, and lawyer

Women...group themselves at the center of human knowledge, whereas men disperse themselves toward its outer boundaries. While men are always pushing analysis to its utmost limits, women are seeking a synthesis. While men are becoming more technical, women

are becoming more intellectual. They are better placed to observe the correlations of the different sciences, and to subordinate them to the common and unique source of truth from which they all descend. We seem, indeed, to be approaching a time when women will become the conservers of general ideas.

In H.J. Mozans

*Women in Science.*

Chapter XII (pp. 409–410)

The MIT Press. Cambridge, Massachusetts, USA. 1974

### **Marcet, Jane Haldimand** 1769–1858

English expository author in chemistry, botany, religion, and economics

In writing these pages, the author was more than once checked in her progress by the apprehension that such an attempt might be considered by some, either as unsuited to the ordinary pursuits of her sex, or ill justified by her own recent and imperfect knowledge of the subject. But, on the one hand, she felt encouraged by the establishment of those public institutions, open to both sexes, for the dissemination of philosophical knowledge, which clearly prove that the general opinion no longer excludes women from an acquaintance with the elements of science...

*Conversations on Chemistry, in Which the Elements of that Science Are Familiarly Explained and Illustrated by Experiments*

Preface (p. iv)

Sidney's Press for Cooke. New Haven, Connecticut, USA. 1809

### **Merchant, Carolyn** 1936? –

American ecofeminist philosopher

While learned ladies had always been present among the educated of nobility, and women had contributed to science and mathematics from earliest times, the “scientific lady” was a product of the Scientific Revolution.

*The Death of Nature: Women, Ecology, and the Scientific Revolution*

Chapter 11 (p. 269)

Harper & Row, Publishers. San Francisco, California, USA. 1980

### **Mitchell, Maria** 1818–89

American astronomer and educator

Women, more than men, are bound by tradition and authority. What the father, the brother, the doctor, and the minister have said has been received undoubtingly. Until women throw off this reverence for authority, they will not develop. When they do this, when they come to truth through their investigations, when doubt leads them to discovery, the truth which they get will be theirs, and their minds will work on and on unfettered.

In Eve Merriam

*Growing Up Female in America*

Maria Mitchell (p. 96)

Doubleday & Company, Inc. Garden City, New York, USA. 1971

### **Mozans, H. J. (John Augustine Zahm)** 1851–1921

American priest, professor of physics, and science writer

Whilst men of science will be forced to continue as specialists as long as the love of fame, to consider no other motives of research, continue to be a potent influence in their investigations, it is probable that women will have less love for the long and tedious processes involved in the more difficult kinds of specialization. They will, it seems likely, be more inclined to acquire a general knowledge of the whole circle of the sciences — a knowledge that will enable them to take a comprehensive survey of nature. And it will be fortunate for themselves, as well as for the men who must perforce remain specialists, if they elect to do so. For nothing gives false views of nature as a whole, nothing more unfit the mind for a proper apprehension of higher and more important truths, nothing more incapacitates one for the enjoyment of the masterpieces of literature or the sweeter amenities of life, than the narrow occupation of a specialist who sees nothing in the universe but electrons, microbes and protozoa.

*Women in Science*

Chapter XII (pp. 408–409)

The MIT Press. Cambridge, Massachusetts, USA. 1974

### **Myrdal, Sigrid**

American scientist and inventor

There's the question of how you react when your data do not turn out the way you want them to. One possibility is to think “Oh no, something went wrong, my experiment failed.” or “Did I ask the question wrong?” and put the data in the drawer. I think the feminine approach is to ask “What's this trying to tell me?” and consider that nature may be more interesting and complicated than... expected, but therefore probably a bit more elegant. By actually having to deal with the data, I've gone to totally different interpretations. If something turns out quite screwy, I give it a chance. It's possible that it's more feminine to give something a chance.

In Linda Jean Shepherd

*Lifting the Veil: The Feminine Face of Science*

Receptivity (p. 86)

Shambhala. Boston, Massachusetts, USA. 1993

### **Plato** 428 BCE–347 BCE

Greek philosopher

Nothing can be more absurd than the practice, which prevails in our country, of men and women not following the same pursuits with all their strength and with one mind, for thus the state, instead of being a whole, is reduced to a half.

In H.J. Mozans

*Women and Science* (p. 2)

The MIT Press. Cambridge, Massachusetts, USA. 1974

### **Poullain de la Barre, François** 1647–1723

French feminist theorist and philosopher

*L'esprot n'a point de sexe.*

The mind has no sex.

*De l'éducation des dames pour la conduite de l'esprit dans les sciences et dans les moeurs*  
Paris, France. 1674.

**Rich, Adrienne** 1929–  
American poet

The belief that established science and scholarship — which have so relentlessly excluded women from their making — are “objective” and “value-free” and that feminist studies are “unscholarly,” “biased,” and “ideological” dies hard. Yet the fact is that all science, and all scholarship, and all art are ideological; there is no neutrality in culture!

*Blood, Bread and Poetry*  
Chapter 1 (p. 3)  
W.W. Norton & Company. New York, New York, USA. 1986

**Yentsch, Clarice M.**  
No biographical data available

**Sindermann, Carl J.**  
No biographical data available

Science, as a remarkably conservative human institution despite its relatively brief history, has typically cast women in supporting roles in which they were subservient to male professionals, usually dreadfully underpaid, and totally unrecognized.

*The Woman Scientist: Meeting the Challenges for a Successful Career*  
Chapter 2 (p. 27)  
Plenum Press. New York, New York, USA. 1992

## SCIENCE CREED

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

Science corrects the old creeds....

*The Complete Works of Ralph Waldo Emerson* (Volume 8)  
Letters and Social Aims  
Chapter VII (p. 228)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Hall, Asaph** 1829–1907  
American astronomer

The scientific creed is constantly growing and expanding, and we have no fears, but rejoice at its growth. We need no consistency of bishops, no synod of ministers, to tell us what to believe. Everything is open to investigation and criticism.

In Sir Richard Arman Gregory  
*Discovery; or, The Spirit and Service of Science*  
Chapter II (pp. 30–31)  
Macmillan & Company Ltd. London, England. 1918

**Huxley, Thomas Henry** 1825–95  
English biologist

...science... commits suicide when it adopts a creed.

*Collected Essays* (Volume 2)  
*Darwiniana*  
The Darwin Memorial (p. 252)  
Macmillan & Company Ltd. London, England. 1904

**LeShan, Lawrence**

No biographical data available

**Margenau, Henry** 1901–97  
American physicist

1. We believe that the search for truth is a never-ending quest; yet we pledge ourselves to seek it.
2. We will not recognize or accept any kind of truth that pretends to be ultimate or absolute. We will consider and weigh all claims as provisional conclusions. If examination shows them to be stop signs on the road of inquiry, we will ignore them; if they are signposts, we will note them and move on.
3. We recognize no subjects and no facts that are alleged to be forever closed to inquiry or understanding; for science, every mystery is but a challenge.
4. We believe that new principles of understanding are constantly created through the efforts of man, and that a philosophy which sees the answers to all questions already implied in what is now called science is presumptuous and contrary to the spirit of science.
5. We are confident that scientific illumination can be made to penetrate not only the realms now affirmed as scientific, but also the shadowy regions that surround human consciousness, the essence of the mind, including features that are still obscure or occult and mysterious.

*Einstein's Space and Van Gogh's Sky*  
Chapter 4 (pp. 70–71)  
The Macmillan Company. New York, New York, USA. 1982

## SCIENCE FICTION

**Asimov, Isaac** 1920–92  
American author and biochemist

Individual science fiction stories may seem as trivial as ever to the blinder critics and philosophers of today — but the core of science fiction, its essence...has become crucial to our salvation if we are to be saved at all.

In Robert Holdstock (ed.)  
*The Encyclopedia of Science Fiction*  
Foreword (p. 7)  
Octopus Books Ltd. London, England. 1978

**Ballard, James Graham** 1930–  
English writer

Everything is becoming science fiction. From the margins of an almost invisible literature has sprung the intact reality of the 20<sup>th</sup> century.

Fictions of Every Kind  
*Books and Bookmen*, February 1971

**Hawking, Stephen William** 1942–  
English theoretical physicist

There is a two-way trade between science fiction and science. Science fiction suggests ideas that scientists incorporate into their theories, but sometimes science turns up notions that are stranger than any science fiction.

In Lawrence M. Krauss  
*The Physics of Star Trek*  
Forward (p. xii)  
Harp Perennial Publishers. New York, New York, USA. 1995

We may not yet be able to boldly go where no man (or woman) has gone before, but at least we can do it in the mind.

In Lawrence M. Krauss  
*The Physics of Star Trek*  
Foreword (pp. xi–xii)  
Harp Perennial Publishers. New York, New York, USA. 1995

Nevertheless, today's science fiction is often tomorrow's science fact. The physics that underlies Star Trek is surely worth investigating. To confine our attention to the terrestrial matters would be to limit the human spirit.

In Lawrence M. Krauss  
*The Physics of Star Trek*  
Forward (p. xiii)  
Harp Perennial Publishers. New York, New York, USA. 1995

## SCIENCE GEEK

**Willis, Connie** 1945–  
American science fiction writer

The effect, especially with the Coke-bottle glasses, should have been science geek, but it wasn't.... Science geeks wear black shoes and white socks. he wasn't even wearing a pocket protector, though he should have been.

*Bellwether* (p. 12)  
Bantam Spectra. New York, New York, USA. 1997

## SCIENTIFIC COMMUNITY

**Latour, Bruno** 1947–  
French sociologist of science

**Woolgar, S.**  
No biographical data available

...a body of practices widely regarded by outsiders as well organized, logical, and coherent, in fact consists of a disordered array of observations with which scientists struggle to produce order.... Despite participants' well-ordered reconstructions and rationalizations, actual scientific practice entails the confrontation and negotiation of utter confusion.

*Laboratory Life: The Social Construction of Scientific Facts*  
Chapter 1 (p. 36)  
Sage Publications. Beverly Hills, California, USA. 1979

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

In any science there is harmony between practitioners. A man may work as an individual, learning of what his colleagues do through reading or conversation; he may be working as a member of a group on problems whose technical equipment is too massive for individual effort. But whether he is part of a team or solitary in his own study, he, as a professional, is a member of a community. His colleagues in his own branch of science will be grateful to him for the inventive or creative thoughts he has, will welcome his criticism....

*The Open Mind*  
Chapter VIII (pp. 137–138)  
Simon & Schuster. New York, New York, USA. 1955

**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

There isn't a scientific community. It is a culture. It is a very undisciplined organization.

In Daniel S. Greenberg  
*The Politics of Pure Science*  
Book One, Chapter I (p. 3)  
New American Library. New York, New York, USA. 1967

## SCIENTIFIC CRITICISM

**Pearson, Karl** 1857–1936  
English mathematician

In an age like our own, which is essentially an age of scientific inquiry, the prevalence of doubt and criticism ought not to be regarded with despair or as a sign of decadence. It is one of the safeguards of progress; — *la critique est la vie de la science*, I must again repeat. One of the most fatal (and not so impossible) futures for science would be the institution of a scientific hierarchy which would brand as heretical all doubt as to its conclusions, all criticism of its results.

*The Grammar of Science*  
Chapter II, Section 7 (p. 66)  
Charles Scribner's Sons. London, England. 1892

**Tagore, Rabindranath** 1861–1941  
Indian poet and philosopher

Our scientific world is our world of reasoning. It has its greatness and uses and attractions. We are ready to pay homage due to it. But when it claims to have discovered the real world for us and laughs at the worlds of all simple-minded men, then we must say it is like a general grown intoxicated with his power, usurping the throne of his king.

*Personality*  
The World of Personality (p. 70)  
The Macmillan Company. New York, New York, USA. 1917

**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

Our age is possessed by a strong surge towards the criticism of traditional customs and opinions. A new spirit is arising which is unwilling to accept anything on authority, which does not so much permit as demand independent, rational thought on every subject, and which refrains from hampering any attack based upon such thought, even though it be directed against things which formerly were considered to be as sacrosanct as you please. ...Its results can only be advantageous: no scientific structure falls entirely into ruin: what is worth preserving preserves itself and requires no protection.

*Science and the Human Temperament*

Chapter I (p. 38)

W.W. Norton & Company, Inc. New York, New York, USA. 1935

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

A scientific researcher must always think of himself as a member of a jury. His only concern should be the adequacy of the evidence and the clarity of the proofs which support it. Guided by this, he will form his opinion and cast his vote without regard for whether he shares the author's views.

*Scientific Studies* (Volume 12)

Chapter VIII (pp. 306–307)

Suhrkamp. New York, New York, USA. 1988

**von Mises, Ludwig** 1881–1973  
Austrian economist

...scientific criticism has no nobler task than to shatter false beliefs.

*Socialism: An Economic and Sociological Analysis*

Preface to the Second German Edition (p. 19)

Yale University Press. New Haven, Connecticut, USA. 1951

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

If science is not to degenerate into a medley of ad hoc hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations.

*Science and the Modern World*

Chapter I (pp. 16–17)

The Macmillan Company. New York, New York, USA. 1929

**Ziman, John M.** 1925–2005  
British physicist

The community of those who are competent to contribute to, or criticize, scientific knowledge must not be closed; it must be larger, and more open, than the group of those who entirely accept a current consensus or orthodoxy. It is an essential element in the health of Science, or of a science, or of the sciences, that self-confirming, mutually validating circles be unable to

close. Yet it is also essential that technical scientific discussion be not smothered in a cloud of ignorant prejudices and cranky speculations.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 4 (p. 64)

Cambridge University Press. Cambridge, England. 1968

## SCIENTIFIC DOUBT

**Richet, Charles** 1850–1935  
French physiologist

Scientific doubt is a first-class quality, but rather eliminates piquancy from controversy.

*The Natural History of a Savant*

Chapter III (p. 25)

J.M. Dent & Sons Ltd. London, England. 1927

## SCIENTIFIC INQUIRY

**Dewey, John** 1859–1952  
American philosopher and educator

The routine of custom tends to deaden even scientific inquiry; it stands in the way of discovery and of the active scientific worker. For discovery and inquiry are synonymous as an occupation. Science is a pursuit, not a coming into possession of the immutable; new theories as points of view are more prized than discoveries that quantitatively increase the store on hand.

*Reconstruction in Philosophy*

Introduction (p. xvii)

Beacon Press. Boston, Massachusetts, USA. 1920

**Heinlein, Robert A.** 1907–88  
American science fiction writer

There ought not to be anything in the whole universe that man can't poke his nose into — that's the way we're built and I assume there's some reason for it.

*Methuselah's Children*

Chapter 8 (p. 160)

Aeonian Press. Mattituck, New York, USA. 1976

**Herschel, Sir John Frederick William** 1792–1871  
English astronomer and chemist

A mind which has once imbibed a taste for scientific inquiry, and has learnt the habit of applying its principles readily to the cases which occur, has within itself an inexhaustible source of pure and exciting contemplations...

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 11 (pp. 14–15)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Herwitz, Daniel**  
No biographical data available

Cosmological inquiry takes place in the space between mathematics, theory, experiment, simulation, observation, and philosophic speculation. It is where science lives.

In Heather Wax and Gerald Shaw

Master of His Universe

*Science & Spirit*, November–December 2004

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

If the purpose of scientific methodology is to prescribe or expound a system of enquiry or even a code of practice for scientific behavior, then scientists seem able to get on very well without it.

*Pluto's Republic*

Induction and Intuition in Scientific Thought (p. 78)

Oxford University Press, Inc. Oxford, England. 1982

The purpose of scientific enquiry is not to compile an inventory of factual information, nor to build up a totalitarian world picture of Natural Laws in which every event that is not compulsory is forbidden. We should think of it rather as a logically articulated structure of justifiable beliefs about nature. It begins as a story about a Possible World — a story which we invent and criticize and modify as we go along, so that it winds by being, as nearly as we can make it, a story about real life.

*Pluto's Republic*

Mainly About Intuition, Section 4 (pp. 110–111)

Oxford University Press, Inc. Oxford, England. 1982

...it is high time that laymen abandoned the misleading belief that scientific enquiry is a cold dispassionate enterprise, bleached of imaginative qualities, and that a scientist is a man who turns the handle of discovery; for at every level of endeavor scientific research is a passionate undertaking and the Promotion of Natural Knowledge depends above all on a *sortée* into what can be imagined but is not yet known.

Imagination and Hypothesis

*The Times Literary Supplement* (London), October 25, 1963 (p. 850)

**Rothschild, Lord Nathaniel Mayer** 1910–90

English banker

It is sometimes said in justification of basic research, that chance observations made during such work, and their subsequent study may be just as important as those made during applied R & D. While there is some truth in this contention, the country's needs are not so trivial as to be left to the mercies of a form of scientific roulette, with many more than the conventional 37 numbers on which the ball may land.

*A Framework for Government Research and Development* (p. 3)

Her Majesty's Stationery Office. London, England. 1971

**Thomson, J. Arthur** 1861–1933

Scottish biologist

Scientific inquiry may be likened to fishing in the sea of reality with a particular kind of tackle. The tackle has well-known excellences, but it has also recognized limitations; and there may be much in the sea that the net used will not catch, being of too wide a mesh.

The New World of Science

*The Atlantic Monthly*, June 1930

## SCIENTIFIC INVESTIGATION

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Scientific investigation in our day should be inspired by a purpose as animating to the general sympathy, as was the religious zeal which built the Cathedral of Cologne or the Basilica of St. Peter's. The time is passed when men expressed their deepest convictions by these wonderful and beautiful religious edifices; but it is my hope to see, with the progress of intellectual culture, a structure arises among us which may be a temple of the revelations written in the material universe.

*Louis Agassiz: His Life and Correspondence* (Volume 2)

Dredging Expedition (pp. 670–671)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1885

**Bayliss, William Maddock** 1860–1925

English physiologist

It is not going too far to say that the greatness of a scientific investigator does not rest on the fact of his having never made a mistake, but rather on his readiness to admit that he has done so, whenever the contrary evidence is cogent enough.

*Principles of General Physiology*

Preface (pp. xvi–xvii)

Longmans, Green & Company. London, England. 1920

**Born, Max** 1882–1970

German-born English physicist

The Scientist's urge to investigate, like the faith of the devout or the inspiration of the artist, is an expression of mankind's longing for something fixed, something at rest in the universal whirl: God, Beauty, Truth.

*The Restless Universe*

Chapter V (p. 278)

Dover Publications, Inc. New York, New York, USA. 1951

**Boycott, A. E.**

No biographical data available

The difficulty in most scientific work lies in framing the questions rather than in finding the answers.

The Transition from Live to Dead

*Nature*, Volume 123, January 19, 1929 (p. 93)

**Carryl, Charles Edward** 1841–1920

American writer

Then we gather as we travel,  
 Bits of moss and dirty gravel,  
 And we chip off little specimens of stone;  
 And we carry home as prizes  
 Funny bugs, of handy sizes,  
 Just to give the day a scientific tone.

In Franklin P. Adams

*Innocent Merriment: An Anthology of Light Verse*

Robinson Crusoe's Story

McGraw-Hill Book Company, Inc. New York, New York, USA. 1942

**Chargaff, Erwin** 1905–2002

Austrian biochemist

The scientific professions began to develop a momentum of their own, thereby creating a vested interest in always having more science, bigger science, better-endowed science. This is, incidentally, quite in contrast, for instance, to orchestra musicians whose influence on the number of orchestra pieces being written is minimal.

Voices in the Labyrinth

*Perspectives in Biology and Medicine*, Volume 18, Number 3, Spring 1975 (p. 324)

**Crookes, Sir William** 1832–1919

English chemist and physicist

To stop short in any research that bids fair to widen the gates of knowledge, to recoil from fear of difficulty or adverse criticism, is to bring reproach on science. There is nothing for the investigator to do but to go straight on; to explore up and down, inch by inch, with the taper of his reason; to follow the light wherever it may lead, even should it at times resemble a will-o'-the-wisp.

Address

British Association for the Advancement of Science, Bristol, England (1898)

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Holmes is a little too scientific for my tastes — it approaches to cold-bloodedness. I could imagine his giving a friend a little pinch of the latest vegetable alkaloid, not out of malevolence, you understand, but simply out of a spirit of inquiry in order to have an accurate idea of the effects. To do him justice, I think that he would take it himself with the same readiness. He appears to have a passion for definite and exact knowledge.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 1)

A Study in Scarlet, Chapter 1 (p. 149)

Wings Books. New York, New York, USA. 1967

**Farrington, Benjamin** 1891–1974

Irish scholar

Just as all scientific investigation is fruitless which is not pursued in a spirit of truth, so the results of all scientific endeavor are wasted if the continuity of tradition cannot

be assured. It is of the very essence of science to be a co-operation and that not only of the men of the same generation, but of the generations successively.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 2)

Chapter 35 (p. 503)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Hall, Alfred Rupert** 1920–

English historian of science

The cumulative growth of science, arising from the employment of methods of investigation and reasoning which have been justified by their fruits and their resistance to the corrosion of criticism, cannot be reduced to any single themes. We cannot say...why some men can perceive the truth, or a technical trick, which has eluded others. From the bewildering variety of experience in its social, economic and psychological aspects it is possible to extract only a few factors, here and there, which have had a bearing on the development of science. At present at least, we can only describe, and begin to analyse, where we should like to understand.

*The Scientific Revolution, 1500–1800*

Introduction (p. xiv)

Longmans, Green & Company. London, England. 1954

**Hertz, Heinrich** 1857–94

German physicist

I have never forgotten what I often used to say to myself, that I would rather be a great scientific investigator than a great engineer, but would rather be a second-rate engineer than a second-rate investigator.

*Miscellaneous Papers*

Introduction (p. x)

Macmillan & Company Ltd. London, England. 1896

**Huxley, Thomas Henry** 1825–95

English biologist

The method of scientific investigation is nothing but the expression of the necessary mode of working of the human mind. It is simply the mode in which all phenomena are reasoned about, rendered precise and exact.

*Collected Essays* (Volume 2)

*Darwiniana*

Six Lectures to Working Men (p. 363)

Macmillan & Company London, England. 1904

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The man of action has to believe, the inquirer has to doubt; the scientific investigator is both.

In J.B. Conant

*Modern Science and Modern Man*

Science and Spiritual Values (p. 103)

Columbia University Press. New York, New York, USA. 1952

**von Lommel, Eugen** 1837–99

German physicist



The deeds of a man of science are his scientific investigations. Truth once discovered does not remain shut up in the study or the laboratory. When the moment comes, it bursts its narrow bonds and joins the quick pulse of life. That which has been discovered in solitude, in the unselfish struggle for knowledge, in pure love of science, is often fated to be the mighty lever to advance the culture of our race.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter VII (p. 184)

Macmillan & Company Ltd. London, England. 1918

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

The popular idea of scientific investigation is a vehement, aimless collection of little facts, collected as a bower of birds collects shells and pebbles, in methodical little rows, and out of this process, in some manner unknown to the popular mind, certain conjuring tricks — the celebrated “wonders of science” — in a sort of accidental way emerge.

*The Discovery of the Future* (p. 34)

B.W. Huebsch. New York, New York, USA. 1913

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

In the course of a scientific investigation we say all kinds of things; we make many utterances whose role in the investigation we do not understand. For it isn't as though everything we say has a conscious purpose; our tongues just keep going. Our thoughts run in established routines, we pass automatically from one thought to another according to the techniques we have learned. And now comes the time for us to survey what we have said. We have made a whole lot of movements that do not further our purpose, or that even impede it, and now we have to clarify our thought processes philosophically.

Translated by Peter Winch

*Culture and Value* (p. 64e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

## SCIENTIFIC LITERACY

**Deason, Hilary J.** d. 1971

No biographical data available

Scientific literacy has become a real and urgent matter for the informed citizen. Many have allowed themselves to lapse into a coma of scientific illiteracy because of the misconception that science and mathematics are beyond their understanding, have no personal appeal, and can be rejected or ignored. For them a tocsin [alarm bell] has been sounded by hundreds of intelligent men and women whose personal crusade is the awakening of people

everywhere to scientific awareness. They admonish, “read, mark, learn, and inwardly digest.”

*A Guide to Science Reading*

Foreword to the First Edition (p. ix)

The New American Library. New York, New York, USA. 1966

## SCIENTIFIC METHOD

**Agre, Peter** 1949–

American biologist

The field was essentially stuck, but following the well known scientific approach known as “sheer blind luck,” we stumbled upon the protein that is the answer to the question: do water channels exist?

*Les Prix Nobel. The Nobel Prizes in 2003*

Nobel lecture for award received in 2003

Nobel Foundation. Stockholm, Sweden. 2004

**Bauer, Henry H.** 1931–

American chemist

There is no good reason to discard the scientific method as an ideal; rather, there is good reason to keep it so. Myths, after all, even if not literally true, are stories that embody moral truths.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 2 (p. 39)

University of Illinois Press. Urbana, Illinois, USA. 1992

One of the things wrong with the popular, classical definition of the scientific method is the implication that solitary people can successfully do good science, for example frame hypotheses and test them. In practice, however, the people who put forward the hypotheses are not usually the same people who apply the best test to them.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 3 (p. 52)

University of Illinois Press. Urbana, Illinois, USA. 1992

**Becker, Carl L.** 1873–1945

American historian

It is one of the engaging ironies of modern thought that the scientific method, which it was once fondly hoped would banish mystery from the world, leaves it every day more inexplicable.

*The Heavenly City of the Eighteenth Century Philosophers*

Chapter 1 (p. 24)

Yale University Press. New Haven, Connecticut, USA. 1932

**Bernard, Claude** 1813–78

French physiologist

I believe, in a word, that the true scientific method confines the mind without suffocating it, leaves it as far as possible face to face with itself, and guides it, while respecting the creative originality and the spontaneity which are its most precious qualities.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter III, Section iv (p. 226)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Born, Max** 1882–1970  
German-born English physicist

There are two objectionable types of believers: those who believe the incredible and those who believe that “belief” must be discarded and replaced by “the scientific method.”

*Natural Philosophy of Cause and Chance*  
Appendix One (p. 209)  
At The Clarendon Press. Oxford, England. 1949

**Bridgman, Percy Williams** 1882–1961  
American physicist

The scientific method, as far as it is a method, is nothing more than doing one’s damndest with one’s mind, no holds barred.

*Reflections of a Physicist*  
Chapter 21 (p. 351)  
Philosophical Library. New York, New York, USA. 1950

It seems to me that there is a good deal of ballyhoo about scientific method. I venture to think that the people who talk most about it are the people who do least about it. Scientific method is what working scientists do, not what other people or even they themselves may say about it... Scientific method is something talked about by people standing on the outside and wondering how the scientist manages to do it....

*Reflections of a Physicist*  
Chapter 5 (p. 81)  
Philosophical Library. New York, New York, USA. 1955

[S]cience is what scientists do, and there are as many scientific methods as there are individual scientists.

*Reflections of a Physicist*  
Chapter 5 (p. 81)  
Philosophical Library. New York, New York, USA. 1955

**Butler, Nicholas Murray** 1862–1947  
American educator and university administrator

The making of a few score of admirable specialists, and the annual production of a small army of youths with narrow, if minute, information useful in some particular vocation, is a sorry substitute for reaching the great mass of the population with the influence and ideals of scientific inquiry and the scientific method.

In Bernard Jaffe  
*New World of Chemistry*  
Preface (p. vii)  
Silver, Burdett & Company. New York, New York, USA. 1935

**Campbell, Norman R.** 1880–1949  
English physicist and philosopher

If the discovery of laws could be reduced to a set of formal rules, anyone who learnt the rules could discover

laws. But there is no broad road to progress. Herein lies the most serious objection to much that has been written on the methods of science. There is no method, and it is because there is no method which can be expounded to all the world that science is a delight to those who possess the instincts which make methods unnecessary.

*Physics: The Elements*  
Chapter IV (p. 112)  
At The University Press. Cambridge, England. 1920

**Conant, James Bryant** 1893–1978  
American educator and scientist

There is no such thing as the scientific method. If there were, surely an examination of the history of physics, chemistry, and biology would reveal it. For as I have already pointed out, few would deny that it is the progress in physics, chemistry and experimental biology which gives everyone confidence in the procedures of the scientist. Yet, a careful examination of these subjects fails to reveal any one method by means of which the masters in these fields broke new ground.

*Science and Common Sense*  
Chapter Three (p. 45)  
Yale University Press. New Haven, Connecticut, USA. 1951

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

What, then, do Jim Watson and I deserve credit for? If we deserve any credit at all, it is for persistence and the willingness to discard ideas when they became untenable. One reviewer thought that we couldn’t have been very clever because we went on so many false trails, but that is the way discoveries are usually made. Most attempts fail not because of lack of brains but because the investigator gets stuck in a cul-de-sac or gives up too soon.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 6 (p. 74)  
Basic Books, Inc. New York, New York, USA. 1988

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

The success of the scientific method at unlocking the secrets of nature is so dazzling it can blind us to the greatest scientific miracle of all: science works.

*The Mind of God: The Scientific Basis for a Rational World*  
Chapter 1 (p. 20)  
Simon & Schuster. New York, New York, USA. 1992

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

...like its literary and artistic counterparts, the process of scientific creation is a completely personal experience for which no technique of observation has yet been devised. Moreover, out of false modesty, pride, lack of inclination or psychological insight, very few of the great

discoverers have revealed their own mental processes; at the most they have described methods of work — but rarely their dreams, urges, struggles and visions.

*Louis Pasteur: Free Lance of Science*

Chapter XIII (p. 369)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

The idea that science can, and should, be run according to fixed and universal rules, is both unrealistic and pernicious.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 18 (p. 295)

Verso. London, England. 1978

**Feynman, Richard P.** 1918–88

American theoretical physicist

After we look for the evidence we have to judge the evidence. There are the usual rules about the judging the evidence; it's not right to pick only what you like, but to take all of the evidence, to try to maintain some objectivity about the thing — enough to keep the thing going — not to ultimately depend upon authority. Authority may be a hint as to what the truth is, but is not the source of information. As long as it's possible, we should disregard authority whenever the observations disagree with it.

In Jeffrey Robbins (ed.)

*The Pleasure of Finding Things Out: The Best Short Works of Richard P. Feynman*

Chapter 4 (p. 104)

Perseus Books. Cambridge, Massachusetts, USA. 1999

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

Observation, reason, and experiment make up what we call the scientific method.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 2–1 (p. 2–1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1983

**Flexner, Abraham** 1866–1959

American educator

So long as men strive to transcend their native powers, to rid themselves of prejudice and preconception, to observe phenomena in a dry light, the effort is scientific, whether at the moment it attains mathematical accuracy or not.

*Medical Education: A Comparative Study*

Chapter I (p. 3)

The Macmillan Company. New York, New York, USA. 1925

**France, Anatole (Jean Jacques Brousson)** 1844–1924

French writer

...the scientific reasons for preferring one piece of evidence to another are sometimes very strong, but they are never strong enough to outweigh our passions, our prejudices, our interests, or to overcome that levity of mind common to all grave men. It follows that we continually present the facts in a prejudiced or frivolous manner.

*Penguin Island*

Preface (p. vi)

Dodd, Mead & Company. New York, New York, USA. 1923

**Garrod, Archibald** 1857–1936

English physician

[Scientific method] acts as a check, as well as a stimulus, sifting the value of the evidence, and rejecting that which is worthless, and restraining too eager flights of the imagination and too hasty conclusions.

In Alexander G. Bearn

*Archibald Garrod and the Individuality of Man*

Chapter 7 (p. 82)

Clarendon Press. Oxford, England. 1993

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

It is important that we, as working scientists, combat these myths of our profession as something superior and apart. The myths may serve us well in the short and narrow as rationale for a lobbying strategy — give us the funding and leave us alone, for we know what we're doing and you don't understand anyway. But science can only be harmed in the long run by its self-proclaimed separation as a priesthood guarding a sacred rite called the scientific method. *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 7)

Harvard University Press. Cambridge, Massachusetts, USA. 1987

The Nobel prizes focus on quantitative nonhistorical, deductively oriented fields with their methodology of perturbation by experiment and establishment of repeatable chains of relatively simple cause and effect. An entire set of disciplines, different though equal in scope and status, but often subjected to ridicule because they do not follow this pathway of "hard" science, is thereby ignored: the historical sciences, treating immensely complex and nonrepeatable events (and therefore eschewing prediction while seeking explanation for what has happened) and using the methods of observation and comparison.

Balzan Prize to Ernst Mayr

*Science*, Volume 223, Number 4633, January 20, 1984 (p. 255)

If justification required eyewitness testimony, we would have no sciences of deep time — no geology, no ancient human history either. (Should I believe Julius Caesar

ever existed? The hard bony evidence for human evolution...surely exceeds our reliable documentation of Caesar's life.)

Dorothy, *It's Really Oz*

*Time Magazine*, August 23, 1999 (p. 59)

[O]ur ways of learning about the world are strongly influenced by the social preconceptions and biased modes of thinking that each scientist must apply to any problem. The stereotype of a fully rational and objective "scientific method," with individual scientists as logical (and interchangeable) robots, is self-serving mythology.

This View of Life. In *Mind of the Beholder*

*Natural History*, Volume 103, Number 2, February 1994 (p. 14)

### **Hoffman, Paul** 1934–

American writer

...sometimes serious scientific problems are solved by a scientific method that can be described only as playful.

*Playing for Keeps*

*Discover*, October 1990 (p. 4)

### **Huxley, Thomas Henry** 1825–95

English biologist

I am not afraid of the priests in the long-run. Scientific method is the white ant which will slowly but surely destroy their fortifications. And the importance of scientific methods in modern practical life — always growing and increasing — is the guarantee for the gradual emancipation of the ignorant upper and lower classes, the former of whom especially are the strength of the priests.

*Collected Essays* (Volume 3)

*Science and Education*

*Life and Letters* (p. 330)

Macmillan & Company Ltd. London, England. 1904

### **Kropotkin, Peter Alekseyevich** 1842–1921

Russian revolutionary and geographer

He who has once in his life experienced this joy of scientific creation will never forget it; he will be longing to renew it; and he cannot but feel with pain that this sort of happiness is the lot of so few of us, while so many could also live through it, — on a small or on a grand scale, — if scientific methods and leisure were not limited to a handful of men.

*Memoirs of a Revolutionist*

Part IV, I (p. 6)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

### **Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

We are committed to the scientific method, and measurement is the foundation of that method; hence we are prone to assume that whatever is measurable must be significant and that whatever cannot be measured may as well be disregarded.

*Human Nature and the Human Condition*

Chapter V (p. 78)

Random House, Inc. New York, New York, USA. 1959

### **Maxwell, James Clerk** 1831–79

Scottish physicist

Nature is a journal of science, and one of the several tests of a scientific mind is to discern the limits of the legitimate application of scientific methods.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

*Paradoxical Philosophy* (p. 759)

Dover Publications, Inc. New York, New York, USA. 1965

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The scientific method, as it is sometimes called, is a potentiation of common sense.

*Advice to a Young Scientist*

Chapter 11 (p. 93)

Basic Books, Inc., Publishers. New York, New York, USA. 1979

The accusation is sometimes directed against scientists that there is in reality no such thing as the scientific method, i.e., that there is no logically accountable and intellectually rigorous process by which we may proceed directly to the solution of a given problem. Scientific method works only in retrospect. This accusation is perfectly just but it doesn't in practice amount to anything more than saying that there is no set of cut-and-dried rules for writing a poem or passage of music or conducting any other imaginative exercise.

*The Cost-Benefit Analysis of Pure Research*

*Hospital Practice*, Sept 1973

Ask a scientist what he conceives the scientific method to be, and he will adopt an expression that is at once solemn and shifty-eyed; solemn because he feels he ought to declare an opinion; shifty-eyed, because he is wondering how to conceal the fact that he has no opinion to declare.

*Induction and Intuition in Scientific Thought*

Chapter I, Section 2 (p. 11)

American Philosophical Society. Philadelphia, Pennsylvania, USA. 1969

### **Pearson, Karl** 1857–1936

English mathematician

I assert that the encouragement of scientific investigation and the spread of scientific knowledge by largely inculcating scientific habits of mind will lead to more efficient citizenship and so to increased social stability. Minds trained to scientific methods are less likely to be led by mere appeal to the passions or by blind emotional excitement to sanction acts which in the end may lead to social disaster.

*The Grammar of Science*

Introductory, Section 3 (pp. 10–11)

Charles Scribner's Sons. London, England. 1892

**Pirsig, Robert M.** 1928–  
American writer

Traditional scientific method has always been at the very best, 20–20 hindsight. It's good for seeing where you've been.

*Zen and the Art of Motorcycle Maintenance: An Inquiry Into Values*  
Part III, Chapter xxiv (p. 280)  
William Morrow & Company, Inc. New York, New York, USA. 1974

When I think of formal scientific method an image sometimes comes to mind of an enormous juggernaut, a huge bulldozer — slow, tedious, lumbering, laborious, but invincible. It takes twice as long, five times as long, maybe a dozen times as long as informal mechanic's techniques, but you know in the end you're going to get it. There's no fault isolation problem in motorcycle maintenance that can stand up to it. When you've hit a really tough one, tried everything, racked your brain and nothing works, and you know that this time Nature has really decided to be difficult, you say, "Okay, Nature, that's the end of the nice guy," and you crank up the formal scientific method.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part II, Chapter 9 (p. 107)  
William Morrow & Company, Inc. New York, New York, USA. 1974

The real purpose of scientific method is to make sure Nature hasn't misled you into thinking you know something you don't actually know. There's not a mechanic or scientist or technician alive who hasn't suffered from that one so much that he's not instinctively on guard.... If you get careless or go romanticizing scientific information, giving it a flourish here and there, Nature will soon make a complete fool out of you.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part II, Chapter 9 (p. 108)  
William Morrow & Company, Inc. New York, New York, USA. 1974

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

Scientists who believe that the old, tried, and true is sufficient or who underestimate and fail to understand the need for change may soon be lost in a challenging and exciting period of history. But those who have the vision to see beyond the obvious, the wisdom to search for and recognize the truth, and the ability to apply basic knowledge for the good of mankind will find this period one of great reward and satisfaction.

Challenges to Editors of Scientific Journals  
*Science*, Volume 141, Number 3585, September 13, 1963 (p. 1017)

**Raymo, Chet** 1936–

American physicist and science writer

How is it that astronomers can tell such stories, stories more fabulous than any myth of gods and nymphs, when the ink of night offers to the eye only pinpricks of light?

The answer is both simple and complex. We look, we invent, we look again. We test our inventions against what we see, and we insist that our inventions be consistent with one another, that our stories of the stars be consistent with our stories of the earth, of life, and of matter and energy.... The story of the falling apple and the story of the stars must resonate together. Only then, when our stories of the world vibrate with a symphonic harmony, are we confident that our inventions partake of reality.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 19 (p. 175)  
The Viking Press. New York, New York, USA. 1991

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

Whatever knowledge is attainable, must be attained by scientific methods; and what science cannot discover, mankind cannot know.

*Religion and Science*  
Science and Ethics (p. 243)  
Henry Holt & Company. New York, New York, USA. 1935

Scientific method...consists mainly in eliminating those beliefs which there is reason to think a source of shocks, while retaining those against which no definite argument can be brought.

*Human Knowledge: Its Scope and Limits*  
Part III, Chapter III (p. 185)  
Simon & Schuster. New York, New York, USA. 1948

Scientific method...consists in observing such facts as will enable the observer to discover general laws governing facts of the kind in question.

*The Scientific Outlook*  
Chapter I (p. 15)  
George Allen & Unwin Ltd. London, England. 1931

In arriving at a scientific law there are three main stages: The first consists in observing the significant facts; the second in arriving at a hypothesis, which, if it is true, would account for these facts; the third is deducing from this hypothesis consequences which can be tested by observation. If the consequences are verified, the hypothesis is provisionally accepted as true, although it will usually require modification later on as a result of the discovery of further facts.

*The Scientific Outlook*  
Chapter II (p. 58)  
George Allen & Unwin Ltd. London, England. 1931

**Stansfield, William D.** 1930–

American biologist

Most scientific theories, however, are ephemeral. Exceptions will likely be found that invalidate a theory in one or more of its tenets. These can then stimulate a new round of research leading either to a more comprehensive theory or perhaps to a more restrictive (i.e., more precisely

defined) theory. Nothing is ever completely finished in science; the search for better theories is endless.

*The Science of Evolution*

Introduction (p. 8)

Macmillan Company. New York, New York, USA. 1977

The interpretation of a scientific experiment should not be extended beyond the limits of the available data. In the building of theories, however, scientists propose general principles by extrapolation beyond available data. When former theories have been shown to be inadequate, scientists should be prepared to relinquish the old and embrace the new in their never-ending search for better solutions. It is unscientific, therefore, to claim to have “proof of the truth” when all that scientific methodology can provide is evidence in support of a theory.

*The Science of Evolution*

Introduction (p. 8)

Macmillan Publishing Company. New York, New York, USA. 1977

**Skinner, Burrhus Frederick** 1904–90

American psychologist

Here was a first principle not formally recognized by scientific methodologists: When you run into something interesting, drop everything else and study it.

A Case History in Scientific Method

*The American Psychologist*, Volume 11, 1956 (p. 223)

**Skolimowski, Henryk** 1930–

Polish philosopher

We are the proud inheritors and perpetuators of the scientific tradition. But perhaps also the slaves of certain modes of thinking; subjects to a conceptual tyranny which we glorify, thus being perfect slaves — slaves who enjoy their imprisonment.

In A.J. Ayala (ed.)

*Studies in the Philosophy of Biology: Reduction and Related Problems*

Problems of Rationality in Biology (p. 213)

Macmillan & Company Ltd. London, England. 1974

**Sullivan, John William Navin** 1886–1937

Irish mathematician

To judge from the history of science, the scientific method is excellent as a means of obtaining plausible conclusions which are always wrong, but hardly as a means of reaching the truth.

The Justification of the Scientific Method

*The Athenaeum*, Number 4644, 2 May 1919 (p. 275)

**Tate, Allen** 1899–1979

American poet, teacher, and novelist

Scientific approaches, because each has its own partial conventions momentarily arrogating to themselves the authority of total explanation, must invariably fail to see all the experience latent in the work.

Critical Responsibility

*The New Republic*, Volume 51, Number 663, August 17, 1927 (p. 340)

**Tennant, F. R.**

No biographical data available

Half a century ago, it was taught that the scientific method is the sole means of approach to the whole realm of possible knowledge: that there were no reasonably propounded questions worth discussing to which its method was inapplicable. Such belief is less widely held today. Since many men of science became their own epistemologists, science has been more modest.

*Philosophical Theology* (Volume 1)

Chapter XIII (p. 333)

At The University Press. Cambridge, England. 1956

**Thomson, Sir George** 1892–1975

English physicist

The scientific method is not a royal road leading to discoveries in research, as Bacon thought, but rather a collection of pieces of advice, some general, some rather special, which may help to guide the explorer in his passage through the jungle of apparently arbitrary facts.

*The Inspiration of Science*

Chapter II (p. 7)

Oxford University Press, Inc. London, England. 1961

**Weisz, Paul B.** 1919–

German-born American chemical engineer and biomedical researcher

All science begins with observation, the first step of the scientific method. At once this delimits the scientific domain; something that cannot be observed cannot be investigated by science.

*Elements of Biology* (p. 40)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1965

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

For the true scientific method is this:

To trust no statements without verification,  
to test all things as rigorously as possible,  
to keep no secrets, to attempt no monopolies,  
to give out one’s best modestly and plainly,  
serving no other end but knowledge.

In William Beebe

*Edge of the Jungle*

Cover page (p. 1)

Garden City Publishing Company, Inc. Garden City, New York, USA. 1925

**Wolpert, Lewis** 1929–

British embryologist

Even distinguished philosophers of science... recognize the failure of philosophy to help understand the nature of science. They have not discovered a scientific method that provides a formula or prescriptions for how to make discoveries. But many famous scientists have given advice: try many things; do what makes

your heart leap; think big; dare to explore where there is no light; challenge expectation; cherchez le paradox; be sloppy so that something unexpected happens, but not so sloppy that you can't tell what happened; turn it on its head; never try to solve a problem until you can guess the answer; precision encourages the imagination; seek simplicity; seek beauty.... One could do no better than to try them all.

*The Unnatural Nature of Science*

Chapter 6 (p. 108)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

No one method, no paradigm, will capture the process of science. There is no such thing as the scientific method.

*The Unnatural Nature of Science*

Chapter 6 (p. 108)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

### **Zimmerman, Michael** 1946–

American biologist

Having a scientific outlook means being willing to divest yourself of a pet hypothesis, whether it relates to easy self-help improvements, homeopathy, graphology, spontaneous generation, or any other concept, when the data produced by a carefully designed experiment contradict that hypothesis. Retaining a belief in a hypothesis that cannot be supported by data is the hallmark of both the pseudoscientist and the fanatic. Often the more deeply held the hypothesis, the more reactionary is the response to nonsupportive data.

*Science, Nonscience, and Nonsense: Approaching Environmental Literacy*

Chapter Two (p. 37)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1995

## SCIENTIFIC MIND

### **Abbey, Edward** 1927–89

American environmentalist and nature writer

Any good poet, in our age at least, must begin with the scientific view of the world; and any scientist worth listening to must be something of a poet, must possess the ability to communicate to the rest of us his sense of love and wonder at what his work discovers.

*The Journey Home: Some Words in Defense of the American West*

Chapter 8 (p. 87)

E.P. Dutton & Company. New York, New York, USA. 1977

### **Ackerman, Edward A.** 1911–73

American geographer

The mind of the scientist, no less than that of the poet or musician, must be structured by thought and experience before it reaches the creative stage.

Where Is a Research Frontier?

*Annals of the Association of American Geographers*, Volume 30, 1931 (p. 433)

### **Bauer, Henry H.** 1931–

American chemist

Science progresses not because scientists as a whole are passionately open-minded but because different scientists are passionately closed-minded about different things.

*Scientific Literacy and the Myth of the Scientific Method*

Chapter 4 (p. 76)

University of Illinois Press. Urbana, Illinois, USA. 1992

### **Beveridge, William Ian Beardmore** 1908–

Australian zoologist

It is true that much time and effort is devoted to training and equipping the scientist's mind, but little attention is paid to the techniques of making the best use of it.

*The Art of Scientific Investigation*

Preface (p. viii)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

### **Compton, Karl Taylor** 1887–1954

American educator and physicist

Science requires straight and independent thinking. Every hypothesis or idea is capable of definite proof or disproof. The habit of mind that subjects every idea to rigid test is of utmost value. Much of the loose thinking in social, educational, political, and economic affairs would be avoided if the workers in these fields could be given a real training in accurate scientific thinking.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton*

*During the Years 1930–1949* (p. 39)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA.

1955

### **Dewey, John** 1859–1952

American philosopher and educator

The future of our civilization depends on the widening spread and deepening hold of the scientific habit of mind.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 11 (p. 137)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

### **Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

The true scientific mind is not to be tied down by its own conditions of time and space. It builds itself an observatory erected upon the border line of present, which separates the infinite past from the infinite future. From this sure post it makes its sallies even to the beginning and to the end of all things.

*The Poison Belt*

Chapter Three (p. 84)

The Macmillan Company. New York, New York, USA. 1964

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The scientific mind must have a faith which is science.

*The Complete Works of Ralph Waldo Emerson* (Volume 6)

The Conduct of Life

Chapter VI (p. 240)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

In scientific subjects, the natural remedy for dogmatism has been found in research. By temperament and training, the research worker is the antithesis of the pundit. What he is actively and constantly aware of is his ignorance, not his knowledge; the insufficiency of his concepts, of the terms and phrases in which he tries to excogitate his problems: not their final and exhaustive sufficiency. He is, therefore, usually only a good teacher for the few who wish to use their mind as a workshop, rather than to store it as a warehouse.

Eugenics, Academic and Practical

*Eugenics Review*, Volume 27, 1935

**Foster, Sir Michael** 1836–1907

English physiologist and educator

...the mind which has been already sharpened by the methods of one science takes a keener edge, and the more quickly, when it is put on the whetstone of another science, than does a mind which knows nothing of no science.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1898

Recent Advances in Science, and Their Bearing on Medicine and Surgery (p. 340)

Government Printing Office. Washington, D.C. 1899

**Kingsley, Charles** 1819–75

English clergyman and author

In one word, [scientific] men [have] acquired just the habit of mind which the study of Natural Science can give, and must give; for without it there is no use studying Natural Science; and the man who has not got that habit of mind, if he meddles with science, will merely become a quack and a charlatan, only fit to get his bread as a spirit-rapper, or an inventor of infallible pills.

*Town Geology*

Preface

D. Appleton & Company. New York, New York, USA. 1873

**Knickerbocker, William Skinkle** 1892–1972

American professor of English and author

...the scientific...mind produces many of the virtues which in old-fashioned courses of ethics were taught as objectively as a problem in geometry. Patience, endurance, humility, teachableness, honesty, accuracy — without these it is impossible for a scientist to work.

*Classics of Modern Science*

Preface

Alfred A Knopf. New York, New York, USA. 1927

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Kruger, Otto** 1885–1974

American actor

My mind is just as open as it ever was, professor. But it's a scientific mind, and there's no place in it for superstitions.

*Dracula's Daughter*

Film (1936)

**Large, E. C.**

No biographical data available

There were two age-old tendencies toward stagnation in scientific thought which those of youthful spirit had always to resist. One was the human weakness of accepting the uncorroborated say-so of eminent authorities, and the other was the human stupidity of regarding natural science as something divisible into watertight compartments.

*The Advance of the Fungi*

Chapter XXIII (p. 317)

Henry Holt & Company. New York, New York, USA. 1940

**Lévi-Strauss, Claude** 1908–

French social anthropologist and structuralist

The scientific mind does not so much provide the right answers as ask the right questions.

Translated by John and Doreen Weightman

*The Raw and the Cooked*

Overture (p. 7)

Harper & Row, Publishers. New York, New York, USA. 1975

**Maxwell, James Clerk** 1831–79

Scottish physicist

...one of the severest tests of a scientific mind is to discern the limits of the legitimate application of the scientific method.

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Paradoxical Philosophy (p. 759)

At The University Press. Cambridge, England. 1890

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

There is no such thing as a Scientific Mind. Scientists are people of very dissimilar temperaments doing different things in very different ways. Among scientists are collectors, classifiers and compulsive tidiers-up; many are detectives by temperament and many are explorers; some are artists and others artisans. There are poet-scientists and philosopher-scientists and even a few mystics. What sort of mind or temperament can all these people be supposed to have in common? Obligative scientists must be very



rare, and most people who are in fact scientists could easily have been something else instead.

*The Art of the Soluble*

Hypothesis and Imagination (p. 132)

Methuen & Company Ltd. London, England. 1967

**Menzel, Donald H.** 1901–76

American astronomer and astrophysicist

**Boyd, Lyle B.**

No biographical data available

The creative scientist, eternally curious, keeps an open mind toward strange phenomena and novel ideas, knowing that we have only begun to understand the universe we live in. He remembers, too, that Biot's discovery that meteorites were "stones from the sky" was at first greeted with disbelief, and he hopes never to be guilty or similar obtuseness. But an open mind does not mean credulity or a suspension of the logical faculties that are man's most valuable asset.

*The World of Flying Saucers: A Scientific Examination of a Major Myth of the Space Age*

Chapter VIII (p. 289)

Doubleday & Company, Inc. Garden City, New York, USA. 1963

**Pagels, Heinz R.** 1939–88

American physicist and science writer

I like to browse in occult bookshops if for no other reason than to refresh my commitment to science.

*The Dreams of Reason: The Computer and the Rise of the Sciences of Complexity*

Chapter 11 (p. 242)

Simon & Schuster. New York, New York, USA. 1988

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...the scientific attitude is in some degree unnatural to man; the majority of our opinions are wish-fulfillments, like dreams in the Freudian theory.

*The Scientific Outlook*

Chapter I (p. 16)

George Allen & Unwin Ltd. London, England. 1931

**Thomson, J. Arthur** 1861–1933

Scottish biologist

The scientific mood is especially marked by a passion for facts, by cautiousness of statement, by clearness of vision, and by a sense of the inter-relatedness of things.

*Introduction to Science*

Chapter I (p. 34)

Williams & Norgate Ltd. London, England. 1916

**Trotter, Wilfred** 1872–1939

British surgeon and sociologist

The truly scientific mind is altogether unafraid of the new, and while having no mercy for ideas which have served their turn or shown their uselessness, it will not

grudge to any unfamiliar conception its moment of full and friendly attention, hoping to expand rather than to minimize what small core of usefulness it may happen to contain.

Observation and Experiment and Their Use in the Medical Sciences

*British Medical Journal*, Volume 2, 1930

**Valéry, Paul** 1871–1945

French poet and critic

Each mind can regard itself as a laboratory in which processes peculiar to the individual are used for transforming a substance common to all.

The results obtained by certain individuals are a source of wonderment to others. Starting out with ordinary carbon, one man produces a diamond, by means of temperatures and pressures that others never dreamt of. "Why, it's only carbon!" they say, after analyzing it. But they don't know how to do what he did.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

Analects (p. 482)

Princeton University Press. Princeton, New Jersey, USA. 1971

**Weidlein, Edward Ray**

Chemical engineer

A true scientist never grows old in his way of thinking. His mind is constantly working to improve his surroundings and to better understand the laws of nature. He expects to live in a changing world.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1938*

A World of Change (p. 199)

Government Printing Office. Washington, D.C. 1939

**Weil, Simone** 1909–43

French philosopher and mystic

A scientific conception of the world doesn't prevent one from observing what is socially fitting.

Translated by Arthur Wills

*The Need for Roots: Prelude to a Declaration of Duties Toward Mankind*

Part Three (p. 248)

The Beacon Press. Boston, Massachusetts, USA. 1952

**Weisskopf, Victor Frederick** 1908–2002

Austrian-American physicist

Some people maintain that scientific insight has eliminated the need for meaning. I do not agree. The scientific worldview established the notion that there is a sense and purpose in the development of the universe when it recognized the evolution from the primal explosion to matter, life, and humanity. In humans, nature begins to recognize itself.

*The Joy of Insight: Passions of a Physicist*

Chapter Fourteen (pp. 317–318)

Basic Books, Inc. New York, New York, USA. 1991

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The aim of scientific thought are to see the general in the particular and the eternal in the transitory.

*OMNI Magazine*

Volume 2, Number 41, November 1979

A man who only knows his own science, as a routine peculiar to that science, does not even know that. He has no fertility of thought, no power of quick seizing the bearing of alien ideas. He will discover nothing, and be stupid in practical applications.

*The Organisation of Thought*

Chapter II (p. 46)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

**SCIENTIFIC PROGRESS****Bush, Vannevar** 1890–1974

American electrical engineer and physicist

Scientific progress on a broad front results from free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for the exploration of the unknown.

*Science: The Endless Frontier*

Chapter I (p. 2)

United States Government Printing Office. Washington, D.C. 1945

**Compton, Karl Taylor** 1887–1954

American educator and physicist

The whole history of scientific progress illustrates the importance of free communication of ideas, of co-operative work at all levels, of adequate support and facilities, and above all, of high grade research workers and top-notch leadership.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 11)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

The geographical pioneer is now supplanted by the scientific pioneer... Without the scientific pioneer our civilization would stand still and our spirit would stagnate; with him mankind will continue to work toward his higher density. This being so, our problem is to make science as effective an element as possible in our American program for social progress.

*A Scientist Speaks: Excerpts from Addresses by Karl Taylor Compton During the Years 1930–1949* (p. 2)

Undergraduate Association, MIT. Cambridge, Massachusetts, USA. 1955

**Crick, Francis Harry Compton** 1916–2004

English biochemist

It can be confidently stated that our present knowledge of the brain is so primitive — approximately at the stage of

the four humours in medicine or of bleeding in therapy (what is psychoanalysis but mental bleeding?) — that when we do have fuller knowledge our whole picture of ourselves is bound to change radically. Much that is now culturally acceptable will then seem to be nonsense. People with training in the arts still feel that in spite of the alterations made in their life by technology — by the internal combustion engine, by penicillin, by the Bomb — modern science has little to do with what concerns them most deeply. As far as today's science is concerned this is partly true, but tomorrow's science is going to knock their culture right out from under them.

*Of Molecules and Men*

The Prospect Before Us (p. 94)

University of Washington Press. Seattle, Washington, USA. 1966

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

The most important scientific revolutions all include, as their only common feature, the dethronement of human arrogance from one pedestal after another of previous convictions about our centrality in the cosmos.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 13 (p. 164)

Random House, Inc. New York, New York, USA. 1995

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

The discovery of a law of Nature is always of great advantage to scientific progress. By the warp and woof of experiment, the man of science weaves a pattern from the threads of evidence, and presents the result to the world for anyone to improve.

*Discovery: Or the Spirit and Service of Science*

Chapter VII (p. 183)

Macmillan &amp; Company Ltd. London, England. 1918

**Jacob, François** 1920–

French biologist

Contrary to what I once thought, scientific progress did not consist simply in observing, in accurately formulating experimental facts and drawing up a theory from them. It began with the invention of a possible world, or a fragment thereof, which was then compared by experimentation with the real world. And it was this constant dialogue between imagination and experiment that allowed one to form an increasingly fine-grained conception of what is called reality.

In William Calvin

*The Cerebral Symphony: Seashore Reflections on the Structure of Consciousness*

Chapter 10 (p. 206)

Bantam Books. New York, New York, USA. 1989

**Mather, Kirtley F.** 1888–1978

American geologist

The more we know about the world, the more mysterious and marvelous it becomes. The arrogance which characterized so many scientists of preceding generations has given place to a true humility, admirably displayed by most of the leaders in contemporary scientific progress.

In Edward H. Cotton

*Has Science Discovered God?*

Sermons from Stones (p. 3)

Thomas Y. Crowell Company, Publishers. New York, New York, USA. 1931

**Trimble, George S.** d. 1863

No biographical data available

Actually the biggest deterrent to scientific progress is a refusal of some people, including scientists, to believe that things that seem amazing can really happen.

In Charles Berlitz and William Moore

*The Philadelphia Experiment: Project Invisibility* (p. 8)

Souvenir Press Ltd. London, England. 1979

**Virchow, Rudolf Ludwig Karl** 1821–1902

German pathologist and archaeologist

...if we would serve science, we must extend her limits, not only as far as our own knowledge is concerned, but in the estimation of others.

Translated by Frank Chase

*Cellular Pathology: As Based Upon Physiological and Pathological History*

Authors Preface (p. 7)

Dover Publications, Inc. New York, New York, USA. 1971

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

When science appears to be slowing down and, despite the efforts of many energetic individuals, comes to a dead stop, the fault is often to be found in a certain basic concept that treats the subject too conventionally. Or the fault may lie in a terminology which, once introduced, is unconditionally approved and adopted by the great majority, and which is discarded with reluctance even by independent thinkers, and only as individuals in isolated cases.

*Goethe's Botanical Writings*

An Attempt to Evolve a General Comparative Theory (p. 81)

University of Hawaii Press. Honolulu, Hawaii, USA. 1952

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

...Who put up that big City and Guilds place at South Kensington? Enterprising business men! They fancy they'll have a bit of science going on, they want a handy Expert ever and again, and there you are! And what do you get for research when you've done it? Just a bare living and no outlook. They just keep you to make discoveries, and if they fancy they'll use 'em they do.

*Tono-Bungay*

Book the Second, Chapter the Second, II (p. 156)

Duffield & Company. New York, New York, USA. 1921

## SCIENTIFIC PUBLISHING

**Agnew, Neil McK.**

No biographical data available

**Pyke, Sandra W.**

No biographical data available

...perhaps the most deceptive myth of all is that the Ph.D. represents the last hurdle in some kind of knowledge race. A student who has just cleared the jump should enjoy this illusion while it lasts. The science game now shifts to a new ground with new rules. Your rating first depends on getting some articles out; then, once you've demonstrated that you can publish, your rating depends on whether you are publishing in respectable journals; then your rating depends on whether you have a good book out; and then...

*The Science Game*

Chapter 12 (p. 146)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1969

**Arber, Agnes Robertson** 1879–1960

English botanist

A record of research should not resemble a casual pile of quarried stone; it should seem "not built, but born", as Vasari said in praise of a building.

*The Mind and the Eye: A Study of the Biologist's Standpoint*

Chapter V (p. 50)

At The University Press. Cambridge, England, USA. 1954

## Author undetermined

As this paper contains nothing which deserves the name either of experiment or discovery, and as it is, in fact, destitute of every species of merit, we should have allowed it to pass among the multitude of those articles which must always find their way into the collections of a society which is pledged to publish two or three volumes every year... We wish to raise our feeble voice against innovations, that can have no other effect than to check the progress of science, and renew all those wild phantoms of the imagination which Bacon and Newton put to flight from her temple.

Review of Dr. Young's Bakerian Lecture

*Edinburgh Review*, January 1803 (p. 450)

**Batchelor, G. K.** 1920–2000

English applied mathematics professor and fluid mechanics engineer

Reading a paper is a voluntary and demanding task, and a reader needs to be enticed and helped and stimulated by the author.

Preoccupations of a Journal Editor

*Journal of Fluid Mechanics*, Volume 106, 1981 (p. 8)

**Buckle, Henry Thomas** 1821–62  
English historian

The publications of our scientific authors overflow with minute and countless details, which perplex the judgment, and which no memory can retain. In vain do we demand that they should be generalized, and reduced into order. Instead of that, the heap continues to swell. We want ideas, and get more facts. We hear constantly what nature is doing, but we rarely hear what man is thinking.

*History of Civilization in England* (Volume 2)

Chapter VI (p. 396)

D. Appleton & Company, New York, New York, USA. 1891

**Casimir, Hendrik B. G.** 1909–2000  
Dutch physicist

I should like to find a way of discouraging unnecessary publications, but I have not found a solution, save the radical one...that all scientific papers be published anonymously.

In Praise of Smallness — How Can We Return to Small Science

*Perspectives in Biology and Medicine*, Volume 23, Number 3, Spring

1980 (p. 383)

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Scientific journals must remain the preserve of articles capable of affecting the consensus of the scientific public. Books are the place for opinions, speculations, and fanciful accounts of ricocheting planets. The publisher has only to convince enough buyers to cover their cost of publication. In a free society with a vigorous press, there is little danger that an important idea will not get a fair hearing.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 8 (pp. 149–150)

Oxford University Press, Inc. New York, New York, USA. 1993

**Comroe, Jr., Julius H.** 1911–84  
American physician

Almost every scientist working today can get his work published, somewhere, once he decides to “write it up”; maybe it will be in the Bulletin of the Podunk Medical Society rather than in a journal with international prestige or readership, or maybe it will be published only as an abstract. The main determinant of what is or is not published therefore seems to be the scientist, for it is he who decides to become or not to become an author.

Publish and/or Perish

*American Review of Respiratory Disease*, Volume 113, 1976

**Dubos, René Jules** 1901–82  
French-born American microbiologist and environmentalist

...a scientific paper should never try to make more than one point.

In B.D. Davis

Two Perspectives

*Perspectives in Biology and Medicine*, Volume 35, Number 1, Autumn

1991 (p. 38)

**Dyson, Freeman J.** 1923–  
American physicist and educator

Most of the papers which are submitted to the Physical Review are rejected, not because it is impossible to understand them, but because it is possible. Those which are impossible to understand are usually published.

Innovation in Physics

*Scientific American*, Volume 199, Number 3, September 1958

**Elder, Joseph**  
No biographical data available

Publication is the end-product of research. Research without publication is sterile.

Jargon—Good and Bad

*Science* Volume 119, Number 3095, 23 April 1954 (p. 536)

**Gastel, Barbara**  
American medical science writing educator

Every master’s thesis or doctoral dissertation should be accompanied by a lay summary or press release written by the graduate student (with the guidance, if possible, of a science writing instructor or public information officer at the student’s institution).

*Earth and Life Science Editing*, Volume 24, 1985 (p.3)

**Gelernter, David** 1955–  
Computer scientist

Scientists nowadays rarely know how to read seriously. They are accustomed to strip-mining a paper to get the facts out and then moving on, not to mollycoddling the thing in search of nuances; there probably aren’t any.

In John Brokman and Katinka Matson (eds.)

*How Things Are: A Tool Kit For the Mind*

Study Talmud (p. 213)

William Morrow & Company, Inc. New York, New York, USA. 1995

**Glaisher, James Whitbread Lee** 1848–1928  
English mathematician

In other branches of science, where quick publication seems to be so much desired, there may possibly be some excuse for giving to the world slovenly or ill-digested work, but there is no excuse in mathematics. The form ought to be as perfect as the substance, and the demonstrations as rigorous as those of Euclid. The mathematician has to deal with the most exact facts of Nature, and he should spare no effort to render his interpretation worthy of his subject, and to give to his work its highest degree of perfection.

Presidential Address, British Association for the Advancement of Science, *Nature*, Section A (1890), Volume 42 (p. 467)

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

I do not know when the technical and popular prose of science became separated, although I accept the inevitability of such a division as knowledge became increasingly more precise, detailed, and specialized. We have now reached the point where most technical literature not only falls outside the possibility of public comprehension but also (as we would all admit in honest moments) outside our own competence in scientific disciplines far removed from our personal expertise. I trust that we all regard this situation as saddening, even though we accept its necessity.

Take Another Look

*Science*, Volume 286, Number 5441, October 29, 1999 (p. 899)

**Hagstrom, Warren O.**

No biographical data available

Manuscripts submitted to scientific periodicals are often called “contributions,” and they are, in fact, gifts. Authors do not usually receive royalties or other payments, and their institutions may even be required to aid in the financial support of the periodical. On the other hand, manuscripts for which the scientific authors do receive financial payments, such as textbooks and popularizations, are, if not despised, certainly held in much lower esteem than articles containing original research results.

*The Scientific Community*

Basic Books, Inc. New York, New York, USA. 1965

**Haldane, John Burdon Sanderson** 1892–1964

English biologist

Four stages of acceptance: i) this is worthless nonsense; ii) this is an interesting, but perverse, point of view; iii) this is true, but quite unimportant; iv) I always said so.

*Journal of Genetics*, Volume 58 (p. 464)

**Hudson, Jeffrey**

No biographical data available

There’s this desert prison... with an old prisoner, resigned to his life, and a young one just arrived. The younger one talks constantly of escape, and, after a few months, he makes a break. He’s gone a week, and then he’s brought back by the guard. He’s half dead, crazy with hunger and thirst. He describes how awful it was to the old prisoner. The endless stretches of sand, no oasis, no sign of life anywhere. The old prisoner listens for awhile, then says. “Yep. I know. I tried to escape myself, twenty years ago.” The younger prisoner says “You did? Why didn’t you tell me, all these months I was planning my escape? Why didn’t you let me know it was impossible?” And the old prisoner shrugs, and says, “So who publishes negative results?”

*A Case of Need*

Tuesday, 11 October

Nine (p. 121)

The World Publishing Company. New York, New York, USA. 1968

**Huth, Edward Janavel** 1923–

American physician

Why should the investigators confine themselves to one paper when they can slice up data and interpretations into two, three, five, or more papers that will better serve their needs when they face promotion or tenure committees? “Salami science” does not always equal baloney, but such divided publication is often an abuse of scientific publication.

Irresponsible Authorship and Wasteful Publication

*Annals of Internal Medicine*, Volume 104, 1986

**Ingle, Dwight J.** 1907–78

Biologist and endocrinologist

Science cannot be equated to measurement, although many contemporary scientists behave as though it can. For example, the editorial policies of many scientific journals support the publication of data and exclude the communication of ideas.

*Principles of Research in Biology and Medicine*

Chapter 1 (p. 3)

Lippincott. Philadelphia, Pennsylvania, USA. 1958

**Kennedy, Donald**

No biographical data available

All the thinking, all the textual analysis, all the experiments and the data-gathering aren’t anything until we write them up. In the world of scholarship we are what we write.

*Academic Duty* (p. 186)

Harvard University Press. Cambridge, Massachusetts, USA. 1997

**Maslow, A. H.** 1908–70

American psychologist

I do not recall seeing in the literature with which I am familiar any paper that criticized another paper for being unimportant, trivial or inconsequential.

*Motivation and Personality*

Chapter 2 (p. 14)

Harper & Row, Publishers. New York, New York. 1970

**Mayo, William J.** 1861–1939

American physician

Reading papers is not for the purpose of showing how much we know and what we are doing, but is an opportunity to learn.

The Value of the Weekly General Staff Meeting

*Proceedings of Staff Meetings, Mayo Clinic*, Volume 10, January 30, 1935

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

...it is no use looking to scientific “papers,” for they not merely conceal but actively misrepresent the reasoning that goes into the work they describe.... Nor is it any use listening to accounts of what scientists say they do, for their opinions vary widely enough to accommodate almost any methodological hypothesis we may care to devise. Only unstudied evidence will do — and that means listening at a keyhole.

*The Art of the Soluble*

Hypothesis and Imagination (p. 151)

Methuen & Company Ltd. London, England. 1967

**Nelkin, Dorothy** 1933–2003

American sociologist

...too often science in the press is more a subject for consumption than for public scrutiny, more a source of entertainment than of information. Too often science is presented as an arcane activity outside and above the sphere of normal human understanding, and therefore beyond our control. Too often the coverage is promotional and uncritical, encouraging apathy, a sense of impotence, and the ubiquitous tendency to defer to expertise.

*Selling Science: How the Press Covers Science and Technology*  
Chapter 10 (p. 173)

W.H. Freeman & Company. New York, New York, USA. 1995

**Price, Derek John de Solla** 1922–83

English science historian and information scientist

...scientists have a strong urge to write papers but only a relatively mild one to read them.

*Little Science, Big Science*

Chapter 3 (pp. 69–70)

Columbia University Press. New York, New York, USA. 1963

**Rowland, Henry Augustus** 1848–1901

American physicist

A hermit philosopher we can imagine might make many useful discoveries. Yet, if he keeps them to himself, he can never claim to have benefited the world in any degree. His unpublished results are his private gain, but the world is not better off until he has made them known in language strong enough to call attention to them and to convince the world of their truth.

*The Physical Papers of Henry Augustus Rowland*

The Highest Aim of the Physicist (p. 669)

Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Schrödinger, Erwin** 1887–1961

Australian theoretical physicist

...a typical scientific paper has never pretended to be more than another little piece in a larger jigsaw — not significant in itself but as an element in a grander scheme. This technique, of soliciting many modest contributions to the vast store of human knowledge, has been the secret of Western science since the seventeenth century, for it

achieves a corporate, collective power that is far greater than any one individual can exert.

Information, Communication, Knowledge  
*Nature*, Volume 224, Number 5217, October 25, 1969 (p. 324)

Primary scientific papers are not meant to be final statement of indisputable truths; each is merely a tiny tentative step forward, through the jungle of ignorance.

Information, Communication, Knowledge  
*Nature*, Volume 224, Number 5217, October 25, 1969 (p. 324)

**Shrady, George**

No biographical data available

The time is already past when any man can hope to rise to be an authority in any department of medical science through any royal road of social influence, political manipulations, or even personal charms. Those who are to be the leaders and guides of medical science for the coming generation must earn their position by persistent, original investigation, and by faithfully recording their experience in the permanent literature of the day.

Medical Authorship  
*Medical Record*, Volume 2, 1867

**Simpson, Michael A.**

No biographical data available

We still consistently overvalue poor research and semi-literate publication; again, partly, because quantity, in number of publications, is easier to measure than quality.

A Mythology of Medical Education  
*Lancet*, Volume 3, 1974

**Wilson, Logan**

No biographical data available

Results unpublished are little better than those never achieved.... One must write something and get it into print. Situational imperatives dictate a “publish or perish” credo within the ranks.

*The Academic Man: A Study in the Sociology of a Profession* (p. 197)  
Oxford University Press, Inc. London, England. 1942

**Woolley, Sir Charles Leonard** 1880–1960

English archaeologist

The prime duty of the field archaeologist is to collect and set in order material with not all of which he can himself deal at first hand. In no case will the last word be with him; and just because that is so his publication of the material must be minutely detailed, so that from it others may draw not only corroboration of his views but fresh conclusions and more light.

*Digging Up the Past*  
Chapter V (pp. 133–134)  
Charles Scribner’s Sons. New York, New York, USA. 1931

**Ziman, John M.** 1925–2005

British physicist

The moment of truth for many young scientists comes when they first act as a referee for a scientific paper; having striven for years to get their own work published against the criticism of anonymous referees, they find themselves, by psychological role-reversal, on the other side of the fence. Thus do we eventually internalize the “scientific attitude.”

*Reliable Knowledge*

Chapter 6 (fn 13, p. 132)

Cambridge University Press. Cambridge, England. 1978

## SCIENTIFIC SPIRIT

**Bernard, Claude** 1813–78

French physiologist

In my opinion the true scientific spirit is that whose high aspiration fertilize the sciences and draw them on in search of truths which are still beyond them but which must not be suppressed, because they have been attacked by stronger and more delicate philosophic minds.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter III, Section iv (p. 223)

Henry Schuman, Inc. New York, New York, USA. 1927

**Clifford, William Kingdon** 1845–79

English philosopher and mathematician

There is no scientific discoverer, no poet, no painter, no musician, who will not tell you that he found ready made his discovery or poem or picture — that it came to him from outside, and that he did not consciously create it from within.

In Leslie Stephen and Frederick Pollock (eds.)

*Lectures and Essays* (Volume 1)

Some of the Conditions of Mental Development (p. 99)

Macmillan & Company Ltd. London, England. 1879

The subject of science is the human universe; that is to say, everything that is, or has been, or may be related to man.

In Leslie Stephen and Frederick Pollock (eds.)

*Lectures and Essays* (Volume 1)

On the Aims and Instruments of Scientific Thought (p. 126)

Macmillan & Company Ltd. London, England. 1879

**Compton, Arthur H.** 1892–1962

American physicist

The spirit of science knows no national or religious boundaries, and it is thus a powerful force for the peace of the world.

*Les Prix Nobel. The Nobel Prizes in 1927*

Nobel banquet speech for award received in 1927

Nobel Foundation. Stockholm, Sweden. 1928

**Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

Furnished as all Europe now is with Academies of Science, with nice instruments and the spirit of experiment, the progress of human knowledge will be rapid and discoveries made of which we have at present no conception. I begin to be almost sorry I was born so soon, since I cannot have the happiness of knowing what will be known a hundred years hence.

*The Writings of Benjamin Franklin*

Letter, July 27, 1783, to naturalist Sir Joseph Banks (p. 74)

Macmillan & Company Ltd. London, England. 1906

**Garrod, Archibald** 1857–1936

English physician

...scientific method is not the same as the scientific spirit. The scientific spirit does not rest content with applying that which is already known, but is a restless spirit, ever pressing forward towards the regions of the unknown....

*Archibald Garrod and the Individuality of Man*

Chapter 7 (p. 82)

Clarendon Press. Oxford, England. 1993

**Hocking, W. E.** 1873–1966

American philosopher

We are scientific people and we want our students to feel the enthusiasm and promise of the scientific method. We want them to feel the moral quality of exact technique, as exact as the subject matter permits. We want them to feel that science is a spiritual experience.

In Lloyd William Taylor

*Physics: The Pioneer Science* (Volume 1)

Chapter 6 (p. 63)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Huxley, Thomas Henry** 1825–95

English biologist

...the scientific spirit is of more value than its products, and irrationally held truths may be more harmful than reasoned errors. Now the essence of the scientific spirit is criticism. It tells us that whenever a doctrine claims our assent we should reply, “Take it if you can compel it.” The struggle for existence holds as much in the intellectual as in the physical world. A theory is a species of thinking, and its right to exist is coextensive with its power of resisting extinction by its rivals.

*Collected Essays* (Volume 2)

*Darwiniana*

The Coming of Age of “The Origin of Species” (p. 229)

Macmillan & Company Ltd. London, England. 1904

**Millikan, Robert Andrews** 1868–1953

American physicist

The God of science is the Spirit of rational order, and of orderly development. Atheism as I understand it is the denial of the existence of the spirit. Nothing could therefore be more antagonistic to the whole spirit of science.

*Evolution in Science and Religion*

Chapter III (p. 88)  
Yale University Press. New Haven, Connecticut, USA. 1927

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

...the scientific spirit requires a man to be at all times ready to dump his whole cartload of beliefs, the moment experience is against them.

In Justus Buchler (ed.)  
*Philosophical Writings of Peirce*  
Chapter 4 (pp. 46–47)  
Dover Publications, Inc. New York, New York, USA. 1955

**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

The essence of the scientific spirit is to use the past only as a springboard to the future.

In A.A. Warner, Dean Morse, and T.E. Cooney (eds.)  
*The Environment of Change*  
The Revolution in Science (p. 47)  
Columbia University Press. New York, New York, USA. 1969

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science, of course, is not the only way of giving sense to our lives. Art does it; so does religion. But when this sense is missing, that's when spiritual pollution is present, when people don't know why they are here. We can have leisure time diversions, of course. But until we learn to fill the vacuum in our minds with content — with meaning, with sense — we will never find solutions to our problems.

*The Privilege of Being a Physicist*  
Chapter 13 (p. 107)  
W.H. Freeman & Company. New York, New York, USA. 1989

## SCIENTIFIC TRENDS

**Cooper, Leon** 1930–  
American physicist

I like to say sometimes that scientific fashion is like fashion in men's and women's clothes.... One year the ties are wide; the next year they're narrow. One year the skirts are high; the next year they're low. And if everyone is wearing a short skirt, you're just hopelessly out of fashion if you're wearing a long skirt. That's the way it sometimes seems with science. You want to be in the middle of what everyone is talking about; you want to be in the mainstream. And the next year it might be something completely different.

In George Johnson  
*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*  
A Model of Memory (p. 149)  
Alfred A. Knopf. New York, New York, USA. 1991

## SCIENTIFIC TRUTH

**Agassiz, Jean Louis Rodolphe** 1807–73  
Swiss-born American naturalist, geologist, and teacher

...the time has come when scientific truth must cease to be the property of the few, when it must be woven into the common life of the world; for we have reached the point where the results of science touch the very problem of existence, and all men listen for the solving of that mystery.

*Methods of Study in Natural History*  
Chapter IV (p. 42)  
Ticknor & Fields. Boston, Massachusetts, USA. 1863

**Black, Max** 1909–88  
Anglo-American philosopher

Scientists can never hope to be in a position to know the truth, nor would they have any means of recognizing it if it came into their possession.

*Critical Thinking: An Introduction to Logic and Scientific Method*  
Chapter 19 (p. 396)  
Prentice-Hall. New York, New York, USA. 1952

**Broad, William** 1951–  
Science writer

**Wade, Nicholas**  
British-born scientific writer

Like any other profession, science is ridden with clanishness and clubbiness. This would be in no way surprising, except that scientists deny it to be the case. The pursuit of scientific truth is held to be a universal quest that recognizes neither national boundaries nor the barriers of race, creed or class. In fact, researchers tend to organize themselves into clusters of overlapping clubs.

*Betrayers of the Truth*  
Chapter 9 (p. 180)  
Simon & Schuster. New York, New York, USA. 1982

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

The initial incommunicability of truth, scientific or otherwise, shows that we think in groves, and that it is painful for us to be torn away from the womblike security of accepted concepts.

*Heraclitean Fire: Sketches from a Life Before Nature*  
Part II  
The Exquisiteness of Minute Differences (p. 86)  
Rockefeller University Press. New York, New York, USA. 1978

**Crichton, Michael** 1942–  
American novelist

Scientists have an elaborate line of bullshit about how they are seeking to know the truth about nature.

*Jurassic Park*  
Aviary (p. 284)  
Alfred A. Knopf. New York, New York, USA. 1990



**Dunne, Finley Peter** 1867–1936

American journalist and humorist

There's always wan encouragin' thing about th' sad scientific facts that come out ivry week in th' pa-papers. They're usually not thrue.

*Mr. Dooley on Making a Will and Other Necessary Evils*

On the Descent of Man (p. 90)

Charles Scribner's Sons. New York, New York, USA. 1919

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Amid all our faulty attempts at expression the kernal of scientific truth steadily grows; and of this truth it may be said — The more it changes, the more it remains the same.

*The Nature of the Physical World*

Conclusion (p. 353)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-born physicist

It is difficult even to attach a precise meaning to the term “scientific truth.” Thus the meaning of the word “truth” varies according to whether we deal with a fact of experience, a mathematical proposition, or a scientific theory. “Religious truth” conveys nothing clear to me at all.

*Ideas and Opinions*

On Scientific Truth (p. 261)

Crown Publishers, Inc. New York, New York, USA. 1954

**Feynman, Richard P.** 1918–88

American theoretical physicist

No government has the right to decide on the truth of scientific principles, nor to prescribe in any way the character of the questions investigated.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter II (p. 57)

Perseus Books. Reading, Massachusetts, USA. 1998

**Geikie, Sir Archibald** 1835–1924

English geologist

In scientific as in other mundane questions there may often be two sides, and the truth may ultimately be found not to lie wholly with either.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1892*

Geological Change and Time (p. 125)

Government Printing Office. Washington, D.C. 1893

**Gesenius, Wilhelm** 1786–1842

German orientalist and biblical critic

Unwearing personal observation and an impartial examination of the researches of others; the grateful admission and adoption of every real advance and illustration of science; but also a manly foresight and caution, which does not with eager levity adopt every novelty thrown out in

haste and from the love of innovation, all these must go hand in hand, wherever scientific truth is to be successfully promoted.

*Hebrew Grammar*

Preface (p. 7)

Gould, Kendall & Lincoln. Boston, Massachusetts, USA. 1834

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

It is necessary to believe in the holiness of scientific work in order to preserve to the end; for without the encouragement which such belief gives, many investigators would fall by the wayside.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 12–13)

Macmillan & Company Ltd. London, England. 1918

Scientific truth is not won by prayer and fasting, but by patient observation and persistent inquiry.

*Discovery; or, The Spirit and Service of Science*

Chapter I (p. 12)

Macmillan & Company Ltd. London, England. 1918

**Hawkins, Michael** 1942–

British astrophysicist

“Scientific truths” is simply another way of saying “the fittest, most beautiful, and most elegant survivors of scientific debate and testing.”

*Hunting Down the Universe: The Missing Mass, Primordial Black Holes, and Other Dark Matters*

Chapter 1 (p. 6)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1997

**Hoagland, Hudson** 1899–1982

American physiologist

In a scientific oriented society the quest for truth is the important thing, even though we know that ultimate, final truth with a capital T is not to be found.

Science and the New Humanism

*Science*, Volume 143, Number 3062, 10 January 1964 (p. 112)

**Inscription**

The works of those who have stood the test of ages have a claim to that respect and veneration to which no modern can pretend.

On the dome of the National Gallery

**Jeffers, Robinson** 1887–1962

American poet

...they work alongside the truth

Never touching it; their equations are false

But the things work.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Mathematicians and Physics Men (p. 459) Stanford University Press. Stanford, California, USA. 1988

**Lee, Oliver Justin** 1881–1964  
American astronomer

The truth to a scientist is not the vague metaphysical concept about which philosophers talk and write so much and know so little. To him truth is that body of statements and conclusions about any set of features and phenomena in nature which represent most accurately all the best observations he can make and which conform most closely to all findings in adjacent or related phases and fields of investigations. He may and does often wonder what the so-called ultimate truth may be, but he does not worry about it. He knows that a priori pure thinking will never reveal it so far as knowledge of the physical universe is concerned, and that observation and deduction alone in the manner of science will ever do it.

*Measuring Our Universe: From the Inner Atom to Outer Space*  
Chapter 14 (pp. 149–150)  
The Ronald Press Company. New York, New York, USA. 1950

**Maxwell, James Clerk** 1831–79  
Scottish physicist

For the sake of these different types, scientific truth should be presented in different forms, and should be regarded as equally scientific, whether it appears in the robust form of vivid colouring of a physical illustration, or in the tenuity and paleness of a symbolical expression.

*The Collected Papers of James Clerk Maxwell* (Volume 2)  
Chapter XLI, Address to the Mathematical and Physical Sections of the British Association, September 15, 1870 (p. 220)  
At the University Press. Cambridge, England. No data

**Mendeléeff, Maria** ca. 1800–ca. 1850  
Siberian factory manager and mother of Russian chemist Dmitri Mendeléeff

Refrain from illusions, insist on work, and not on words, patiently search divine and scientific truth.

In Benjamin Harrow  
*Eminent Chemists of Our Time*  
Dmitri Ivanowitch Mendeléeff (p. 22)  
D. Van Nostrand Company, Inc. New York, New York, USA. 1927

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

For a superficial observer, scientific truth is beyond the possibility of doubt; the logic of science is infallible, and if the scientists are sometimes mistaken, this is only from their mistaking its rules.

*The Foundations of Science*  
Science and Hypothesis, Introduction (p. 27)  
The Science Press. New York, New York, USA. 1913

**Raymo, Chet** 1936–  
American physicist and science writer

Science is not a smorgasbord of truths from which we can pick and choose.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 16 (p. 144)  
The Viking Press. New York, New York, USA. 1991

Scientific truths are tentative and partial, and subject to continual revision and refinement, but as we tinker with truth in science — amending here, augmenting there — we always keep our ear attuned to the timbre of the web.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*  
Chapter 16 (p. 145)  
The Viking Press. New York, New York, USA. 1991

**Renan, Ernest** 1823–92  
French philosopher and Orientalist

Orthodox people have as a rule very little scientific honesty. They do not investigate, they try to prove, and this must necessarily be so. The result has been given to them beforehand; this result is true, undoubtedly true. Science has no business with it, science which starts from doubt without knowing whither it is going, and gives itself up bound hand and foot to criticism which leads it where-soever it lists.

*The Future of Science*  
Chapter III (p. 33)  
Roberts Brothers. Boston, Massachusetts, USA. 1893

**Serge, Corrado**  
No biographical data available

Many times a scientific truth is placed as it were on a lofty peak, and to reach it we have at our disposal at first only dark paths along perilous slopes whence it is easy to fall into the abysses where dwells error; only after we have reached the peak by these paths is it possible to lay out safe roads which lead there without peril. Thus it has frequently happened that the first way of obtaining a result has not been quite satisfactory, and that only afterwards did the science succeed in completing the demonstration.

On Some Tendencies in Geometric Investigations  
*Bulletin of the American Mathematical Society*, 2<sup>nd</sup> Series, Volume 10,  
June 1904 (pp. 453–454)

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

In the Middle Ages people believed that the earth was flat, for which they at least had the evidence of their senses: we believe it to be round, not because as many as one percent of us could give the physical reasons for so quaint a belief, but because modern science has convinced us that nothing that is obvious is true, and that everything that is magical, improbable, extraordinary, gigantic, microscopic, heartless, or outrageous is scientific.

*Man and the Gods: Three Tragedies*  
Saint Joan, Preface, The Real Joan Is Not Marvellous for Us (p. 132)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1964

**Spencer, Herbert** 1820–1903  
English social philosopher

Scientific truths, of whatever order, are reached by eliminating perturbing or conflicting factors, and recognizing only fundamental factors.

*The Data of Ethics*

Chapter XV, Section 104 (p. 311)

William & Norgate. London, England. 1907

**Thomas, Lewis** 1913–93

American physician and biologist

The only solid piece of scientific truth about which I feel totally confident is that we are profoundly ignorant about nature.

*The Medusa and the Snail: More Notes of a Biology Watcher*

The Hazard of Science (p. 73)

The Viking Press. New York, New York, USA. 1979

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The eye which can appreciate the naked and absolute beauty of a scientific truth is far more rare than that which is attracted by a moral one. Few detect the morality in the former, or the science in the latter.

*The Writings of Henry David Thoreau* (Volume 1)

A Week on the Concord and Merrimack Rivers

Friday (p. 476)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Weaver, Warren** 1894–1978

American mathematician

...[one] finds unresolved and apparently unresolvable disagreement among scientists concerning the relationship of scientific thought to reality — and concerning the nature of reality itself...that the explanations of science have utility, but that they do in sober fact not explain. He finds that the old external appearance of inevitability completely vanished, for he discovers a charming capriciousness in all the individual events. He finds that logic, so generally supposed to be infallible and unassailable, is in fact shaky and incomplete. He finds that the whole concept of objective truth is a will-o-the-wisp.

The Imperfections of Science

*American Scientist*, Volume 49, 1961 (pp. 99–113)

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Scientific truth is the remotest of mistresses; She hides in strange places, she is attained by tortuous and laborious roads, but she is always there! Win to her and she will not fail you; she is yours and mankind's forever. She is reality, the one reality I have found in this strange disorder of existence...

*Tono-Bungay*

Book the Third, Chapter the Third, I (p. 324)

Duffield & Company. New York, New York, USA. 1921

## SCIENTIFIC WORK

**Einstein, Albert** 1879–1955

German-born physicist

To be sure, it is not the fruits of scientific research that elevate a man and enrich his nature, but the urge to understand, the intellectual work, creative or receptive.

*Ideas and Opinions*

Good and Evil (p. 12)

Crown Publishers, Inc. New York, New York, USA. 1954

**Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

The concept that the scientific worker can regard himself as an inert item in a vast co-operative concern working according to accepted rules is encouraged by directing attention away from his duty to form correct scientific conclusions, to summarize them and to communicate them to his scientific colleagues, and by stressing his supposed duty mechanically to make a succession of automatic “decisions”...

*Statistical Methods and Scientific Inference*

Chapter IV (p. 101)

Hafner Publishing Company. New York, New York, USA. 1959

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Take from your scientific work a serious and incorruptible method of thought, help to spread it, because no understanding is possible without it. Revere those things beyond science which really matter and about which it is so difficult to speak.

*Philosophic Problems of Nuclear Science*

Chapter 8 (p. 128)

Faber & Faber Ltd. London, England. 1952

**Huxley, Thomas Henry** 1825–95

English biologist

The only people, scientific or other, who never make mistakes are those who do nothing.

*Collected Essays* (Volume 5)

*Science and Christian Traditions*

An Episcopal Trilogy (p. 156)

Macmillan & Company Ltd. London, England. 1904

**Lorand, Arnold**

American physician and prolongevity advocate

...we have often observed in persons whose lives have been devoted to serious scientific work, which has entirely absorbed them, a total absence of sexual desire for a long time, and even impotence.

*Old Age Deferred*

Chapter XLIX (p. 399)

F.A. Davis Company, Publishers. Philadelphia, Pennsylvania, USA.

1911

**Payne-Gaposchkin, Cecelia** 1900–79  
British-American astronomer

Do not undertake a scientific career in quest of fame or money. There are easier and better ways to reach them. Undertake it only if nothing else will satisfy you; for nothing else is probably what you will receive. Your reward will be the widening of the horizon as you climb. And if you achieve that reward you will ask no other.

*Cecilia Payne-Gaposchkin: An Autobiography and Other Recollections*  
Chapter 22 (p. 227)  
Cambridge University Press. New York, New York, USA. 1984

**Rosenthal-Schneider, Ilse** 1891–1990  
German physicist and author of history and philosophy of science

The deep satisfaction found in scientific work, akin to the delight derived from genuine art, is one of the fundamental human emotions which is highly intensified by personal contact with the creative mind.

In Paul Arthur Schlipp (ed.)  
*Albert Einstein: Philosopher-Scientist*  
Presuppositions and Anticipations in Einstein's Physics (p. 145)  
The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Snow, Charles Percy** 1905–80  
English novelist and scientist

Scientific work...has a value of its own, whether you're liking it or not. It's — there. It's permanent. It's work which is always going to last. It's a real creation.

*The Search*  
Part IV, Chapter II, Section II (p. 326)  
The Bobbs-Merrill Company. Indianapolis, Indiana, USA. 1935

**Weber, Max** 1864–1920  
German founder of modern sociology and economic thinker

In science, each of us knows that what he has accomplished will be antiquated in ten, twenty, fifty years. That is the fate to which science is subjected; it is the very meaning of scientific work, to which it is devoted in a quite specific sense, as compared with other spheres of culture.... Every scientific "fulfillment" raises new "questions"; it asks to be surpassed and outdated. Whoever wishes to serve science has to resign himself to this fact.... We cannot work without hoping that others will advance further than we have.

In H.H. Gerth and C. Wright Mills (eds.)  
*From Max Weber: Essays in Sociology*  
Science as a Vocation (p. 138)  
Oxford University Press, Inc. New York, New York, USA. 1970

## SCIENTIST

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

You can't possibly be a scientist if you mind people thinking that you're a fool.

*The Ultimate Hitchhiker's Guide to the Galaxy*  
So Long And Thanks For All The Fish  
Chapter 31 (p. 587)  
The Ballantine Book Company. New York, New York, USA. 2002

**Agnew, Ralph Palmer**  
American mathematician

Scientists, like professional golfers and piano players, should sometimes concentrate upon a task until they can perform it with professional skill.

*Differential Equations*  
Chapter 1, Problem 1.49 (p. 16)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1972

**Appleton, Sir Edward** 1892–1965  
English physicist

It seems to me that we must recognize that the proper use of science is one of the most important challenges of the present day. And here I think the scientist has a twofold mission, not only of extending the frontiers of knowledge but also of interpreting his results to his fellow-men.

*Les Prix Nobel. The Nobel Prizes in 1947*  
Nobel banquet speech for award received in 1947  
Nobel Foundation. Stockholm, Sweden. 1948

**Appleyard, Bryan** 1951–  
Author and journalist

Scientists inevitably take on the mantle of the wizards, sorcerers and witch doctors. Their miracle cures are our spells, their experiments our rituals.

*Understanding the Present: Science and the Soul of Modern Man*  
Chapter 1 (p. 9)  
Doubleday. New York, New York, USA. 1992

**Artuad, Antonin** 1896–1948  
French poet, actor, and director

But how is one to make a scientist understand that there is something unalterably deranged about differential calculus, quantum theory, or the obscene and so inately liturgical ordeals of the precession of the equinoxes — ....

In Susan Sontag  
*Selected Writings*  
Part 33, Van Gogh, the Man Suicided by Society (p. 497)

**Auden, W. H.** 1907–72  
English-born poet

The true men of action in our time, those who transform the world, are not the politicians and statesmen, but the scientists.

*The Dyer's Hand*  
Part II, The Poet and The City (p. 81)  
Random House. New York, New York, USA. 1962

When I find myself in the company of scientists, I feel like a shabby curate who has strayed by mistake into a drawing room full of dukes.

*The Dyer's Hand*

Part II, *The Poet and The City* (p. 81)  
Random House. New York, New York, USA. 1962

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

Those who have treated of the sciences have been either empirics or dogmatical. The former like ants only heap up and use their store, the latter like spiders spin out their own webs. The bee, a mean between both, extracts matter from the flowers of the garden and the field, but works and fashions it by its own efforts. The true labor of philosophy resembles hers, for it neither relies entirely nor principally on the powers of the mind, nor yet lays up in the memory of matter afforded by the experiments of natural history and mechanics in its raw state, but changes and works it in the understanding.

In *Great Books of the Western World* (Volume 30)  
*Novum Organum*  
First Book, Aphorism 95 (p. 126)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Baker, Russell** 1925–  
American writer and journalist

Two leading Congressional scientists, Senator Helms and Representative Hyde, have been doing pioneering research on the nature of life. This has produced the Helms–Hyde theory which states that scientific fact can be established by a majority vote of the United States Congress.

*The Rescue of Miss Yaskel and Other Pipe Dreams*  
Congdon & Weed. New York, New York, USA. 1983

**Barr, Amelia Edith Huddleston** 1831–1919  
Anglo-American novelist

Whatever the scientists may say, if we take the supernatural out of life, we leave only the unnatural.

*All the Days of My Life*  
Chapter 26 (p. 477)  
Arno Press. New York, New York, USA. 1980

**Beveridge, William Ian Beardmore** 1908–  
Australian zoologist

The scientist who has an independent mind and is able to judge the evidence on its merits rather than in light of prevailing conceptions is the one most likely to be able to realize the potentialities in something really new.

*The Art of Scientific Investigation*  
Chapter Three (p. 35)  
W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Every sentence I utter must be understood not as an affirmation, but as a question.

*New York Times Book Review*, October 20, 1957

**Born, Max** 1882–1970  
German-born English physicist

It seems to me that the scientists who led the way to the atomic bomb were extremely skillful and ingenious, but not wise men. They delivered the fruits of their discoveries unconditionally into the hands of politicians and soldiers; thus they lost their moral innocence and their intellectual freedom...

*The Restless Universe*  
Postscript (p. 280)  
Dover Publications, Inc. New York, New York, USA. 1951

**Brain, Lord Walter Russell** 1895–1966  
British neurologist

Scientists...meet one another to exchange ideas, to promote their own particular branch of science, or science in general, or because they are aware of its social implications. Nevertheless, such collective activities...play a small part in their lives. Scientists, though they must always be aware of the work of their fellows in their own fields, are essentially individualists; and the body of knowledge to which they are contributing is an impersonal one. Apart from contributing to it, they have no collective consciousness, interest, or aim.

*Science and Antiscience*  
*Science*, Volume 148, Number 3667, April 1965 (p. 193)

**Brewster, Edwin Tenney** 1866–1960  
Educator

For scientific people are after all precisely like the rest of us, and can no more resist — most of them — the urge to speculate where they can not prove than other men can.

*This Puzzling Planet*  
Chapter XIX (p. 301)  
The Bobbs-Merrill Company, Indianapolis, Indiana. 1928

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Dissent is the native activity of the scientist, and it has got him into a good deal of trouble in the last years. But if that is cut off, what is left will not be a scientist. And I doubt whether it will be a man.

*Science and Human Values*  
*The Sense of Human Dignity* (p. 61)  
Harper & Row, Publishers. New York, New York, USA. 1965

The society of scientists must be a democracy. It can keep alive and grow only by a constant tension between dissent and respect; between independence from the view of others, and tolerance from them.

*Science and Human Values*  
*The Sense of Human Dignity* (pp. 62–63)  
Harper & Row, Publishers. New York, New York, USA. 1965

The most remarkable discovery made by scientists is science itself.

*A Sense of the Future: Essays in Natural Philosophy*  
Chapter 2 (p. 6)  
The MIT Press. Cambridge, Massachusetts, USA. 1977

It is important that students bring a certain ragamuffin, barefoot irreverence to their studies; they are not here to worship what is known, but to question it.

*The Ascent of Man*  
Chapter 11 (p. 360)  
Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Buchanan, Scott** 1895–1968  
American educator and philosopher

The scientist is the contemporary monk copyist, writing over old literature on the palimpsest of experience, triumphantly announcing his faithfulness and accuracy in transferring the copy.

*Poetry and Mathematics*  
Chapter I  
The University of Chicago Press. Chicago, Illinois, USA. 1975

**Buck, Pearl S.** 1892–1973  
American author

No one really understood music unless he was a scientist, her father had declared, and not just a scientist, either, oh, no, only the real ones, the theoreticians, whose language mathematics. She had not understood mathematics until he had explained to her that it was the symbolic language of relationships. “And relationships,” he had told her, “contained the essential meaning of life.”

*The Goddess Abides*  
Part I  
John Day Company. New York, New York, USA. 1972

**Burroughs, William S.** 1914–97  
American writer

Too many scientists seem to be ignorant of the most rudimentary spiritual concepts. And they tend to be suspicious, bristly, paranoid-type people with huge egos they push around like some elephantiasis victim with his distended testicles in a wheelbarrow terrified no doubt that some skulking ingrate of a clone student will sneak into his very brain and steal his genius work.

*The Adding Machine: Selected Essays*  
Immortality (p. 132)  
Seaver Books. New York, New York, USA. 1986

**Calder, Alexander** 1898–1976  
American sculptor and inventor of the mobile

Scientists leave their discoveries, like foundlings, on the doorstep of society, while the stepparents do not know how to bring them up.

In Alan J. Friedman and Carol C. Donley  
*Einstein as Myth and Muse*  
Chapter 1 (p. 7)  
Cambridge University Press. Cambridge, England. 1985

**Chargaff, Erwin** 1905–2002  
Austrian biochemist

Great scientists are particularly worth listening to when they speak about something of which they know little; in their own specialty they are usually great and dull.

*Heraclitean Fire: Sketches from a Life before Nature*  
Part II  
The Hereditary Code-Script (p. 85)  
Rockefeller University Press. New York, New York, USA. 1978

...outside his own ever-narrowing field of specialization, a scientist is a layman. What members of an academy of science have in common is a certain form of semiparasitic living.

*Bitter Fruits from the Tree of Knowledge*  
*Perspectives in Biology and Medicine*, Section III, Volume 16, Number 4, Summer 1973 (p. 492)

A scientific autobiography belongs to a most awkward literary genre. If the difficulties facing a man trying to record his life are great — and few have overcome them successfully — they are compounded in the case of scientists, of whom many lead monotonous and uneventful lives and who, besides, often do not know how to write...

Book Review of *The Double Helix*  
*Science*, Volume 159, Number 3822, 29 March 1968 (p. 1448)

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

Apparently a scientist is a man who surveys all the sciences, without any particular study of them, and then gives expression to his own moral principles or prejudices.

*All Is Grist: A Book of Essays*  
On Mr. Mencken and Fundamentalism (p. 50)  
Methuen & Company Ltd. London, England. 1931

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong.

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 2 (p. 14)  
Harper & Row, Publishers. New York, New York, USA. 1973

...scientists of over fifty are good for nothing except board meetings and should at all costs be kept out of the laboratory!

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 2 (pp. 14–15)  
Harper & Row, Publishers. New York, New York, USA. 1973

**Conant, James Bryant** 1893–1978  
American educator and scientist

...scientists today represent the progeny of one line of descent who migrated, so to speak, some centuries ago into certain fields which were ripe for cultivation. Once science had become self-propagating, those who till these fields have had a relatively easy time keeping up the tradition of their forebears.

*Science and Common Sense*

Chapter One (p. 13)

Yale University Press. New Haven, Connecticut, USA. 1951

**Cornforth, John W.** 1917–2004

English organic chemist

Scientists do not believe; they check.

Scientists as Citizens

*Australian Journal of Chemistry*, Volume 46, 1993 (p. 266)

**Cousteau, Jacques-Yves** 1910–77

French naval officer and ocean explorer

What is a scientist after all? It is a curious man looking through a keyhole, the keyhole of nature, trying to know what's going on.

*Christian Science Monitor*, 21 July 1971

**Cramer, F.**

No biographical data available

In the long run it pays the scientist to be honest, not only by not making false statements, but by giving full expression to facts that are opposed to his views. Moral sloveness is visited with far severer penalties in the scientific than in the business world.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Eleven (p. 142)

W.W. Norton & Company, Inc. New York, New York, USA. 1957

**Crichton, Michael** 1942–

American novelist

I sometimes think scientists really don't notice that their colleagues have flaws. But in my experience scientists are very human people: which means that some are troubled, deceitful, petty or vain.

*Science Views Media*, January 25, 1999

**Cronenberg, David** 1943–

Canadian film director

...everybody's a mad scientist, and life is their lab. We're all trying to experiment to find a way to live, to solve problems, to fend off madness and chaos.

In Chris Rodley

*Cronenberg on Cronenberg*

Chapter 1 (p. 7)

Faber & Faber Ltd. London, England. 1992

**de Jouvenel, Bertrand** 1903–87

French man of letters

No one can become a scientist who is not driven by a primary urge for discovery, who is not the ardent suitor of a hidden beauty. Somewhat romantically, scientists can be likened to a company of knights dispersed in search of Sleeping Princesses, all of whom are more or less distantly related. The spirit of the quest is essential to the making of a scientist, and forms a fundamental bond between scientists.

*The Logic of Personal Knowledge*

The Republic of Science

The Free Press. Glencoe, Illinois, USA. 1961

**de Madariaga, Salvador** 1886–1978

Spanish writer and statesman

There are two kinds of scientists: they were once described...as the "why" and the "how." The how-scientist is mainly interested in the way things happen; the why-scientist seeks to find out the cause of things. The first is more of a technician; the second, more of a philosopher. The first is more of a man of talent; the second, more of a man of genius.

*Essays with a Purpose*

Science and Freedom (p. 43)

Hollis & Carter. London, England. 1954

**Devine, Betsy**

No biographical data available

**Cohen, Joel E.**

No biographical data available

Scientists are funny people. Not just the great ones who think they've discovered the secret of life or of the brain or of the common cold. Even ordinary day-to-day scientists are funny, because they all think that the world makes sense! Most people know better.

*Absolute Zero Gravity: Science Jokes, Quotes, and Anecdotes*

Fireside/Simon & Shuster. New York, New York, USA.

**Dr. Kemp**

Fictional character

Straightforward scientists have no need for barred doors and drawn blinds.

*The Invisible Man*

Film (1933)

**du Noüy, Pierre Lecomte** 1883–1947

French scientist

The scientist with imagination is the pioneer of progress.

*The Road to Reason*

Chapter 3 (p. 81)

Longmans, Green & Company. London, England. 1949

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

Scientists, like artists, unavoidably reflect the characteristics of the civilization and the time in which they live.

In this sense, they are “enchained”...by the inexorable logic of their time and their work.

*Louis Pasteur: Free Lance of Science*

Introduction (p. xxxviii)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

...like other men, scientists become deaf and blind to any argument or evidence that does not fit into the thought pattern which circumstances have led them to follow.

*Louis Pasteur: Free Lance of Science*

Chapter VII (p. 197)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Dyson, Freeman J.** 1923–

American physicist and educator

When something ceases to be mysterious it ceases to be of absorbing concern to scientists. Almost all the things scientists think and dream about are mysterious.

*Infinite in All Directions*

Part One, Chapter Two (p. 14)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

**Egler, Frank E.** 1911–96

American botanist and ecologist

Scientists are only men, and are subject to all the foibles of their kind. They have the same drives for freedom, security, certainty, image and status as have other men. ...the same attraction for the known the familiar and the comfortable, and will cling to old and sterile ideas like a broody hen sitting on boiled eggs. Like those others, there is a lunatic fringe, and a reasonable quota of social misfits, small-pool big-frogs, megalomaniacs, prima donnas, nymphomaniacs, gold diggers, entrepreneurs, prophets and devout disciples.

*The Way of Science*

The Nature of Science (p. 1)

Hafner Publishing Company. New York, New York, USA. 1970

**Einstein, Albert** 1879–1955

German-born physicist

The eyes of the scientist are directed upon those phenomena which are accessible to observation, upon their apprehension and conceptual formulation.

*Concepts of Space: The History of Theories of Space in Physics*

Preface (p. xi)

Harvard University Press. Cambridge, Massachusetts, USA. 1954

For the scientist, there is only “being,” but no wishing, no valuing, no good, no evil — in short, no goal. As long as we remain within the realm of science proper, we can never encounter a sentence of the type: “Thou shalt not lie.”

In Philipp Frank

*Relativity — A Richer Truth*

The Laws of Science and the Laws of Ethics (p. 9)

Jonathan Cape. London, England. 1951

...the scientist finds his reward in what Henri Poincaré calls the joy of comprehension, and not in the possibilities of application to which any discovery may lead.

In Max Planck

*Where Is Science Going?*

Epilogue (p. 211)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Emelyanov, A. S.**

No biographical data available

A scientist cannot be a “pure” mathematician, biophysicist or sociologist for he cannot remain indifferent to the fruits of his work, to whether they will be useful or harmful to mankind. An indifferent attitude as to whether people will be better or worse off as a result of scientific achievement is cynicism, if not a crime.

In E.H.S. Burhop In Maurice Goldsmith and Alan Mackay (eds.)

*Society and Science*

Scientist and Public Affairs (p. 31)

Simon & Schuster. New York, New York, USA. 1965

**England, Terry**

No biographical data available

...if three scientists ever agree completely on anything, it’s a cult.

*Rewind* (p. 71)

Avon Books. New York, New York, USA. 1997

**Eysenck, Hans Jurgen** 1916–97

Founder of theory of personality

Scientists, especially when they leave the particular field in which they have specialized, are just as ordinary, pig-headed and unreasonable as anybody else.

Continuum

*OMNI Magazine*, Volume 2, December 1979 (p. 49)

**Faulkner, William** 1897–1962

American novelist and short story writer

Our privacy...has been slowly and steadily and increasingly invaded until now our very dream of civilization is in danger. Who will save us but the scientist and the humanitarian? Yes, the humanitarian in science, and the scientist in the humanity of man.

Quoted in Warren Weaver

Science and People

*Science*, Volume 122, Number 3183, December 30, 1955 (p. 1259)

**Feibleman, James K.** 1904–1987

American philosopher

It is not the business of scientists to investigate just what the business of science is.

Pure Science, Applied Science, Technology, Engineering: An Attempt at Definitions

*Technology and Culture*, Volume II, Number 4, Fall 1961 (p. 305)

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science



Scientists are sculptors of reality — but sculptors in a special sense. They do not merely act causally upon the world (though they do that, too, and they have to if they want to “discover” new entities); they also create semantic conditions engendering strong inferences from known effects to novel projections and, conversely, from the projections to testable effects.

Realism and the Historicity of Knowledge

*The Journal of Philosophy*, Volume LXXXVI, Number 8, 1989 (pp. 404–405)

**Feynman, Richard P.** 1918–88

American theoretical physicist

It is our responsibility as scientists, knowing the great progress which comes from a satisfactory philosophy of ignorance, the great progress which is the fruit of freedom of thought, to proclaim the value of this freedom; to teach how doubt is not to be feared but welcomed and discussed; and to demand this freedom as our duty to all coming generations.

*What Do You Care What Other People Think?*

The Value of Science (p. 248)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

I would like to point out that people are not honest. Scientists are not honest at all, either. It's useless. Nobody's honest. Scientists are not honest. And people usually believe that they are. That makes it worse. By honest I don't mean that you only tell what's true. But you make clear the entire situation. You make clear all the information that is required for somebody else who is intelligent to make up their mind.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter III (p. 106)

Perseus Books. Reading, Massachusetts, USA. 1998

**Finniston, Sir Monty** 1912–91

British industrialist

You mustn't think scientists are stupid.

Saying of the Week

*Observer*, 16 January 1983

**Fitzgerald, Penelope** 1916–2000

English novelist and biographer

If they don't depend on true evidence, scientists are no better than gossips.

*The Gate of Angels*

Chapter 3 (p. 24)

Doubleday & Company, New York, New York, USA. 1992

**Foster, Alan Dean** 1946–

American science fiction writer

A man of science is helpless by himself, but two of them constitute an entity capable of ignoring starvation, freezing, and prospects of imminent death just by chatting about some item of mutual interest.

*Icerigger* (p. 116)

Ballantine Books. New York, New York, USA. 1974

**Fox, Robin** 1934–

English anthropologist, poet, and essayist

The real poet, like any artist, tries all the time to see the general in the particular. In this he is no different from the scientist. They are siblings under the skin.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 343)

New York Academy of Sciences. New York, New York, USA. 1996

Scientists, being children of Adam, can be fools and charlatans or even just blind and biased. Indeed, my own despair at the “academic/scientific enterprise” which raised the initial question is a despair over the inevitability of human frailty, not over the ideals of scientific discovery.

In Paul R. Gross, Norman Levitt, and Martin W. Lewis (eds.)

*The Flight from Science and Reason*

State of the Art/Science in Anthropology (p. 329)

New York Academy of Sciences. New York, New York, USA. 1996

**Freud, Sigmund** 1856–1939

Austrian neurologist and co-founder of psychoanalysis

I am not really a man of science, not an observer, not an experimenter, and not a thinker. I am nothing but by temperament a conquistador — an adventurer if you want to translate the word.

Mighty Minds (1900 letter to Fleiss)

*New Scientist*, 4 April 1998 (p. 11)

**Fuller, R. Buckminster** 1895–1983

American engineer and architect

...public journals, assumedly bespeaking public opinion, [say] scientists “wrest order out of chaos.” But the scientists who have made the great discoveries have been trying their best to tell the public that...they have never found chaos to be anything other than the superficial confusion of innately a priori human ignorance at birth — an ignorance that is often burdened by the biases of others to remain gropingly unenlightened throughout its life.

In L.L. Larison Cudmore

*The Center of Life: A Natural History of the Cell* (p. xi)

New York Times Book Company. New York, New York, USA. 1977

What the scientists have always found by physical experiment was an a priori orderliness of nature, or Universe always operating at an elegance level that made the discovering scientist's working hypotheses seem crude by comparison. The discovered reality made the scientists' exploratory work seem relatively disorderly.

In L.L. Larison Cudmore

*The Center of Life: A Natural History of the Cell* (p. xi)

New York Times Book Company. New York, New York, USA. 1977

**Galston, Arthur William** 1920–  
American plant biologist

In my view, the only recourse for a scientist concerned about the social consequences of his work is to remain involved with it to the end.

Science and Social Responsibility  
*Annals of the New York Academy of Science*, Volume 196, 1972 (p. 223)

**Galton, Sir Francis** 1822–1911  
English anthropologist, explorer, and statistician

A special taste for science seems frequently to be so ingrained in the constitution of scientific men, that it asserts itself throughout their whole existence.

In Karl Pearson  
*The Life, Letters and Labours of Francis Galton* (Volume 2) (p. 152)  
At The University Press. Cambridge, England. 1914–30

**Gardner, Martin** 1914–  
American writer and mathematics games editor

When reputable scientists correct flaws in an experiment that produced fantastic results, then fail to get those results when they repeat the test with flaws corrected, they withdraw their original claims. They do not defend them by arguing irrelevantly that the failed replication was successful in some other way, or by making intemperate attacks on whomever dares to criticize their competence.

Reply to Claims for ESP  
*The New York Review of Books*, February 19, 1981

**Gauss, Johann Carl Friedrich** 1777–1855  
German mathematician, physicist, and astronomer

A taste for the abstract sciences in general and, above all, for the mysteries of numbers, is very rare: this is not surprising, since the charms of this sublime science in all their beauty reveal themselves only to those who have the courage to fathom them. But when a woman, because of her sex, our customs, and prejudices, encounters infinitely more obstacles than men in familiarizing herself with their knotty problems, yet overcomes these fetters and penetrates that which is most hidden, she doubtless has the most noble courage, extraordinary talent, and superior genius.

Letter, Carl Friedrich Gauss to Sophie Germain, 30 April, 1807

**Gell-Mann, Murray** 1929–  
American physicist

But the practitioners of science are, after all, human beings. They are not immune to the normal influences of egotism, economic self-interest, fashion, wishful thinking and laziness. A scientist may try to steal credit, knowingly initiate a worthless project for gain, or take a conventional idea for granted instead of looking for a better explanation. From time to time scientists even fudge

their results, breaking one of the most serious taboos of their profession.

*The Quark and the Jaguar: Adventures in the Simple and the Complex* (p. 80)  
W.H. Freeman & Company. New York, New York, USA. 1994

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

A scientist without imagination is a butcher with dull knives and out-worn scales.

*Sand and Foam: A Book of Aphorisms* (p. 46)  
Alfred A. Knopf. New York, New York, USA. 1959

**Glashow, Sheldon L.** 1932–  
American physicist

Many scientists are deeply religious in one way or another, but all of them have a certain rather peculiar faith — they have a faith in the underlying simplicity of nature; a belief that nature is, after all, comprehensible and that one should strive to understand it as much as we can. Now this faith in simplicity, that there are simple rules — a few elementary particles, a few quantum rules to explain the structure of the world — is completely irrational and completely unjustifiable. It is therefore a religion.

*The Quantum Universe*  
Coproduced by WETA-TV and The Smithsonian Institution (1990).

**Gleck, James** 1954–  
American author, journalist, and essayist

Scientists still ask the what if questions. What if Edison had not invented the electric light — how much longer would it have taken? What if Heisenberg had not invented the S matrix? What if Fleming had not discovered penicillin? Or (the king of such questions) what if Einstein had not invented general relativity? “I always find questions like that...odd,” Feynman wrote to a correspondent who posed one. Science tends to be created as it is needed. “We are not that much smarter than each other,” he said.

*Genius: The Life and Science of Richard Feynman*  
Caltec (p. 329)  
Pantheon Books. New York, New York, USA. 1992

Children and scientists share an outlook on life. If I do this, what will happen? is both the motto of the child at play and the defining refrain of the physical scientist...

The unfamiliar and the strange — these are the domain of all children and scientists.

*Genius: The Life and Science of Richard Feynman*  
The Rockaway (p. 19)  
Pantheon Books. New York, New York, USA. 1992

**Goldenweiser, Alexander** 1880–1940  
American anthropologist

The scientist, when in his laboratory, is craftsman and inventor in one. He also faces nature as a learner. Like

the craftsman, he is prepared to commit errors and, having learned from them, to revise his procedure. Like the inventor, he is after something new, he plans his experiments deliberately, watches carefully, ever on the alert for a promising lead — a discovery.

*Robots or Gods*

Chapter IV (p. 44)

Alfred A. Knopf. New York, New York, USA. 1931

A scientist who is no longer capable of framing a hypothesis — or never was — is not a scientist but a methodological fossil.

*Robots or Gods*

Chapter IV (p. 48)

Alfred A. Knopf. New York, New York, USA. 1931

### Goldstein, A.

No biographical data available

Science is always a race...and scientists are competitive people. Because the monetary rewards are minimal, they go for ego rewards....

In J. Goldberg

*Anatomy of a Scientific Discovery*

Locks and Keys (p. 25)

Bantam Books. Toronto, Ontario, Canada. 1988

### Gornick, Vivian

American critic, essayist, and memoirist

To do science today is to experience a dimension unique in contemporary working lives; the work promises something incomparable: the sense of living both personally and historically. That is why science now draws to itself all kinds of people — charlatans, mediocrities, geniuses — everyone who wants to touch the flame, feel alive in the time.

*Women in Science: Portraits from a World in Transition*

Part One (p. 26)

Simon & Schuster. New York, New York, USA. 1983

Whatever a scientist is doing — reading, cooking, talking, playing — science thoughts are always there at the edge of the mind. They are the way the world is taken in; all that is seen is filtered through an everpresent scientific musing.

*Women in Science: Portraits from a World in Transition*

Part One (p. 39)

Simon & Schuster. New York, New York, USA. 1983

### Gray, George W.

Freelance science writer

The modern scientist is like a detective who finds clues, but never gets a glimpse of the fugitive he seeks.

New Eyes of the Universe

*The Atlantic Monthly*, Volume 155, Number 5, May 1935 (p. 607)

### Harding, Rosamund E. M.

No biographical data available

If the scientist has, during the whole of his life, observed carefully, trained himself to be on the look-out for analogy and possessed himself of relevant knowledge, then the “instrument of feeling”...will become a powerful divining rod leading the scientist to discover order in the midst of chaos by providing him with a clue, a hint, or an hypothesis upon which to base his experiments.

*An Anatomy of Inspiration*

Chapter V (p. 86)

W. Heffer & Sons Ltd. Cambridge, England. 1940

### Harnwell, G. P. 1903–1982

No biographical data available

The motivations of the pure scientist would appear to many at first thoughts as whimsical and abstract as the immediate results he achieves. The briefest explanation of why he works is curiosity rather than the necessity of earning a livelihood.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1939*

Our Knowledge of Atomic Nuclei (p. 189)

Government Printing Office. Washington, D.C. 1940

### Heinlein, Robert A. 1907–88

American science fiction writer

Most “scientists” are bottle washers and button sorters.

*Time Enough for Love*

Intermission (p. 257)

G.P. Putnam’s Sons. New York, New York, USA. 1973

### Hight, Gilbert 1906–78

American classicist

There are naive people all over the world — some of them scientists — who believe that all problems, sooner or later, will be solved by Science. The word Science itself has become a vague reassuring noise, with a very ill-defined meaning and a powerful emotional charge: It is now applied to all sorts of unsuitable subjects and used as a cover for careless and incomplete thinking in dozens of fields. But even taking Science at the most sensible of its definitions, we must acknowledge that it is imperfect as are all activities of the human mind.

*Man’s Unconquerable Mind*

Part Two, Chapter 4 (p. 106)

Cambridge University Press. New York, New York, USA. 1954

### Hogan, James P. 1946–

English writer of hard science fiction

Scientists are the easiest to fool...They think in straight, predictable, directable, and therefore misdirectable, lines. The only world they know is the one where everything has a logical explanation and things are what they appear to be. Children and conjurers — they terrify me. Scientists are no problem; against them I feel quite confident.

*Code of the Lifemaker*

Chapter I (p. 14)

Ballantine Books. New York, New York, USA. 1983

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

The scientist who now takes off his shoes knows that the place whereon he stands is holy ground. Science is reverent and speaks with lowered voice, for she has caught glimpses of mysteries undefinable, and to her have come thoughts that are beyond speech. Science cultivates the receptive heart and hospitable mind, and her prayer is for more light, and to that prayer the answer is even now coming.

In Albert Lane

*Elbert Hubbard and His Work* (p. 100)

The Blanchard Press. Worcester, Massachusetts, USA. 1901

**Hubble, Edwin Powell** 1889–1953

American astronomer

Scientists in general are not very articulate; they work in comparative seclusion and they do not cultivate the art of persuasion.

*The Nature of Science and Other Lectures*

Part I, The Nature of Science (p. 3)

The Huntington Library. San Marino, California, USA. 1954

The scientist, in his purely scientific moods, seeks to understand the world — not to reform it, not to control it, but merely to understand it.

*The Nature of Science and Other Lectures*

Part I, Science and Technology (p. 20)

The Huntington Library. San Marino, California, USA. 1954

**Huggins, Charles** 1901–1997

Canadian born-American surgeon

...there are two kinds of scientists — The “gee whiz” kind and the “so what” kind. Flies around the urine cause the first type to exclaim: “Gee whiz, what could that mean?” whereas the other says: “so what, let’s clean up this mess and get on with a proper experiment.”

In Elwood V. Jensen

*The Science of Science*

*Perspectives in Biology and Medicine*, Volume 12, Number 2, Winter 1969 (p. 283)

**Hull, David L.** 1935–

American philosopher of biology

From the beginning of their careers, scientists are presented with a dilemma. They can make their work look as conventional as possible — just one more brick in the edifice of science — or as novel and controversial as possible — declaring a whole new theory or possibly even a whole new science.... From my own reading of the recent history of science, I see no strong correlation between my own estimates of the novelty of an idea and the strategy that an author adopts.

*Science as a Process: An Evolutionary Account of the Social and Conceptual Development of Science*

Chapter Six (p. 202)

The University of Chicago Press. Chicago, Illinois, USA. 1988

**Husserl, Edmund** 1859–1938

German philosopher

When it is actually natural science that speaks, we listen gladly and as disciples. But it is not always natural science that speaks when natural scientists are speaking...

Translated by W.R. Boyce Gibson

*Ideas: General Introduction to Pure Phenomenology*

Second Chapter, Section 20 (p. 86)

George Allen & Unwin Ltd. London, England. 1931

**Ian**

Fictional character

Your scientists were so preoccupied with whether or not they could, they didn’t stop to think if they should.

*Jurassic Park*

Film (1993)

**Imhof, Peter**

German computer scientist and social science modeler

...scientists are not a select few intelligent enough to think in terms of “broad sweeping theoretical laws and principles.” Instead, scientists are people specifically trained to build models that incorporate theoretical assumptions and empirical evidence. Working with models is essential to the performance of their daily work; it allows them to construct arguments and to collect data.

Tools for Thinking (book review)

*Science*, Volume 287, 1935–1936

**Ingram, Jay** 1945–

Canadian author and television host

The caricature of the nerdy scientist in his/her lab coat, complete with pocket protector, uttering incomprehensible jargon is bad enough. But the implied character of the person behind the wardrobe is worse: strait-jacketed by conservatism, too quick to demand hard data, hell-bent on reducing life’s mysteries to uninteresting sets of numbers and graphs. ...The truth is that scientists love a mystery as much as anyone (it’s their business to chase mysteries after all) even when...there is almost no chance it will be solved. Why? Because it’s intriguing, challenging, and fun.

*The Barmaid’s Brain and other Strange Tales from Science*

The Burning Mirrors of Syracuse

**Jensen, Elwood V.**

No biographical data available

Research among the less imaginative scientists has been likened to a fox-hunt. A creative investigator shouts “Tally-ho”, and the entire troop rides off in the same direction.

*The Science of Science*

*Perspectives in Biology and Medicine*, Volume 12, Number 2, Winter 1969 (p. 278)

**Katscher, F.**

No biographical data available

That great scientists were believing Christians does not prove anything. In this century many free-thinkers have also made great contributions to science, scientific thinking and ethical questions regarding the application of science.

Correspondence

*Nature*, Volume 363, Number 6428, 3 June 1993 (p. 390)

**Killian, Jr., James R.** 1904–88

American manager

The scientist, it is repeatedly said, should be on tap but not on top. He thus is considered to be merely one of the hired men who has no business doing anything but what he is told to do in the field of his specialty.... I do not imply that the scientist has any right or unique qualifications to be on top. I am disturbed by the attitude that because a man is a scientist, he is disqualified for public and private administrative responsibility even though he may have the qualifications.

The Shortage Re-Examined

*American Scientist*, Spring, April 1956 (p. 126)

**Kingsley, Charles** 1819–75

English clergyman and author

[Scientists] Good men, honest men, accurate men, righteous men, patient men, self-restraining men, fair men, modest men. Men who are aware of their own vast ignorance compared with the vast amount that there is to be learned in such a universe as this. Men who are accustomed to look at both sides of a question; who, instead of making up their minds in haste like bigots and fanatics, wait like wise men, for more facts, and more thought about the facts. *Town Geology*

Preface

D. Appleton & Company. New York, New York, USA. 1873

**Koestler, Arthur** 1905–83

Hungarian-born English writer

[Scientists are] Peeping Toms at the keyhole of eternity.

*The Roots of Coincidence*

Chapter 5, Section 9 (p. 140)

Random House. New York, New York, USA. 1972

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

No one devotes a lifetime to science in the hope of making small advances. Every scientist secretly or overtly hopes to make great discoveries.

*Blind Watchers of the Sky*

Chapter Two (p. 42)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1996

Most scientists spend their lives groping around trying to find their way, as if lost in a fog.

*Blind Watchers of the Sky*

Chapter Eight (p. 203)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Kornberg, Arthur** 1918–

American biochemist

A scientist...shouldn't be asked to judge the economic and moral value of his work. All we should ask the scientist to do is to find the truth — and then not keep it from anyone.

*San Francisco Examiner*, December 19, 1971

**Kuhn, Thomas S.** 1922–96

American historian of science

Scientists, it should already be clear, never learn concepts, laws, and theories in the abstract and by themselves. Instead, these intellectual tools are from the start encountered in a historically and pedagogically prior unit that displays them with and through their applications.

*The Structure of Scientific Revolutions*

Chapter V (p. 46)

The University of Chicago Press. Chicago, Illinois, USA. 1970

Though many scientists talk easily and well about the particular individual hypotheses that underlie a concrete piece of current research, they are little better than laypersons at characterizing the established basis of their field, its legitimate problems and methods. If they have learned such abstractions at all they show it mainly through their ability to do successful research.

*The Structure of Scientific Revolutions*

Chapter V (p. 47)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Larrabee, Eric** 1922–90

Historian

Perhaps the time has come for [scientists] to wonder about why they sometimes jar the nerves and try the patience of non-scientists.

...Scientists seem able to go about their business in a state of indifference to, if not ignorance of, anything but the going, currently acceptable doctrine of their several disciplines. ...

*Commentary*

Science and the Common Reader, June 1966 (p. 48)

The only thing wrong with scientists is that they don't understand science. They don't know where their own institutions come from, what forces shaped and are still shaping them, and they are wedded to an anti-historical way of thinking which threatens to deter them from ever finding out.

*Commentary*

Science and the Common Reader, June 1966 (p. 48)

**Lebowitz, Fran** 1951–  
American comedian

Scientists are rarely to be counted among the fun people. Awkward at parties, shy with strangers, deficient in irony — they have had no choice but to turn their attention to the close study of everyday objects.

*Metropolitan Life*

Science (p. 106)

Fawcett Crest. New York, New York, USA. 1978

**Lederman, Leon** 1922–  
American high-energy physicist

Physicists today feel the same emotions that scientists have felt for centuries. The life of a physicist is filled with anxiety, pain, hardship, tension, attacks of hopelessness, depression, and discouragement. But these are punctuated by flashes of exhilaration, laughter, joy, and exultation. These epiphanies come at unpredictable times. Often they are generated simply by the sudden understanding of something new and important, something beautiful, that someone else has revealed.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

[If] you are mortal, like most of the scientists I know, the far sweeter moments come when you yourself discover some new fact about the universe. It's astonishing how often this happens at 3 A.M., when you are alone in the lab and you have learned something profound, and you realize that not one of the other five billion people on earth knows what you now know. Or so you hope. You will, of course, hasten to tell them as soon as possible. This is known as "publishing."

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

When I talk about the pain and hardship of a scientist's life, I'm speaking of more than existential angst. Galileo's work was condemned by the Church; Madame Curie paid with her life, a victim of leukemia wrought by radiation poisoning. Too many of us develop cataracts. None of us gets enough sleep. Most of what we know about the universe we know thanks to a lot of guys (and ladies) who stayed up late at night.

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 1 (p. 16)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Leon, Mark**  
No biographical data available

"Read Popper on the philosophy of science," Alan said. "I don't wholly agree with him, but he has a point when he says the scientist's job is to disprove rather than prove theories. Humans are passionate believers. The history of

philosophy and religion is a grand testament to our will to believe. Scientists just try to inject a little sanity into the whole business, and that often requires a passion not to believe."

*The Unified Field* (p. 11)

Avon Books. New York, New York, USA. 1996

**Leonard, Jonathan Norton** 1903–75  
No biographical data available

[A scientist's] real work is done in the silent hours of thought, the apparently aimless days of puttering around in the laboratory, and the mighty searching through reference books.

Steinmetz, Jove of Science, Part II

*The World's Work*, February 1929 (p. 140)

**Levi, Primo** 1919–87  
Italian writer and chemist

A scientist's life, the author says, is indeed conflictual, formed by battles, defeats, and victories: but the adversary is always and only the unknown, the problem to be solved, the mystery to be clarified. It is never a matter of civil war; even though of different opinions, or of different political leanings, scientists dispute each other, they compete, but they do not battle: they are bound together by a strong alliance, by the common faith "in the validity of Maxwell's or Boltzmann's equations," and by the common acceptance of Darwinism and the molecular structure of DNA.

Translated by Raymond Rosenthal

*The Mirror Maker: Stories and Essays by Primo Levi*

Bacteria Roulette (p. 123)

Shocken Books. New York, New York, USA. 1989

**Levinson-Lessing, F. Y.** 1861–1939  
Russian geologist

A scientist lacking imagination can at best become a splendid walking library and source of information — he absorbs, but does not create.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schneierson

Progress Publishers. Moscow, Russia. 1979

**Lewis, Gilbert Newton** 1875–1946  
American chemist

The scientist is a practical man and his are practical aims. He does not seek the ultimate but the proximate. He does not speak of the last analysis but rather of the next approximation. ... On the whole, he is satisfied with his work, for while science may never be wholly right it certainly is never wholly wrong; and it seems to be improving from decade to decade.

*The Anatomy of Science*

Chapter I (pp. 6–7)

Yale University Press. New Haven, Connecticut, USA. 1926

**Lewis, Sinclair** 1885–1951  
American novelist

...the scientist is intensely religious — ...he will not accept quarter-truths, because they are an insult to his faith. He wants that everything should be subject to inexorable laws. He is the only real revolutionary, the authentic scientist, because he alone knows how little he knows. He lives in a cold, clear light. Yet he is not cold nor heartless. And he prays for unclouded eyes and freedom from haste, for a quiet and relentless anger against all pretence and all pretentious work and all work left slack and unfinished,...a restlessness whereby he may neither sleep nor accept praise till his observed results equal his calculated results....

*Arrowsmith* (p. 278)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

He had never dined with a duchess, never received a prize, never been interviewed, never produced anything which the public could understand, nor experienced anything since his schoolboy amours which nice people could regard as romantic.

He was, in fact, an authentic scientist.

*Arrowsmith*

Chapter XII, Section I (p. 128)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

To be a scientist — it is not just a different job so that a man should choose between being a scientist and being an explorer or a bond-salesman or a physician or a king or a farmer. It is a tangle of very obscure emotions, like mysticism, or wanting to write poetry; it makes its victim all different from the good natural man.

*Arrowsmith*

Chapter XXVI, Section I (p. 290)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

The normal man, he does not care much what he does except that he should eat and sleep and make love. But the scientist is intensely religious — he is so religious that he will not accept quarter truths, because they are an insult to his faith.

*Arrowsmith*

Chapter XXVI, Section I (p. 290)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

[The scientist] hates the preachers who talk their fables, but he is not too kindly to the anthropologists and historians who can only make guesses, yet they have the nerve to call themselves scientists!

*Arrowsmith*

Chapter XXVI, Section I (p. 290)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Lightman, Alan** 1948–  
Physicist, novelist, and essayist

Scientists turn reckless and mutter like gamblers who cannot stop betting.

*Einstein's Dreams*

3 May 1905 (p. 41)

Pantheon Books. New York, New York, USA. 1993

**Professor Oliver Lindenbrook**

Fictional character

A scientist who cannot prove what he has accomplished, has accomplished nothing.

*Journey to the Center of the Earth*

Film (1959)

**Martel, Yann** 1963–

Canadian novelist

Scientists are a friendly, atheistic, hard-working, beer-drinking lot whose minds are preoccupied with sex, chess and baseball when they are not preoccupied with science.

*Life of Pi* (p.5)

Harcourt Inc. Orlando, Florida, USA. 2001

**Maxwell, James Clerk** 1831–79

Scottish physicist

[Scientists'] actions and thoughts, being more free from the influence of passion than those of other men, are all the better materials for the study of the calmer parts of human nature. ... [B]y aspiring to noble ends... [scientists] have risen above the region of storms into a clearer atmosphere, where there is no misrepresentation of opinion, nor ambiguity of expression, but where one mind comes into closest contact with another at the point where both approach nearest to the truth.

In C.C. Gillispie (ed.)

*The Edge of Objectivity: An Essay in the History of Scientific Ideas*

Forward (pp. vii, viii)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Mayer, Joseph** 1904–83

American chemist

What does one have to do to be called a scientist? I decided that anyone who spent on science more than 10% of his waking, thinking time for a period of more than a year would be called a scientist, at least for that year.

In "The Way it Was"

*Annual Review of Physical Chemistry*, Volume 33, 1982 (pp. 1–2)

**Mayo, Charles Horace** 1865–1939

American physician

The scientist is not content to stop at the obvious.

Problems in Medical Education

*Collected Papers of the Mayo Clinic & Mayo Foundation*, Volume 18, 1926

**Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

To be creative, scientists need libraries and laboratories and the company of other scientists; certainly a quiet and

untroubled life is a help. A scientist's work is in no way deepened or made more cogent by privation, anxiety, distress, or emotional harassment.

*Advice to a Young Scientist*

Chapter 5 (p. 40)

Basic Books, Inc. New York, New York, USA. 1979

[T]he private lives of scientists may be strangely and even comically mixed up, but not in ways that have any special bearing on the nature and quality of their work. If a scientist were to cut off an ear, no one would interpret such an action as evidence of an unhappy torment of creativity; nor will a scientist be excused any bizarre [action], however extravagant, on the grounds that he is a scientist, however brilliant.

*Advice to a Young Scientist*

Chapter 5 (p. 40)

Basic Books, Inc. New York, New York, USA. 1979

Much of a scientist's pride and sense of accomplishment turns...upon being the first to do something — upon being the man who did actually speed up or redirect the flow of thought and the growth of understanding.

The most heinous offense a scientist as a scientist can commit is to declare to be true that which is not so; if a scientist cannot interpret the phenomenon he is studying, it is a binding obligation upon him to make it possible for another to do so.

*The Limits of Science*

An Essay on Scians [Science] (p. 6)

Harper & Row, Publishers. New York, New York, USA. 1984

[James] Watson's childlike vision makes them seem like the creatures of a Wonderland, all at a strange contentious noisy tea-party which made room for him because for people like him, at this particular kind of party, there is always room.

Lucky Jim

*New York Review of Books*, 28 March 1968

...Watson had one towering advantage over all of [his classmates in other disciplines]: in addition to being extremely clever he had something important to be clever about. This is an advantage which scientists enjoy over most other people engaged in intellectual pursuits, and they enjoy it at all levels of capability. To be a first-rate scientist it is not necessary (and certainly not sufficient) to be extremely clever, anyhow in a pyrotechnic sense.

Lucky Jim

*New York Review of Books*, 28 March 1968

One of the great social revolutions brought about by scientific research has been the democratization of learning. Anyone who combines strong common sense with an ordinary degree of imaginativeness can become a creative scientist, and a happy one besides, in so far as happiness depends upon being able to develop to the limit of one's abilities.

Lucky Jim

*New York Review of Books*, 28 March 1968

People who criticize scientists for wanting to enjoy the satisfaction of intellectual ownership are confusing possessiveness with pride of possession. Meanness, secretiveness and, sharp practice are as much despised by scientists as by other decent people in the world of ordinary everyday affairs; nor, in my experience, is generosity less common among them, or less highly esteemed.

Lucky Jim

*New York Review of Books*, 28 March 1968

Before a good scientist tries to persuade others that he is on to something good, he must first convince himself.

*Florey Story* (London Review of Books, 20 December 1979)

Reprinted in "The Strange Case of the Spotted Mice and Other Classic Essays on Science"

Oxford University Press, Inc. New York, New York, USA. 1996

...scientists tend not to ask themselves questions until they can see the rudiments of an answer in their minds. Embarrassing questions tend to remain unasked or, if asked, to be asked rudely.

*The Future of Man: The BBC Reith Lectures 1959*

Chapter 4 (p. 62)

Methuen & Company Ltd. London, England. 1960

**Mencken, H. L. (Henry Louis)** 1880–1956

American journalist and literary critic

The scientist who yields anything to theology, however slight, is yielding to ignorance and false pretences, and as certainly as if he granted that a horse-hair put into a bottle of water will turn into a snake.

*Minority Report: H.L. Mencken's Notebooks*

No. 45 (p. 33)

Alfred A. Knopf. New York, New York, USA. 1956

**Mendeleyev, Dmitry** 1834–1907

Russian chemist

Science exists separately from scientists, it lives autonomously, it is the sum of knowledge worked out by the whole mass of scientists, similar to how the acknowledged political order of a country is worked out by the mass of persons who live in it. Science is authoritative, separate scientists are not. A scientist can only and should only use this authority when he is following science, just as in a well-ordered state the authority of power is used only by the person who observes the law.

In Michael D. Gordin

*A Well-Ordered Thing: Dmitrii Mendeleev and the Shadow of the Periodic Table*

Chapter 4 (p. 103)

Basic Books, Inc. New York, New York, USA. 2004

**Mitchell, Maria** 1818–89

American astronomer and educator



The true scientist must be self-forgetting. He knows that under the best circumstances he is sowing what others must reap — or rather he is striking the mine which others must open up — for human life at longest has not the measure of a single breath in the long life of science.

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 168)

Macmillan & Company. New York, New York, USA. 1949

It is the highest joy of the true scientist...that he can reap no lasting harvest — that whatever he may bring into the storehouse today will be surpassed by the gleaners tomorrow — he studies Nature because he loves her and rejoices to “look through Nature up to Nature’s God.”

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 168)

Macmillan & Company. New York, New York, USA. 1949

### **Montessori, Maria** 1870–1952

Italian educationist

...what is a scientist?...We give the name scientist to the type of man who has felt experiment to be a means guiding him to search out the deep truth of life, to lift a veil from its fascinating secrets, and who, in this pursuit, has felt arising within him a love for the mysteries of nature, so passionate as to annihilate the thought of himself.

Translated by Anne E. George

*The Montessori Method*

Chapter I (p. 8)

Frederick A. Stokes Company. New York, New York, USA. 1912

The scientist is not the clever manipulator of instrument, he is the worshipper of nature and he bears the external symbols of his passion as does the follower of some religious order.

Translated by Anne E. George

*The Montessori Method*

Chapter I (p. 8)

Frederick A. Stokes Company. New York, New York, USA. 1912

### **Motz, Lloyd** 1910–2004

American astronomer

### **Weaver, Jefferson Hane**

American science author

To the nonscientist, science, particularly in its modern dress and as pursued today, is a glittering intellectual jewel, mysterious, forbidding, and even threatening except to a few chosen ones, the scientists, who appear to be superior beings, endowed with an ability to probe and understand nature far beyond that of the average layman.

*The Concepts of Science: From Newton to Einstein*

Preface (p. vii)

Plenum Press. New York, New York, USA. 1988

### **Muppets**

Fictional characters

German scientist: We are going to perform an electronic cerebractomy.

Doc Hooper: A what?

German Scientist: An electronic cerebractomy! It’s something so sensational, you’ll have to hold on to your hat.... Look, when a German scientist says hold on to your hat he isn’t making casual conversation, he means to hold on to your hat. Hat! Hold!

*The Muppet Movie*

Film (1979)

### **National Academy of Sciences**

Scientists must be fact-seekers, open-minded, and willing to accept changes indicated by the signposts of evidence.

*Science and Creationism — A View from the National Academy of Sciences* (p. 5).

National Academy Press. Washington, D.C. 1984

### **Ninotchka**

Fictional character

[Cyd Charrise talking down love to Fred Astaire] He was one of our greatest scientists. He has proved, beyond any question, that physical affection is purely electrochemical.

*Silk Stockings*

Film (1957)

### **Pasteur, Louis** 1822–95

French chemist

When moving forward toward the discovery of the unknown, the scientist is like a traveler who reaches higher and higher summits from which he sees in the distance new countries to explore.

In Rene Dubos

*Louis Pasteur: Free Lance of Science*

Chapter III (p. 87)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

### **Peabody, Francis Weld** 1881–1927

American physician

...the popular conception of the scientist as a man who works in a laboratory and who uses instruments of precision is as inaccurate as it is superficial, for a scientist is known, not by his technical processes, but by his intellectual processes; and the essence of the scientific method of thought is that it precedes in an orderly manner toward the establishment of truth.

*The Care of the Patient*

The Care of the Patient (p. 21)

Harvard University Press. Cambridge, Massachusetts, USA. 1928

**Pearse, A. S.** 1877–1956

No biographical data available

Science is always right because it seeks only for truth, and truth hurts no one. Unfortunately, scientists are not always right.

Adventure, Romance and Science

*Science*, Volume 58, Number 1492, 3 August, 1923 (p. 78)

**Perelman, S. J. (Sidney Joseph)** 1904–79

American comic writer

I guess I'm just an old mad scientist at bottom. Give me an underground laboratory, half a dozen atom smashers, and a beautiful girl in a diaphanous veil waiting to be turned into a chimpanzee, and I care not who writes the nation's laws.

*Crazy Like a Fox*

Captain Future, Block that Kick (p. 210)

Random House, Inc. New York, New York, USA. 1944

**Perry, Ralph Barton** 1876–1957

American philosopher and educator

Every scientist, furthermore, is himself a “self-made man.” He owes his strictly scientific attainment to his own efforts and to the endowment with which nature has equipped him. Whatever elevation in life he reaches is not an artificial status created by institutions or traditions, but a measure of solid achievement. The scientist, therefore, respects man for what he is rather than for his class or station.

*The Present Conflict of Ideals: A Study of the Philosophical Background of the World War*

Chapter IX (pp. 101–102)

Longmans, Green. New York, New York, USA. 1918

**Planck, Max** 1858–1947

German physicist

Since the real world, in the absolute sense of the word, is independent of individual personalities, and in fact of all human intelligence, every discovery made by an individual acquires a completely universal significance. This gives the inquirer, wrestling with his problem in quiet seclusion, the assurance that every discovery will win the unhesitating recognition of all experts throughout the entire world, and in this feeling of the importance of his work lies his happiness. It compensates him fully for many a sacrifice which he must make in his daily life.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part III (p. 103)

Philosophical Library. New York, New York, USA. 1949

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The scientist should not waste his time on the achievement of practical goals. He will surely reach such goals, but this must be marginal with respect to his principal

activity. He should never forget that the specific object he is investigating is part of a whole which is infinitely greater than this object; love for this whole and an interest in it should constitute the only motives of the actions of the scientist. Science has marvelous applications, but a science in which applications were the only aim would no longer be science but only a kitchen.

In Stefan Amsterdamski

*Between History and Method*

Chapter V. Crisis of the Modern Ideal (p. 94)

Kluwer Academic Publishers. Dordrecht, Netherlands. 1992

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

There are differences in rank between scientists, but these are of secondary importance: everyone's position is sovereign. The Republic of Science realizes the ideal of Rousseau, of a community in which each is an equal partner in a General Will. But this identification makes the General Will appear in a new light. It is seen to differ from any other will by the fact that it cannot alter its own purpose. It is shared by the whole community because each member of it shares in a joint task.

*Science, Faith and Society*

Background and Prospect (pp. 16–17)

The University of Chicago Press. Chicago, Illinois. 1964

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

...what is to be called “science” and who is to be called a “scientist” must always remain a matter of convention or decision.

*The Logic of Scientific Discovery*

Part I, Chapter II, Section 10 (p. 52)

Basic Books, Inc. New York, New York, USA. 1959

**Price, Derek John de Solla** 1922–83

English science historian and information scientist

The ivory tower of the artist can be a one-man cell; that of the scientist must contain many apartments so that he may be housed among his peers.

*Little Science, Big Science*

Chapter 3 (p. 69)

Columbia University Press. New York, New York, USA. 1963

**Primas, Hans** 1928–

German spectroscopy scientist

The legendary image of a scientist as a humble searcher for truth is more and more replaced by the image of a scientist as a well-paid brilliant expert, speaking an unintelligible professional jargon, highly competent in a narrowly defined domain but arrogantly extending his competence into fields in which he knows nothing, and neglecting the fact that science is only a small subdivision of human knowledge.

*Chemistry, Quantum Mechanics and Reductionism: Perspectives in Theoretical Chemistry*  
Chapter 1, Section 1.1 (p. 24)  
Springer-Verlag, Berlin, West Germany. 1981

**Prusiner, Stanley B.** 1942–  
American neurologist

Being a scientist is a special privilege: for it brings the opportunity to be creative, the passionate quest for answers to nature's most precious secrets, and the warm friendships of many valued colleagues. Collaborations extend far beyond the scientific achievements, no matter how great the accomplishments might be, the rich friendships which have no national borders are treasured even more.

*Les Prix Nobel. The Nobel Prizes in 1997*  
Nobel banquet speech for award received in 1997  
Nobel Foundation. Stockholm, Sweden. 1998

**Mark O'Brian**  
Fictional character

I'm a scientist also, Dr. Holden. I know the value of the cold light of reason. But I also know the deep shadows that light can cast. The shadows that can blind men to truth.

*The Curse of the Demon*  
Film (1957)

**Ramon y Cajal, Santiago** 1852–1934  
Spanish neuropathologist

It is certainly true that the scientist's fame is not as great as the playwright or artist's glamour and popularity. People live in a world of sentiment, and it is asking too much of them to provide warmth and support for the heroes of reason.

*Advice for a Young Investigator*  
Chapter 3 (p. 44)  
The MIT Press. Cambridge, Massachusetts, USA. 1999

**Richards, Ivor Armstrong** 1893–1979  
English literary critic

We believe a scientist because he can substantiate his remarks, not because he is eloquent and forcible in his enunciation. In fact, we distrust him when he seems to be influencing us by his manner.

*Science and Poetry*  
Chapter II (p. 24)  
Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1926

**Richet, Charles** 1850–1935  
French physiologist

Probably, what characterizes all scientists, whatever they may be, archivists, mathematicians, chemists, astronomers, physicists, is that they do not seek to reach a practical conclusion by their work.

*The Natural History of a Savant*

Chapter I (p. 4)  
J.M. Dent & Sons Ltd. London, England. 1927

**Roe, Anne**  
No biographical data available

Science is the creation of scientists and every scientific advance bears somehow the mark of the man who made it. . . . The creative scientist, whatever his field, is very deeply involved emotionally and personally in his work, and. . . he himself is his own most essential tool.

*The Psychology of the Scientist*  
*Science*, Volume 134, Number 3477, August 18, 1961 (p. 456)

**Roszak, Theodore** 1933–  
American social critic

. . . science rests itself not in the world the scientist beholds at any particular point in time, but in his mode of viewing that world. A man is a scientist not because of what he sees, but because of how he sees it.

*The Making of a Counter Culture: Reflections on the Technocratic Society and Its Youthful Opposition*  
Chapter VII (p. 213)  
Doubleday & Company, Inc., Garden City, New York, USA; 1969

**Rothman, Milton A.** 1919–2001  
American nuclear physicist and science writer

It makes no sense to complain about a lack of imagination in scientists when their failure is simply that they cannot make the world be what it is not, and they cannot make the world do what it cannot do.

*The Science Gap: Dispelling the Myths and Understanding the Reality of Science*  
Prometheus Books. Buffalo, New York, USA. 1992

**Rothman, Tony** 1953–  
American cosmologist

The makers of *Revenge of the Nerds* know, as do millions who have seen it, that all scientists when young are undernourished sociophobics who relate best to a computer terminal through coke bottle eyeglasses after midnight in a basement laboratory.

*A Physicist on Madison Avenue*  
Chapter 1 (p. 3)  
Princeton University Press. Princeton, New Jersey, USA. 1991

**Ruse, Michael** 1940–  
English historian and philosopher of science

A scientist should not cheat or falsify data or quote out of context or do any other thing that is intellectually dishonest. Of course, as always, some individuals fail; but science as a whole disapproves of such action. Indeed, when transgressors are detected, they are usually expelled from the community.

Response to the Commentary: Pro Justice  
*Science, Technology and Human Values*, Volume 7, Number 41, Fall 1982 (p. 74)

**Rushton, John Phillippe** 1941–

British/Canadian experimental psychology professor and writer

Research has suggested that scientists differ from non-scientists by exhibiting a high level of curiosity, especially at an early age, and in demonstrating a relatively low level of sociability. Scientists also tend to be shy, lonely, slow in social development, and indifferent to close personal relationships, group activities and politics. Other attributes include skepticism, preoccupation, reliability, and a facility for precise, critical thinking. Generally they are cognitively complex, independent, non-conformist, assertive, and unlikely to suppress thoughts and impulses; and, like successful entrepreneurs, eminent scientists are also calculated risk-takers.

*Journal of Social and Biological Structure*, Volume 11, 1980 (p. 140)

**Sabin, Albert** 1906–93

American medical researcher

No matter how good you are, you cannot be a scientist unless you learn to live with frustration.

I Only Ask for a Place to Work

*New Scientist*, Volume 57, Number 835, 1 March 1973 (pp. 491–492)

**Sagan, Carl** 1934–96

American astronomer and author

[Scientists] are capable of self-deception. ... All sorts of socially abhorrent doctrines have at one time or another been supported by scientists, well-known scientists, famous brand-name scientists. And, of course, politicians. And respected religious leaders. Slavery, for instance, or the Nazi brand of racism. Scientists make mistakes, theologians make mistakes, everybody makes mistakes...

*Contact: A Novel* (p. 167)

Simon & Schuster. New York, New York, USA. 1985

Who discovered that CFCs [chlorofluorocarbons] posed a threat to the ozone layer? Was it the principal manufacturer, the DuPont Corporation, exercising corporate responsibility? Was it the Environmental Protection Agency protecting us? Was it the Department of Defense defending us? No, it was two ivory-tower, white-coated university scientists working on something else — Sherwood Rowland and Mario Molina of the University of California, Irvine. Not even an Ivy League university. No one instructed them to look for dangers to the environment. They were pursuing fundamental research. They were scientists following their own interests. Their names should be known to every schoolchild.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 14 (pp. 221–222)

Random House, Inc. New York, New York, USA. 1994

**Seifriz, William** 1888–1955

Professor of Botany

It is no matter of chance that the greatest scientists of all time, Copernicus, Newton, Kepler, Linnaeus, Faraday, Darwin, and Maxwell, were men of noble character, modest, straightforward, and full of human sympathy. The great French mathematician, Henri Poincaré, stated that the chief end of life is contemplation, not action.

A New University

*Science*, Volume 120, Number 3107, 16 July 1954 (pp. 88–89)

**Selye, Hans** 1907–82

Austrian-American endocrinologist

Scientists are probably the most individualistic bunch of people in the world. All of us are and should be essentially different; there would be no purpose in trying to fit us into a common mold.

*From Dream to Discovery: On Being a Scientist*

Introduction

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

**Sheckley, Robert** 1928–2005

American writer

The scientist, who examines everything, should look at himself. Tentatively I would define him as a discovery-producing animal whose products fall from him as naturally and as thoughtlessly as a hen produces eggs. Like the hen, he is largely indifferent to the use made of his products. Scientists are mostly not in favor of atom bombs, of course, and hens presumably dislike omelets; but both are realists and go along with the conditions they find.

In Damon Knight

*The Observers* (p. 189)

Tor. New York, New York, USA. 1988

**Shelley, Mary** 1797–1851

English Romantic writer

The modern masters of chemistry promise very little; they know that metals cannot be transmuted and that the elixir of life is a chimera. But these philosophers, whose hands seem only made to dabble in dirt, and their eyes to pore over the microscope or crucible, have indeed performed miracles. They penetrate into the recesses of nature and show how she works in her hiding places. They ascend into the heavens; they have discovered how the blood circulates, and the nature of the air we breathe. They have acquired new and almost unlimited powers; they can command the thunders of heaven, mime the earthquake, and even mock the invisible world with its own shadows.

*Frankenstein*

Chapter 3 (p. 39)

Running Press. Philadelphia, Pennsylvania, USA. 1990

**Sigurdsson, Haraldur** 1939–

Icelandic volcanologist

The scientist or scholar is the keeper of the flame of knowledge and he or she also advances our knowledge in a chosen field of research, but should also be responsible for linking the present with the past and maintaining a record of the history of knowledge in that field.

*Melting the Earth*

Preface (p. viii)

Oxford University Press, Inc. New York, New York, USA. 1999

### Silver, Brian L.

Israeli professor of physical chemistry

Scientists come in many colors, of which the green of jealousy and the purple of rage are fashionable shades.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

### Sinsheimer, Robert L. 1920–

American molecular biologist

I am a scientist, a member of a most fortunate species. The lives of most people are filled with ephemera. All too soon, much of humanity becomes mired in the tepid tracks of their short lives. But a happy few of us have the privilege to live with and explore the eternal.

*The Strands of a Life: The Science of DNA and the Art of Education*

The University of California Press. Berkeley, California, USA. 1994

### Smith, Homer W.

Renal physiologist

A scientist is one who, when he does not know the answer, is rigorously disciplined to speak up and say so unashamedly; which is the essential feature by which modern science is distinguished from primitive superstition, which knew all the answers except how to say, “I do not know.”

*From Fish to Philosopher*

Chapter XIII (p. 210)

Little, Brown & Company. Boston, Massachusetts, USA. 1953

### Snow, Charles Percy 1905–80

English novelist and scientist

I believe the intellectual life of the whole of western society is increasingly being split into two polar groups. ... Literary intellectuals at one pole — at the other scientists, and as the most representative, the physical scientists. Between the two a gulf of mutual incomprehension — sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding.

*The Two Cultures: And a Second Look*

Chapter I (p. 3)

At The University Press. Cambridge, England. 1964

### Spallanzani, Lazzaro 1729–99

Italian natural philosopher

If I set out to prove something, I am no real scientist — I have to learn to follow where the facts lead me — I have to learn to whip my prejudices.

In R. Coope

*The Quiet Art* (p. 4)

E.S. Livingstone Ltd. Edinburgh, Scotland. 1952

### Standen, Anthony 1907–??

Anglo-American science writer

When a white-robed scientist, momentarily looking away from his microscope or cyclotron, makes some pronouncement for the general public, he may not be understood but at least he is certain to be believed. Scientists are exalted beings who stand at the very top-most pinnacle of popular prestige, for they have the monopoly of the formula “It has been scientifically proved.”, which appears to rule out all possibility of disagreement. Thus the world is divided into Scientists, who practice the art of infallibility, and non-scientists, sometimes contemptuously called “laymen”, who are taken in by it.

*Science Is a Sacred Cow*

Chapter I (p. 13)

E.P. Dutton & Company. New York, New York, USA. 1950

We are having wool pulled over our eyes if we let ourselves be convinced that scientists as a group are anything special in the way of brains. They are very ordinary professional men, and all they know is their own trade, just like all other professional men.

*Science Is a Sacred Cow*

E.P. Dutton & Company. New York, New York, USA. 1950

### Szent-Györgyi, Albert 1893–1986

Hungarian-born American biochemist

The real scientist...is ready to bear privations and, if need be, starvation rather than let anyone dictate to him which direction his work must take.

Science Needs Freedom

*World Digest*, Volume 55, 1943

In the great struggle between ignorance, distrust and brutality on one side, knowledge, understanding and peace on the other the scientist must stand fearlessly on the side of the latter, strengthening link between man and man and preaching that the only effective weapon of self-defense is good-will to others.

*Les Prix Nobel. The Nobel Prizes in 1937*

Nobel banquet speech for award received in 1937

Nobel Foundation. Stockholm, Sweden. 1938

Good science is made by good scientists, poor science by poor scientists, and the most brilliant project is worthless in the hands of a poor scientist, while, conversely, a good scientist has a good chance to come up with something valuable whatever he touches, because “*die Welt rundet sich im Tautropfen*” (Goethe), which could be translated

by saying that all the great laws of nature are represented in a drop of dew.

Research Grants

*Perspectives in Biology and Medicine*, Volume 18, Number 1, Autumn 1974 (p. 41)

**Tait, Peter Guthrie** 1831–1901

Scottish physicist and mathematician

The life of a genuine scientific man is, from the common point of view, almost always uneventful. Engrossed with the paramount claims of inquiries raised high above the domain of mere human passions, he is with difficulty tempted to come forward in political discussions, even when they are of national importance; and he regards with surprise, if not with contempt, the petty municipal squabbles in which local notoriety is so eagerly sought.

In W.J. Miller (ed.)

*Scientific Papers: By W.J. Macquorn Rankine*

Memoir (p. ix)

Charles Griffin & Company. London, England. 1881

To [the scientific man] the discovery of a new law of nature, or even of a new experimental fact, or the invention of a novel mathematical method, no matter who has been the first to reach it, is an event of an order altogether different from, and higher than, those which are so profusely chronicled in the newspapers.

In W.J. Miller (ed.)

*Scientific Papers: By W.J. Macquorn Rankine*

Memoir (p. ix)

Charles Griffin & Company. London, England. 1881

**Taylor, Alfred Maurice** 1903–76

English optics physicist

The three attributes of commitment, imagination, and tenacity seem to be the distinguishing marks of greatness in a scientist. A scientist must be as utterly committed to the pursuit of truth as the most dedicated of mystics; he must be as pertinacious in his struggle to advance into uncharted country as the most indomitable pioneers; his imagination must be as vivid and ingenious as a poet's or a painter's. Like other men, for success he needs ability and some luck; his imagination may be sterile if he has not a flair for asking the right questions, questions to which nature's reply is intelligible and significant.

*Imagination and the Growth of Science*

Chapter I (p. 5)

Schocken Books. New York, New York, USA. 1970

**Thomas, Lewis** 1913–93

American physician and biologist

Scientists at work have the look of creatures following genetic instructions; they seem to be under the influence of a deeply placed human instinct. They are, despite their efforts at dignity, rather like young animals engaged in savage play. When they are near to an answer their hair

stands on end, they sweat, they are awash in their own adrenaline. To grab the answer, and grab it first, is for them a more powerful drive than feeding or breeding or protecting themselves against the elements.

*The Lives of a Cell: Notes of a Biology Watcher*

Natural Science (p. 101)

The Viking Press. New York, New York, USA. 1974

**Thorne, Kip S.** 1940–

American theoretical physicist

I do not aspire to a historian's standards of completeness, accuracy, or impartiality.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Preface (p. 19)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

**Ting, Samuel C. C.** 1936–

Chinese-American physicist

...scientists must go beyond what is taught in the textbook, and they must think independently. Also, they cannot hesitate to ask questions, even when their view may be unpopular.

In Janet Nomura Morey and Wendy Dunn

*Famous Asian Americans*

Samuel C.C. Ting (p. 143)

**Tolkien, J. R. R.** 1892–1973

English philologist, writer, and professor

Merry stared at the lines of marching stones: they were worn and black; some were leaning, some were fallen, some were cracked or broken; they looked like rows of old and hungry teeth. He wondered what they could be...

*The Lord of the Rings*

The Return of the King, Book Three (p. 795)

HarperCollins Publishers. 2004

**Toulmin, Stephen** 1922–

English philosopher

No doubt, a scientist isn't necessarily penalized for being a complex, versatile, eccentric individual with lots of extra-scientific interests. But it certainly doesn't help him a bit.

*Civilization and Science in Conflict or Collaboration*

CIBA Foundation Symposium

Associated Scientific Publishers. Amsterdam, Netherlands. 1972

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

That is their way, those plagues, those scientists — peg, peg, peg — dig, dig, dig — plod, plod, plod. I wish I could catch a cargo of them for my place; it would be an economy. Yes, for years, you see. They never give up. Patience, hope, faith, perseverance; it is the way of all the breed.

*Europe and Elsewhere*

Sold to Satan

Harper &amp; Brothers. New York, New York, USA. 1923

That is the way of the scientist. He will spend thirty years in building up a mountain range of facts with the intent to prove a certain theory; then he is so happy in his achievement that as a rule he overlooks the main chief fact of all — that his accumulation proves an entirely different thing.

*What Is Man? and Other Essays, 1917 ed*

The Bee Essay (p. 283)

Harper &amp; Brothers. New York, New York, USA. 1917

Such is professional jealousy; a scientist will never show any kindness for a theory which he did not start himself. There is no feeling of brotherhood among these people. Indeed, they always resent it when I call them brother. To show how far their ungenerosity can carry them, I will state that I offered to let Prof. H — y publish my great theory as his own discovery; I even begged him to do it; I even proposed to print it myself as his theory. Instead of thanking me, he said that if I tried to fasten that theory on him he would sue me for slander.

*A Tramp Abroad*

Chapter XLIII (p. 321)

Penguin Books. New York, New York, USA. 1997

Scientists have odious manners, except when you prop up their theory; then you can borrow money of them.

*What Is Man? and Other Essays, 1917 ed*

The Bee Essay (p. 283)

Harper &amp; Brothers. New York, New York, USA. 1917

**University of California, Berkeley**

Scientists work better when they're all mixed-up.

Advertisement insert

*Fortune*, April 1986 (p. 814)**Varese, Edgar** 1883–1965 French American composer

Scientists are the poets of today.

*Artspace*, Volume 9, Fall 1985 (p. 30)**Vernadskii, Vladimir Ivanovich** 1863–1945

Russian mineralogist

Scientists are in fact imaginers and artists; they are not free with their ideas; they can work well and hard only at what their thinking accepts and what their feelings are drawn to. Ideas alternate; impossible and often mad ones appear; they swarm and whirl, fuse and sparkle. Scientists live among these ideas and work for them.

Compiled by V.V. Vorontsov

*Words of the Wise: A Book of Russian Quotations*

Translated by Vic Schmeier

Progress Publishers. Moscow, Russia. 1979

**von Frisch, Karl** 1886–1982

Austrian zoologist

No competent scientist *ought* to believe these things on first hearing.

*Bees: Their Vision, Chemical Senses, and Language*

Foreword (p. vii)

Cornell University Press. Ithaca, New York, USA. 1950

**Wald, George** 1906–97

American biologist and biochemist

A scientist should be the happiest of men. Not that science isn't serious; but as everyone knows, being serious is one way of being happy...

*Les Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

A scientist is in a sense a learned small boy. There is something of the scientist in every small boy. Others must outgrow it. Scientists can stay that way all their lives.

*Les Prix Nobel. The Nobel Prizes in 1967*

Nobel banquet speech for award received in 1967

Nobel Foundation. Stockholm, Sweden. 1968

**Walshe, Sir F. M. R.**

No biographical data available

It often is the cloistered scientist who knows least about men who is apt to pontificate most loudly and confidently about Man. Beware of him when he assures you that he knows all the answers about us, for too often his is one of those Peter Pans of science that every generation produces: a clever boy who hasn't grown up.

*Canadian Medical Association Journal*, Volume 67, 1962 (p. 395)**Weil, Simone** 1909–43

French philosopher and mystic

On could count on one's fingers the number of scientists throughout the world with a general idea of the history and development of their particular science: there is none who is really competent as regards sciences other than his own. As science forms an indivisible whole, one may say that there are no longer, strictly speaking, scientists, but only drudges doing scientific work.

Translated by Arthur Wills and John Petrie

*Oppression and Liberty*

Prospects (p. 13)

Routledge &amp; Kegan Paul Ltd. London, England. 1958

**Weinberg, Alvin Martin** 1915–2006

American physicist

The traditional working scientists are at the bottom rung — each one knows almost everything about almost nothing; as one progresses toward the top of the ladder, the subject matter becomes more abstract until one finally reaches the philosopher at the top who knows almost nothing about almost everything.

*Reflections on Big Science*

Chapter II (p. 47)

The MIT Press. Cambridge, Massachusetts, USA. 1967

**Weiss, Paul A.** 1898–1989  
Austrian-born American biologist

Just like the painter, who steps periodically back from his canvas to gain perspective, so the laboratory scientist emerges above ground occasionally from the deep shaft of his specialized preoccupation to survey the cohesive, meaningful fabric developing from innumerable component tributary threads, spun underground much like his own. Only by such shuttling back and forth between the worm's eye view of detail and the bird's eye view of the total scenery of science can the scientist gain and retain a sense of perspective and proportions.

In A. Koestler and J. R. Smithies  
*Beyond Reductionism: New Perspectives in the Life Sciences*  
The Living System (p. 3)  
Beacon Press. Boston, Massachusetts, USA. 1969

**Weisskopf, Victor Frederick** 1908–2002  
Austrian-American physicist

Science has become adult; I am not sure whether scientists have.

In Anthony R. Michaelis & Hugh Harvey eds.  
*Scientists in Search of Their Conscience*  
Conclusion (p. 193)  
Springer-Verlag, Berlin, Germany. 1973

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

What there is great about [scientists] is an annoyance to their fellow scientists and a mystery to the general public, and what is not is evident. There is no doubt about what is not great, no race of men have such obvious little-nesses.... And withal the reef of science that these little "scientists" built and are yet building is so wonderful, so portentous, so full of mysterious half-shapen promises for the mighty future of man! They do not seem to realise the things they are doing.

*Seven Famous Novels by H.G. Wells*  
The Food of the Gods  
Chapter I. (p. 533)  
Alfred A. Knopf. New York, New York, USA. 1934

No doubt long ago even Mr. Bensington, when...he consecrated his life to the alkaloids and their kindred compounds had some inkling of the vision — more than an inkling. Without some great inspiration, for such glories and positions only as a "scientist" may expect, what young man would have given his life to this work, as young men do? No, they must have seen the glory, they must have had the vision, but so near that it has blinded them, mercifully, so that for the rest of their lives they can hold the light of knowledge in comfort — that we may see.

*Seven Famous Novels by H.G. Wells*  
The Food of the Gods  
Chapter I. (p. 533)  
Alfred A. Knopf. New York, New York, USA. 1934

**Weyl, Hermann** 1885–1955  
German mathematician

One of the great differences between the scientist and the impatient philosopher is that the scientist bides his time. We must await the further development of science, perhaps for centuries, perhaps for thousands of years, before we can design a true and detailed picture of the interwoven texture of matter, life and soul. But the old classical determinism of Hobbes and LaPlace need not oppress us any longer.

*The Open World: Three Lectures in the Metaphysical Implications of Science*  
Lecture II (p. 55)  
Yale University Press. New Haven, Connecticut, USA. 1932

**Whewell, William** 1794–1866  
English philosopher and historian

We need very much a name to describe a cultivator of science in general. I should incline to call him a Scientist. Thus we might say, that as an Artist is a Musician, Painter, or Poet, a Scientist is a Mathematician, Physicist, or Naturalist.

*Novum Organum Renovatum*  
Aphorisms Concerning the Language of Science  
John W. Parker & Son. London, England. 1858

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

Many a scientist has patiently designed experiments for the purpose of substantiating his belief that animal operations are motivated by no purpose...Scientists animated by the purpose of proving that they are purposeless constitute an interesting subject for study.

*The Function of Reason*  
Chapter I (p. 12)  
Beacon Press. Boston, Massachusetts, USA. 1929

A few generations ago the clergy, or to speak more accurately, large sections of the clergy were the standing examples of obscurantism. Today their place has been taken by scientists.

*The Function of Reason*  
Chapter I (pp. 34–35)  
Beacon Press. Boston, Massachusetts, USA. 1929

**Whitney, Willis Rodney** 1868–1958  
American chemical and electrical engineer

We humans want better minds, broader horizons, and greater understanding. Scientists everywhere are at work in their respective fields searching for new truths to improve the process by which our minds, our horizons, our powers, and our outlooks grow.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*  
The Vacuum — There's Something in It (p. 193)  
Government Printing Office. Washington, D.C. 1925



**Wiener, Norbert** 1894–1964

American mathematician

...the first industrial revolution, ... of the “dark satanic mills,” [devalued] the human arm by the competition of machinery. ... The modern industrial revolution is similarly bound to devalue the human brain...in its simpler and more routine decisions. Of course, just as the skilled carpenter, the skilled mechanic, the skilled dressmaker have in some degree survived the first industrial revolution, so the skilled scientist and the skilled administrator may survive the second. However, ... the average human being of mediocre attainment or less has nothing to sell that is worth anyone’s money to buy.

*Cybernetics: Or Control and Communication in the Animal and the Machine*

Introduction (pp. 27–28)

The MIT Press. Cambridge, Massachusetts, USA. 1961

...the degradation of the position of the scientist as independent worker and thinker to that of a morally irresponsible stooge in a science-factory has proceeded even more rapidly and devastatingly than I had expected.

A Rebellious Scientist after Two Years

*Bulletin of the Atomic Scientists*, Volume 4, Number 11, November 4, 1948 (p. 338)

[A scientist] must live in a world where science is a career, where he has companions with whom to talk, and in contact with whom he may bring out his own self. It may be true that 95 percent of the really original scientific work is done by less than 5 per cent of the professional scientists, but the greater part of it would not be done at all if the other 95 per cent were not there and did not create a high level of public scientific opinion.

Science, Monkeys, and Mozart

*Saturday Review of Literature*, November 20, 1956

**Wikström, J. E.**

Former Swedish Minister of Education and Cultural Affairs

...Scientists are like children playing with fire without heeding the disastrous consequences of their games or, even worse, “they are like incendiaries which completely destroy property.”

In Torgny Segerstedt

*Ethics for Science Policy: Proceedings of a Nobel Symposium Held at Södergarn, Sweden, 20–25 August 197*

Opening Remarks (p. xiii)

Pergamon Press. Oxford, England. 1979

**Wilder, Thornton** 1897–1975

American playwright and novelist

Then there is technology, the excess of scientists who learn how to make things much faster than we can learn what to do with them.

In Flora Lewis

Thornton Wilder at 65 Looks Ahead – And Back

*New York Times Magazine*, 15 April 1962 (p. 28)

**Wilf, Alexander**

No biographical data available

A scientist can not be measured quantitatively by the number of degrees or the accumulation of information. A true scientist should have a measure of courage to correct error and seek truth — no matter how painful. The alternative is more painful. To build error upon error is to drift into dogmas, metaphysics, science fiction, and mythology.

*Origin and Destiny of the Moral Species* (p. 9)

A.S. Barnes. South Brunswick, New Jersey, USA. 1969

**Wilson, Edward O.** 1929–

American biologist and author

The ideal scientist thinks like a poet and works like a bookkeeper, and I suppose that if gifted with a full quiver, he also writes like a journalist. As a painter stands before canvas or a novelist recycles old emotion with eyes closed, he searches his imagination for subjects as much as for conclusions, for questions as much as for answers.

Scientists, Scholars, Knaves and Fools

*American Scientist*, Volume 86, January–February 1998 (p. 7)

Scientists, I believe, are divided into two categories: those who do science in order to be a success in life, and those who become a success in life in order to do science.

*Naturalist*

The Forms of Things Unknown (p. 210)

Island Press. Washington, D.C. 1994

Scientists do not discover in order to know, they know in order to discover.

*Biophilia*

The Poetic Species (p. 58)

Harvard University Press. Cambridge, Massachusetts. 1984

Scientists live and die by their ability to depart from the tribe and go out into an unknown terrain and bring back, like a carcass newly speared, some new discovery or fact or theoretical insight and lay it in front of the tribe; and then they all gather and dance around it. Symposia are held in the National Academy of Sciences and prizes are given [The symposia are] fundamentally no [different] from a paleolithic camp site celebration.

In Edward Lueders

*Writing Natural History: Dialogues with Authors*

Dialogue One (p. 25)

University of Utah Press. Salt Lake City, Utah, USA. 1989

The scientist is not a very romantic figure. ... [His work] amounts to a sort of puttering: trying to find a good problem, thinking up experiments, mulling over data, arguing in the corridor with colleagues, and making guesses with the aid of coffee and chewed pencils until finally something — usually small — is uncovered. Then comes a flurry of letters and telephone calls, followed by the writing of a short paper in an acceptable jargon. The great majority of scientists are hard-working, pleasant

journeymen, not excessively bright, making their way through a congenial occupation.

*Biophilia*

The Poetic Species (p. 59)

Harvard University Press. Cambridge, Massachusetts. 1984

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

What a curious attitude scientists have — : “We still don’t know that; but it is knowable and it is only a matter of time before we get to know it!” As if that went without saying.

Translated by Peter Winch

*Culture and Value* (p. 40e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Wolpert, Lewis** 1929–

British embryologist

Both Newton and Darwin were driven by the data and were forced to recognize that they couldn’t explain everything. It may be a characteristic of great scientists to know what to accept and what to leave out.

*The Unnatural Nature of Science*

Chapter 4 (p. 72)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Young John Zachary** 1907–97

English zoologist

One of the characteristics of scientists and their work, curiously enough, is a certain confusion, almost a muddle. This may seem strange if you have come to think of science with a big S as being all clearness and light.

*Doubt and Certainty in Science: A Biologist’s Reflections on the Brain*

First Lecture (p. 1)

Oxford University Press, Inc. Oxford, England. 1960

...in his laboratory he does not spend much of his time thinking about scientific laws at all. He is busy with other things, trying to get some piece of apparatus to work, finding a way of measuring something more exactly. ... You may feel that he hardly knows himself what law he is trying to prove. He is continually observing, but his work is a feeling out into the dark, as it were. When pressed to say what he is doing he may present a picture of uncertainty or doubt, even of actual confusion.

*Doubt and Certainty in Science: A Biologist’s Reflections on the Brain*

First Lecture (p. 2)

Oxford University Press, Inc. Oxford, England. 1960

## SCRIBBLES

**Ulam, Stanislaw** 1909–84

Polish-born mathematician

It is still an unending source of surprise for me how a few scribbles on a blackboard or on a piece of paper can change the course of human affairs.

*Adventures of a Mathematician*

Prologue (p. 5)

Charles Scribner’s Sons. New York, New York, USA. 1976

## SEA

**Beebe, William** 1877–1962

American ornithologist

When once it has been seen, it will remain forever the most vivid memory in life, solely because of its cosmic chill and isolation, the eternal and absolute darkness and the indescribable beauty of its inhabitants.

*Half Mile Down*

Chapter 9 (p. 175)

Harcourt, Brace & Company. New York, New York, USA. 1934

**Berger, John** 1926–

English art critic, novelist, painter and author

The sun is low in the sky and the sea is calm. Like a mirror as they say. Only it is not like a mirror. The waves which are scarcely waves, for they come and go in many different directions and their rising and falling is barely perceptible, are made up of innumerable tiny surfaces at variegating angles to one another — of these surfaces those which reflect the sunlight straight into one’s eyes, sparkle with a white light during the instant before their angle, relative to oneself and the sun, shifts and they merge again into the blackish blue of the rest of the sea.

G

Chapter 10 (p. 310)

The Viking Press. New York, New York, USA. 1972

[A]s the sea recedes towards the sun, the number of sparkling surfaces multiplies until the sea indeed looks somewhat like a silver mirror. But...it is not still. Its granular surface is in continual agitation. The further away the ricocheting grains, of which the mass become silver and the visibly distinct minority a dark leaden colour, the greater is their apparent speed. Uninterruptedly receding towards the sun, the transmission of its reflexions becoming ever faster, the sea neither requires nor recognizes any limit. The horizon is the straight bottom edge of a curtain arbitrarily and suddenly lowered on a performance.

G

Chapter 10 (p. 310)

The Viking Press. New York, New York, USA. 1972

**Beston, Henry** 1888–1968

American writer

Listen to the surf, really lend it to your ears, and you will hear in it a world of sounds: hollow boomings and heavy roarings, great watery tumbings and trappings, long hissing seethes, sharp, rifle-shot reports, splashes, whispers, the grinding undertone of stones, and sometimes vocal sounds that might be the half-heard talk of people in the sea.

*The Outermost House*  
Chapter III (p. 43)  
Rinehart & Company. New York, New York, USA. 1928

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

Like the turbulent crowd at the rim of an arena, the sea surrounds the lands and awaits the issue of combat. Fretfully the colossus chafes at the margins of battlefields it is eager but impotent to enter.

*Autobiography of Earth*  
Chapter VI (p. 168)  
Coward-McCann, Inc. New York, New York, USA. 1935

**Broch, Hermann** 1886–1951  
Austrian writer

Those who live by the sea can hardly form a single thought of which the sea would not be part.

*The Spell*  
Forward (p. 3)  
North Point Press. San Francisco, California, USA. 1989

**Carson, Rachel** 1907–64  
American marine biologist and author

There we see the parts of the plan fall into place: the water receiving from earth and air the simple materials, storing them up until the gathering energy of the spring sun wakens the sleeping plants to a burst of dynamic activity, hungry swarms of planktonic animals growing and multiplying upon the abundant plants, and themselves falling prey to the shoals of fish; all, in the end, to be redissolved into their component substances when the inexorable laws of the sea demand it.

*Undersea*  
*Atlantic Monthly*, September 1937 (p. 29)

It is a curious situation that the sea, from which life first arose should now be threatened by the activities of one form of that life. But the sea, though changed in a sinister way, will continue to exist; the threat is rather to life itself.

*The Sea Around Us*  
Preface (p. xiii)  
Oxford University Press, Inc. New York, New York, USA. 1989

**Cousteau, Jacques-Yves** 1910–77  
French naval officer and ocean explorer

The sea is not a bargain basement.  
*The Living Sea*  
Chapter Seventeen (p. 313)  
Harper & Row, Publishers. New York, New York, USA. 1963

From the vast expanses of its surface waters to its beaches and marshes and tidelands and mangrove swamps, from its many thousands of miles of rocky shores to its deepest and darkest abyss, the sea produces life in fantastic abundance.

*The Ocean World of Jacques Cousteau: The Adventure of Life*  
Chapter I (p. 10)  
The World Publishing Company. New York, New York, USA. 1973

The sea is the universal sewer.  
House Committee on Science and Astronautics  
28 January 1971

**Cromie, William J.** 1930–  
American journalist and writer

In the open ocean one sees no green meadows or fertile prairies. Away from the rim of seaweed around the coasts one is aware of only an endless confusion of seemingly barren waves. Yet there are lush pastures in the open sea.

*The Living World of the Sea*  
Chapter 3 (p. 37)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1966

The sea gave birth to life and without its waters no living thing could ever survive on Earth. Now man, rightly or wrongly, is looking to the ocean as his ultimate safety valve, the answer to his problems of food, waste and even space. But the sea has no mind and the sea is not inexhaustible.

*The Living World of the Sea*  
Chapter 15 (p. 332)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1966

**Diolé, Philippe**  
French archaeologist

Between the air and the water a steel blade quivers. What people call the surface is also a ceiling: a mirror from above, watered silk from beneath. Nothing is torn on the way through. Only a few bubbles mark the diver's channel and behind him the frontier soon closes. But once the threshold is crossed, one can turn back slowly and look up: that dazzling screen is the border between two worlds, as clear to one as to the other. Behind the looking glass the sky is made of water.

Translated by Alan Ross  
*The Undersea Adventure*  
Chapter 1 (pp. 6–7)  
Julian Messner, Inc. New York, New York, USA. 1953

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

To the geologist the sea is the only firmament...  
*The Complete Works of Ralph Waldo Emerson* (Volume 5)  
English Traits (p. 29)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

The sea, washing the equator and the poles, offers its perilous aid, and the power and empire that follow it...  
“Beware of me,” it says, “but if you can hold me, I am the key to all the lands.”

*Ralph Waldo Emerson: Essays and Lectures*  
The Conduct of Life

Wealth (p. 991)  
The Library of America. New York, New York, USA. 1983

**Empedocles of Acragas** ca. 490 BCE–430 BCE  
Greek pre-Socratic philosopher

The sea is the sweat of the earth.

In Arthur Fairbanks  
*The First Philosophers of Greece*  
Book I  
Fragment 165 (p. 179)

**Flecker, James Elroy** 1884–15  
English poet and playwright

The dragon-green, the luminous, the dark, the serpent-haunted sea.

*The Collected Poems of James Elroy Flecker*  
The Gates of Damascus  
West Gate  
Doubleday, Page & Company. New York, New York, USA. 1916

**Garfield, James A.** 1831–81  
20<sup>th</sup> president of the United States

I have seen the sea lashed into fury and tossed into spray, and its grandeur moves the soul of the dullest man; but I remember that it is not the billows, but the calm level of the sea from which all heights and depths are measured.

*Proceedings of the Republican National Convention*  
Chicago, Illinois, June 2–8, 1880 (p. 184)

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

Who can say of a particular sea that it is old? Distilled by the sun, kneaded by the moon, it is renewed in a year, in a day, or in an hour.

*The Return of the Native*  
Book the First, Chapter I (p. 14)  
The New American Library. New York, New York, USA. 1959

**Hazlitt, William Carew** 1834–1913  
English bibliographer

I hate to be near the sea, and to hear it roaring and raging like a wild beast in its den. It puts me in mind of the everlasting efforts of the human mind, struggling to be free, and ending just where it began.

*Common Places*

**Houot, Georges** 1913–2000  
French underwater explorer

**Willm, Pierre**  
No biographical data available

We are entering on the last stage of man's march toward a knowledge of the surface of the globe. The battle that remains to be fought will be long and hard. Despite the progress of science, the sea remains a hostile element,

particularly so at the frontier between the water and the atmosphere.

Translated by Michael Bullock  
*2000 Fathoms Down* (p. 182)  
E.P. Dutton & Company. New York, New York, USA. 1955

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

When it wishes to be, the sea is gay.  
Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
Part II, Book Third, Chapter III (p. 406)  
The Heritage Press. New York, New York, USA. 1961

**Knight, Norman L.**  
No biographical data available

O Sea! Thou saline and undulant aqueous solution of halides, carbonates, phosphates, sulfates, and other soluble inorganic compounds! What mysterious colloids are dispersed within thy slightly alkaline bosom? What silent and unseen reactions vibrate in dynamic equilibrium, constantly destroyed and instantly restored, among thy unnumbered oscillating molecules? What uncounted myriads of restless ions migrate perpetually throughout thy tentatively estimated volume? What unguessed phenomena of catalysis, metathesis, and osmosis transpire in thy secret fluid profundities under excessively increased pressure? What cosmic precipitates descend in countless kilograms upon thy argillaceous, gelatinous, siliceous, diatomaceous, and totally unilluminated bottom? In short, most magnificent reservoir, what is thy flow-chart and complete analysis?

A Chemist Addresses the Ocean  
*Industrial and Engineering Chemistry: News Edition*, Volume 8, Number 22, September 20, 1930

**Ledbetter, B. G.**  
No biographical data available

The sea often appears tranquil and serene, but its permanent hills and valleys illustrate that in fact it is restless, always in motion, mixing and flowing in ceaseless search for peace.

Sea Level Isn't Level — It's Hilly  
*Science Digest*, Volume 68, Number 1, July 1970 (p. 72)

**Lindbergh, Anne Marrow** 1906–2001  
American aviator and writer

The sea does not reward those who are too anxious, too greedy, or too anxious. To dig for treasures shows not only impatience and greed, but a lack of faith. Patience, patience, patience, is what the sea teaches. Patience and faith. One should lie empty, open, choiceless as a beach-waiting for a gift from the sea.

*Gift from the Sea*  
Part I, The Beach (p. 17)  
Pantheon Books, Inc. New York, New York, USA. 1955

**Longfellow, Henry Wadsworth** 1807–82

American poet

Learn the secret of the sea?

Only those who brave its dangers

Comprehend its mystery.

*The Seaside and the Fireside*

The Secret of the Sea

Ticknor, Reed &amp; Fields. Boston, Massachusetts, USA. 1850

...my soul is full of longing for the secrets of the sea.

And the heart of the great ocean

Sends a thrilling pulse through me.

*The Seaside and the Fireside*

The Secret of the Sea

Ticknor, Reed &amp; Fields. Boston, Massachusetts, USA. 1850

**Lowell, James Russell** 1819–91

American poet, critic, and editor

The sea was meant to be looked at from shore, as mountains are from the plain.

*Fireside Travels*

At Sea (p. 155)

Ticknor &amp; Fields. Boston, Massachusetts, USA. 1864

There is nothing so desperately monotonous as the sea, and I no longer wonder at the cruelty of pirates.

*Fireside Travels*

At Sea (p. 157)

Ticknor &amp; Fields. Boston, Massachusetts, USA. 1864

**Lubbock, Sir John** 1834–1913

English banker, author, and scientist

The Sea is outside time. A thousand, ten thousand, or a million years ago it must have looked just as it does now, and as it will ages hence.

*The Beauties of Nature and the Wonders of the World We Live In*

Chapter IX (p. 340)

Macmillan &amp; Company New York, New York, USA. 1893

**Maury, Matthew Fontaine** 1806–73

American hydrographer and naval officer

The sea...has its offices and duties to perform;... its currents, and so, too, its inhabitants; consequently, he who undertakes to study its phenomena must cease to regard it as a waste of waters. He must look upon it as a part of that exquisite machinery by which the harmonies of nature are preserved, and then he will begin to perceive the developments of order and the evidence of design; these make it a most beautiful and interesting subject for contemplation.

In J.A. Colin Nicol

*The Biology of Marine Animals* (2<sup>nd</sup> edition)

Chapter I (p. 1)

Sir Isaac Pitman &amp; Sons Ltd. London, England. 1967

Could the waters of the Atlantic be drawn off so as to expose to view this great sea-gash...it would present a scene most rugged, grand, and imposing. The very ribs

of the solid earth, with the foundations of the sea would be brought to light, and we should have presented to us at one view, in the empty cradle of the ocean, "a thousand fearful wrecks," with that dreadful array of dead men's skulls, great anchors, heaps of pearl and inestimable stones, which, in the poet's eye, lie scattered in the bottom of the sea, making it hideous with sights of ugly death.

*The Physical Geography of the Sea*

Chapter XII (p. 208)

Harper &amp; Brothers. New York, New York, USA. 1855

Harmonious in their action, the air and sea are obedient to law and subject to order in all their movements; when we consult them in the performance of their offices, they teach us lessons concerning the wonders of the deep, the mysteries of the sky, the greatness, and the wisdom, and goodness of the Creator.

*The Physical Geography of the Sea*

Chapter III (p. 96)

Harper &amp; Brothers. New York, New York, USA. 1855

Astronomers had measured the volumes and weighed the masses of the most distant planets, and increased thereby the stock of human knowledge. Was it creditable to the age that the depths of the sea should remain in the category of an unsolved problem?... Indeed, telescopes of huge proportions and of vast space-penetrating powers had been erected here and there by the munificence of individuals, and attempts made with them to gauge the heavens and sound out the regions of space. Could it be more difficult to sound out the sea than to gauge the blue ether and fathom the vault of the sky?

*The Physical Geography of the Sea*

Chapter XI (pp. 201, 202)

Harper &amp; Brothers. New York, New York, USA. 1855

**Melville, Herman** 1819–91

American novelist

There is, one knows not what sweet mystery about the sea, whose gently awful stirrings seem to speak of some hidden soul beneath.

In *Great Books of the Western World* (Volume 48)*Moby Dick*

Chapter 107 (p. 354)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Miller, Robert C.**

No biographical data available

We can no longer think of the sea as a vast, illimitable dumping ground for products that man does not know what to do with on land. It must instead be recognized as our greatest natural resource, and one to be conserved in every possible way. So regarded, and wisely used, it can be a permanent source of raw materials, of food, of life-giving water, and of recreation, enjoyment and adventure.

*The Sea*

Chapter 15 (p. 311)

Random House, Inc. New York, New York, USA. 1966

**Muir, John** 1838–1914

American naturalist

...both ocean and sky are already about as rosy as possible; the one with stars, the other with dulse, and foam, and wild light.

*Steep Trails*

Chapter I (p. 3)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Plattes, Gabriel**

No biographical data available

...the Sea never resting, but perpetually winning land in one place and losing in another, doth show what may be done in length of time by a continual operation not subject unto ceasing or intermission.

*Discovery of Subterranean Treasure*

Chapter XI (p. 22)

Printed by Robert Bell. Philadelphia, Pennsylvania, USA. 1784

**Sandburg, Carl** 1878–1967

American poet and biographer

The sea folds away from you like a mystery. You can look and look at it and mystery never leaves it.

*Remembrance Rock* (p. 75)

Harcourt, Brace &amp; World, Inc. New York, New York, USA. 1948

**Sexton, Anne** 1928–74

American poet

The sea is mother-death and she is a mighty female, the one who wins, the one who sucks us all up.

In Howard Moss (ed.)

*The Poet's Story*

A Small Journal (p. 219)

19 November, 1971

The Macmillan Company. New York, New York, USA. 1973

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

“And what is the sea?” asked Will.

“The sea!” cried the miller. “Lord help us all, it is the greatest thing God made! ... There are great fish in it five times bigger than a bull, and one old serpent as long as our river and as old as all the world, with whiskers like a man, and a crown of silver on her head.

*Strange Case of Dr. Jekyll and Mr. Hyde. The Merry Men and Other Tales and Fables*

Will O' the Wisp

The Plain and the Stars (pp. 77–78)

Current Literature Publishing Company New York, New York, USA.

1912

**The Bible**

Others there are who go to sea in ships, plying their trade on the wide ocean. These have seen what the Lord has done, his marvelous actions in the deep.

*The Revised English Bible*

Psalms 107:23–24

Oxford University Press, Inc. Oxford, England. 1989

**Maury, Matthew Fontaine** 1806–73

American hydrographer and naval officer

We never tire of the sea; it is a laboratory in which delightful processes are continually being wrought out for our admiration and use. Its flora and its fauna, its waves and its tides, its salts and its currents, all afford grand and profitable themes of study and thought.

*The Physical Geography of the Sea, and Its Meteorology*

Chapter XVIII, section 740 (p. 394)

Sampson Low, Son &amp; Marston. London, England. 1868

**Young, Louise B.**

Science writer

Throughout the planet's history the sea has carved and molded the character of the land. She has scooped out steep escarpments and deep gorges, impressed the rhythm of her movement on the hard rocky shores of the continents. But still she is ever yielding. Beneath her smiling, enigmatic face there are grave depths where silence and darkness dwell always. Here in these hidden places she watches impassively while the earth tears itself violently apart and makes itself anew. Quietly giving way to make room for the growing landmass, she receives and holds this newborn substance in her soft embrace.

*The Blue Planet*

Chapter 2 (p. 46)

Little, Brown &amp; Company. Boston, Massachusetts, USA. 1983

**Verne, Jules** 1828–1905

French novelist

Yes; I do love it! The sea is everything. It covers seven-tenths of the terrestrial globe. Its breath is pure and healthy. It is an immense desert, where man is never lonely, for he feels life stirring on all sides. The sea is only the embodiment of a supernatural and wonderful existence. ...

Translated by Mercier Lewis

*Twenty Thousand Leagues Under the Sea*

Part One, Chapter 10 (p. 58)

Nelson Doubleday, Inc. Garden City, New York, USA. 1900

Nature manifests herself in it by her three kingdoms, mineral, vegetable, and animal. The sea is the vast reservoir of Nature. The globe began with sea, so to speak; and who knows if it will not end with it? In it is supreme tranquility. The sea does not belong to despots. Upon its surface men can still exercise unjust laws, fight, tear

one another to pieces, and be carried away with terrestrial horrors. But at thirty feet below its level, their reign ceases, their influence is quenched, and their power disappears.

Translated by Mercier Lewis

*Twenty Thousand Leagues Under the Sea*

Part One, Chapter 10 (p. 58)

Nelson Doubleday, Inc. Garden City, New York, USA. 1900

## SEA SERPENT

### 19<sup>th</sup> Century Naval Song

Strange things come up to look at us —  
The masters of the deep.

*The Modern Traveler*

The Return of the Admiral (p. 107)

Printed for T. Lowndes. London, England. 1776–1777

### Pontoppidan, Erich 1698–1754

Bishop in Bergen, Norway

Amongst the many great things which are in the ocean, and concealed from our eyes or only presented to our view for a few minutes, is the Kraken. This creature is the largest and most surprising of all the animal creation, and consequently well deserves such an account as the nature of the thing, according to the Creator's wise ordinance, will admit of.

*Natural History of Norway*

### Tennyson, Alfred (Lord) 1809–92

English poet

Below the thunders of the upper deep;  
Far, far beneath in the abysmal sea,  
His ancient, dreamless, uninvaded sleep  
The Kraken sleepeth...

*Alfred Tennyson's Poetical Works*

The Kraken

Oxford University Press, Inc. London, England. 1953

## SEA SICKNESS

### Charlie Chan

Fictional character

Mention of food more painful than surgeon's knife without anesthetic.

*Charlie Chan on Broadway*

Film (1937)

### Jerome, Jerome K. 1859–1927

English author

It is a curious fact, but nobody ever is seasick — on land. At sea, you come across plenty of people very bad indeed, whole boat-loads of them; but I never met a man yet, on land, who had ever known at all what it was to be seasick.

*Three Men in a Boat, to Say Nothing of the Dog!*

Chapter 1 (p. 10)

Time Incorporated. New York, New York, USA. 1964

## SEASIDE

### Spencer, Herbert 1820–1903

English social philosopher

Whoever at the seaside has not had a microscope and aquarium, has yet to learn what the highest pleasures of the seaside are.

*Education: Intellectual, Moral, and Physical*

Chapter I (pp. 72–73)

A.L. Fowle. New York, New York, USA. 1860

## SEDIMENT

### Geikie, Sir Archibald 1835–1924

English geologist

I know no recent observation in physical geography more calculated to impress deeply the imagination than the testimony of this presumably meteoric iron from the most distant abysses of the ocean. To be told that mud gathers on the floor of these abysses at an extremely slow rate conveys but a vague notion of the tardiness of the process. But to learn that it gathers so slowly, that the very star-dust which falls from outer space forms an appreciable part of it, brings home to us, as hardly anything else could do, the idea of undisturbed and excessively slow accumulation.

*The Harvard Classics*

Scientific Papers: Physiology, Medicine, Surgery, Geology: With Introductions and Notes

Geographical Evolution (p. 347)

P.F. Collier & Son. New York, New York, USA. 1910

### Kipling, Rudyard 1865–1936

British writer and poet

There is no sound, no echo of sound, in the deserts of the deep,

Or the great grey level plains of ooze where the shell-burred cables creep.

Here is the womb of the world — here on the tie-ribs of earth

Words, and the words of men, flicker and flutter and beat.

*Rudyard Kipling's Verse*

The Deep Sea Cables

Hodder & Stroughton. London, England. 1919

## SEED

### Baker, Henry 1698–1774

English naturalist

Each seed includes a Plant: that Plant, again,

Has other Seeds, which other Plants contain:  
 Those other Plants have All their Seeds, and Those  
 More Plants again, successively, inclose.  
 Thus ev'ry single Berry that we find,  
 Has, really, in itself whole Forests of its Kind.  
 The Discovery of a Perfect Plant in Semine  
*Philosophical Transactions of the Royal Society of London*, Number  
 457, 1740 (p. 451)

A ripe seed falling to the earth is in the condition of the ovum of an animal getting loose from its ovary and dropping into the uterus, and, to go on with the analogy, the juices of the earth swell and extend the vessels of the seed as the juices of the uterus do those of the ovum, till the seminal leaves unfold and perform the office of a placenta to the infant included plant; which, imbibing suitable and sufficient moisture, gradually extends its parts, fixes its own root, shoots above the ground, and may be said to be born.

The Discovery of a Perfect Plant in Semine  
*Philosophical Transactions of the Royal Society of London*, Number  
 457, 1740 (p. 451)

**de la Mare, Walter** 1873–1956  
 English poet and novelist

The seeds I sowed —  
 For weeks unseen —  
 Have pushed up pygmy  
 Shoots of green;  
 So frail you'd think  
 The tiniest stone  
 Would never let  
 A Glimpse be shown.

*Rhymes and Verses: Collected Poems for Children*  
 Seeds

H. Holt & Company. New York, New York, USA. 1947

**Muir, John** 1838–1914  
 American naturalist

The dispersal of Juniper seeds is effected by the plum and cherry plan of living birds at the cost of their board, and thus obtaining the use of a pair of extra good wings.

*Our National Parks*  
 Chapter IV (p. 121)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Sequoia seeds have flat wings and glint and glance in their flight like a boy's kite.

*Our National Parks*  
 Chapter IV (p. 121)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Ruskin, John** 1819–1900  
 English writer, art critic and social reformer

The reason for seeds is that flowers may be; not the reason of flowers that seeds may be.

*The Queen of the Air Being a Study of the Greek Myths of Cloud and Storm*

II, Section 60, Athena in the Earth (p. 67)  
 Smith, Elder & Company London, England. 1869

**Tabb, John Banister** 1845–1909  
 American poet

Bearing a life unseen,  
 Thou lingerest between  
 A flower withdrawn,  
 And — what thou ne'er shalt see —  
 A blossom yet to be  
 When thou art gone.

*The Poetry of Father Tabb*

Nature — Miscellaneous, The Seed  
 Dodd, Mead. New York, New York, USA. 1928

**Wilde, Oscar** 1854–1900  
 Irish wit, poet, and dramatist

To look at a thing is very different from seeing a thing.

*The Decay of Lying* (p. 19)

Sunflower Company. New York, New York, USA. 1902

## SEISMOGRAPH

**Oldham, Richard Dixon** 1858–1936  
 English geologist

... the seismograph, recording the unfelt motion of distant earthquakes, enables us to see up to a certain point into the Earth and determine its nature with as great a certainty, as if we could drive a tunnel through it and take samples of the matter passed through.

Geological Society, The Constitution of the Interior of the Earth as Revealed by Earthquakes

*Quarterly Journal*, Volume 62, August 1906 (p. 456)

## SEISMOGRAPHER

**Karch, Carroll S.**  
 No biographical data available

Seismographer: Shudder bug.

*Quote, the Weekly Digest*  
 August 4, 1968 (p. 97)

## SEISMOGRAPHY

**Richter, Charles** 1900–85  
 American seismologist

Since my first attachment to seismology, I have had the horror of [earthquake] predictions and of predictors. Journalists and the general public rush to any suggestion of earthquake prediction like hogs toward a full trough.

Annals of the New York Academy of Sciences, Ethical and Scientific Issues Posed by Human Uses of Molecular Genetics, Announcements  
*Bulletin American Seismological Society*, Volume 67, Number 4, August 1977 (p. 1246)



**Schrödinger, Erwin** 1887–1961  
Austrian theoretical physicist

...there are natural sciences which have obviously no practical bearing at all on the life of the human society: astrophysics, cosmology, and some branches of geophysics. Take, for instance, seismology. We know enough about earthquakes to know that there is very little chance of foretelling them, in the way of warning people to leave their houses, as we warn trawlers to return when a storm is drawing near.

*Science and Humanism: Physics in Our Time*  
The Spiritual Bearing of Science on Life (pp. 2–3)  
At The University Press. Cambridge, England. 1952

## SELF

**Pascal, Blaise** 1623–62  
French mathematician and physicist

When I consider the small span of my life absorbed in the eternity of all time, or the small part of space which I can touch or see engulfed by the infinite immensity of spaces that I know not and that know me not, I am frightened and astonished to see myself here instead of there...now instead of then.

In Rudy Rucker  
*Infinity and the Mind*  
Chapter 1 (p. 2)  
Princeton University Press. Princeton, New Jersey, USA. 1995

## SELF-AWARENESS

**Nuland, Sherwin B.** 1930–  
American surgeon and teacher of bioethics and medicine

Self-awareness has never been the strong suit of those who choose to become doctors. When so much fuel is readily available for stoking the fires of ego, there is little inclination to apply it in raising the candlepower of the searching light that might illumine the inner man or woman.

The Uncertain Art: The Whole Law of Medicine  
*The American Scholar*, Volume 67, Number 3, Summer, 1998

## SELF-DELUSION

**Sylvester, James Joseph** 1814–97  
English mathematician

It is difficult to estimate the lengths to which human self-delusion can be carried.

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 3)  
A Lady's Fan on Parallel Motion, and on an Orthogonal Web of Jointed Rods (p. 82)  
University Press. Cambridge, England. 1904–1912

## SEMINAR

**Djerassi, Carl** 1929–  
Austrian-born American organic chemist and educator

Seminar is not yet officially a transitive verb. Still, most graduate students in any large research-oriented university have at times felt themselves more the helpless objects of a seminar than its active participants. Seminared into numbness describes that feeling of oversaturation.

*Cantor's Dilemma 1989*  
Chapter 14 (p. 122)  
Penguin Group Inc. New York, New York, USA.

## SENSES

**Einstein, Albert** 1879–1955  
German-born physicist

We can only see the universe by the impressions of our senses reflecting indirectly the things of reality.

*Cosmic Religion, with Other Opinions and Aphorisms*  
On Science (p. 101)  
Covici-Fiede. New York, New York, USA. 1931

## SERIES

**Abel, Niels Henrik** 1802–29  
Norwegian mathematician

With the exception of the geometric series, there does not exist in all of mathematics a single infinite series whose sum has been determined rigorously.

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 29)  
Birkhäuser. Boston, Massachusetts, USA. 1987

The divergent series are the invention of the devil, and it is a shame to base on them any demonstration whatsoever. By using them, one may draw any conclusion he pleases and that is why these series have produced so many fallacies and so many paradoxes...

In Eli Maor  
*To Infinity and Beyond: A Cultural History of the Infinite* (p. 33)  
Birkhäuser. Boston, Massachusetts, USA. 1987

## SET THEORY

**Armstrong, David Malet** 1926–  
Australian philosopher

Set theory is peculiarly important...because mathematics can be exhibited as involving nothing but set-theoretical propositions about set-theoretical entities.

*A Combinatorial Theory of Possibility*  
Part I, Chapter 1, Section II (p. 10)  
Cambridge University Press. Cambridge, England. 1989

Philosophers have not found it easy to sort out sets...

*A Combinatorial Theory of Possibility*  
Part II, Chapter 9, Section iv (p. 133)  
Cambridge University Press. Cambridge, England. 1989

**Barwise, Jon** 1942–2000  
American mathematician, philosopher, and logician

**Moss, Lawrence**  
No biographical data available

Set theory has a dual role in mathematics. In pure mathematics, it is the place where questions about infinity are studied. Although this is a fascinating study of permanent interest, it does not account for the importance of set theory in applied areas. There the importance stems from the fact that set theory provides an incredibly versatile toolbox for building mathematical models of various phenomena.

*Vicious Circles: On the Mathematics of Non-Wellfounded Phenomena*  
Chapter 1 (p. 5)  
Center for the Study of Language and Information. Stanford, California, US. 1996

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

For a “mixt company” implies, that, save  
Yourself and friends, and half a hundred more,  
Whom you may bow to without looking grave,  
The rest are but a vulgar set.

*The Complete Poetical Works of Byron*  
Beppo: A Venetian Story  
Houghton Mifflin. Boston, Massachusetts, USA. 1933

**Cleveland, Richard**

No biographical data available

We can’t be assured of a full set,  
Or even a reasonable dull set.  
It wouldn’t be clear  
That there’s any set here,  
Unless we assume there’s a null set.

The Axioms of Set Theory  
*Mathematics Magazine*, Volume 52, Number 4, September 1979  
(pp. 256–257)

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Later generations will regard *Mengenlehre* as a disease from which one has recovered.

In Jeremy Gray  
Did Poincaré Say “Set Theory Is a Disease”?  
*The Mathematical Intelligencer*, Volume 13, Number 1, Winter 1991  
(p. 19)

**Quine, Willard Van Orman** 1908–2000

American logician and philosopher

To say that mathematics in general has been reduced to logic hints at some new firming up of mathematics at its

foundations. This is misleading. Set theory is less settled and more conjectural than the classical mathematical superstructure than can be founded upon it.

*Elementary Logic*  
Chapter IV, Section 48 (p. 125)  
Harper & Row, Publishers. New York, New York, USA. 1965

## SEX

**Heinlein, Robert A.** 1907–88

American science fiction writer

Sex is a learned art, as much so as ice skating or tight wire walking or fancy diving; it is not instinct. Oh, two animals couple by instinct, but it takes intelligence and patient willingness to turn copulation into a high and lively art.

*Time Enough for Love*  
Chapter XII (p. 314)  
G.P. Putnam’s Sons. New York, New York, USA. 1973

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Our civilization bothers us less with food tabus than with sexual restrictions. In modern society these have come to play the role of an injured deity that is getting its own back in every sphere of human activity, including psychology, where it would reduce “spirit” to sexual repression.

Translated by R.F.C. Hull  
*Flying Saucers: A Modern Myth of Things Seen in the Skies*  
Chapter Two (p. 45)  
Routledge & Kegan Paul. London, England. 1959

**Stoppard, Tom** 1937–

Czech-born English playwright

Lending one’s bicycle is a form of safe sex, possibly the safest there is.

*Arcadia*  
Act I, Scene Four (p. 51)  
Faber & Faber Ltd. London, England. 1993

**Watts, Alan Wilson** 1915–73

American philosopher

Perhaps one of the subordinate reasons why sex is a matter for laughter is that there is something ridiculous in “doing” it with set purpose and deliberation...

*Nature, Man, and Woman*  
Part II, Chapter 8 (p. 201)  
Vintage Books. New York, New York, USA. 1970

## SEXUALITY

**Linnaeus, Carl (von Linné)** 1707–78

Swedish botanist and explorer

The organs of generation, which in the animal kingdom are by nature generally removed from sight, in the

vegetable kingdom are exposed to the eyes of all, and that when their nuptials are celebrated, it is wonderful what delight they afford to the spectator by their most beautiful colors and delicious odors.

*Oeconomia naturae*

*Amoenitates Academicæ*, Volume 2, 1752 (p. 16)

By what mechanisms are the sexuality of the worker naked mole rats suppressed, and how does the queen exert her supremacy? Research at London's Institute of Zoology by Chris Faulkes and others shows surprisingly that the main mechanism are not pheromonal (chemical) as we might immediately suppose. Mysteriously, it is the queenly presence, her behavior, that keeps the rest so firmly switched off; which one of the British researcher has called the "Thatcher effect."

*New Scientist*, Volume 131, No 1780, 3 August 1991 (p. 43)

## SHADOW

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

In the world of physics we watch a shadowgraph performance of familiar life. The shadow of my elbow rests on the shadow-tables as the shadow-ink flows over the shadow-paper...The frank realisation that physical science is concerned with a world of shadows is one of the most significant of recent advances.

*The Nature of the Physical World*

Introduction (p. xiv, xv)

The Macmillan Company. New York, New York, USA. 1930

## SHAPES

**Lovecraft, H. P. (Howard Phillips)** 1890–1937

American writer of fantasy, horror, and science fiction

They told him that every figure of space is but the result of the intersection by a plane of some corresponding figure of one or more dimension — as a square is cut from a cube, or a circle from a sphere.

Through the Gates of the Silver Key

*Weird Tales*, Chapter 5, Volume 24, Number 1, July 1934

## SHELL

**Glaessner, M. F.** 1906–1989

Australian paleontologist and professor of pre-Cambrian life

The naive assumption that shells are acquired because they protect soft bodies seems influenced by anthropocentric thinking: man uses shields for protection from aggressors.

*The Dawn of Animal Life: A Biohistorical Study*

Chapter 4.6 (p. 174)

Cambridge University Press. Cambridge, England. 1984

**Hooke, Robert** 1635–1703

English physicist

I...humbly conceive (tho' some possibly may think there is too much notice taken of such a trivial thing as a rotten Shell, yet) that Men do generally too much...pass over without regard these Records of Antiquity which Nature have left as Monuments and Hieroglyphick Characters of preceding Transactions in the like duration or Transactions of the Body of the Earth, which are infinitely more evident and certain tokens than any thing of Antiquity that can be fetched out of Coins or Medals...since the best of those ways may be counterfeited or made by Art and Design...

*The Posthumous Works of Robert Hooke*

A Discourse on Earthquakes (p. 411)

S. Smith & B. Walford. London, England. 1705

**Hsi, Chu (Zhu Xi)** 1130–1200

Chinese philosopher

I have seen on high mountains conchs and oyster shells, often embedded in the rocks. These rocks in ancient times were earth or mud, and the conchs and oysters lived in water. Subsequently everything that was at the bottom came to be at the top, and what was originally soft became solid and hard. One should meditate deeply on such matters, for these facts can be verified.

In Joseph Needham

*Science and Civilisation in China* (Volume 3)

Chapter 23 (p. 598 ff)

The University Press. Cambridge, England. 1954

**Tennyson, Alfred (Lord)** 1809–92

English poet

See what a lovely shell,  
Small and pure as pearl,  
Lying close to my foot,  
Frail, but a work divine,  
Made so fairly well,  
With delicate spire and whorl,  
How exquisitely minute,  
A miracle of design!

*Alfred Tennyson's Poetical Works*

Maud, Part II, Section II, Stanza I

Oxford University Press, Inc. London, England. 1953

## SHORE

**Carson, Rachel** 1907–64

American marine biologist and author

...the shore has a dual nature, changing with the swing of the tides, belonging now to the land, now to the sea. On the ebb tide it knows the harsh extremes of the land world, being exposed to heat and cold, to wind, to rain and drying sun. On the flood side it is a water world, returning briefly to the relative stability of the open sea.

*The Edge of the Sea*  
Chapter I (p. 1)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

The shore is an ancient world, for as long as there has been an earth and sea there has been this place of the meeting of land and water.

*The Edge of the Sea*  
Chapter I (p. 2)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

I with my hammer pounding evermore  
The rocky coast, smite Andes into dust,  
Strewing by beds and, in another age,  
Rebuild a continent for better men.

*The Complete Works of Ralph Waldo Emerson* (Volume 9)  
Seashore (p. 243)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

## SICKNESS

**Barnes, Djuna** 1892–1982  
American author

No man needs curing of his individual sickness; his universal malady is what he should look to.

*Nightwood*  
La Somnambule (p. 41)  
Harcourt, Brace & Company. New York, New York, USA. 1937

**Burton, Robert** 1577–1640  
English clergyman and scholar

Sickness is the mother of modesty, putteth us in minde of our mortality; and, when wee are in the full careere of worldly pompe and jollity, she pulleth us by the eare, and maketh us knowe ourselves.

*The Anatomy of Melancholy* (Volume 1)  
Part II, Sect. III, Memb. IV, Subsect. 6 (p. 399)  
AMS Press, Inc. New York, New York, USA. 1973

**Chrysostom, John** ?–407  
Christian bishop and preacher

Princes, Masters, Parents, Magistrates, Judges, Friends, Eniemies, faire or foule meanes cannot containe, us; but a little sickness will correct and amend us.

In Robert Burton  
*The Anatomy of Melancholy* (Volume 2)  
Part II, Sect. III, Memb. II (p. 157)  
AMS Press, Inc. New York, New York, USA. 1973

**Donne, John** 1572–1631  
English poet and divine

And can there be worse sickness, than to know that we are never well, nor can be so?

*An Anatomy of the World*  
The First Anniversary, l. 93–4

Presented for presentation to members of the Roxburghe Club. Cambridge, England. 1951

**Dunlap, William** 1766–1839  
American dramatist and theatrical manager

He seems a little under the weather, somehow; and yet he's not sick.

*The Memoirs of a Water Drinker* (Volume 1)  
Chapter VIII (p. 80)  
Saunders & Otley. New York, New York, USA. 1837

**Dunne, Finley Peter** 1867–1936  
American journalist and humorist

...whin a man's sick, he's sick an' nawthin' will cure him or annything will.

*Mr. Dooley Says*  
Drugs (p. 97)  
Charles Scribner's Sons. New York, New York, USA. 1910

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

It is dainty to be sick, if you have leisure and convenience for it.

*Journals of Ralph Waldo Emerson 1838–1841*  
February 7, 1839 (p. 162)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

For sickness is a cannibal which eats up all the life and youth it can lay hold of, and absorbs its own sons and daughters.

*Ralph Waldo Emerson: Essays and Lectures*  
The Conduct of Life  
Consideration by the Way (p. 1088)  
The Library of America. New York, New York, USA. 1983

**Fuller, Thomas** 1608–61  
English clergyman and author

He who was never sick dies the first fit.

In Thomas Fuller  
*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings. Ancient and Modern, Foreign and British*  
Proverb  
Printed for Thomas & Joseph Allman. London, England. 1816

**Harris, Joel Chandler** 1848–1908  
American journalist

You know w'at de jay-bird say ter der squinch-owls!, "I'm sickly but sassy."

*The Complete Tales of Uncle Remus*  
Chapter 50 (p. 311)  
Houghton Mifflin Company. New York, New York, USA. 1955

**Halsted, Anna Roosevelt** 1906–75  
Daughter of Franklin and Eleanor Roosevelt

There are so many indignities to being sick and helpless...

In Joseph P. Lash  
*Eleanor: The Years Alone*

To The End, Courage, Letter to David Gray, November 1, 1962 (p. 327)  
W.W. Norton & Company, Inc. New York, New York, USA. 1972

**Hood, Thomas** 1799–1845

English poet and editor

I'm sick of gruel, and the dietics,  
I'm sick of pills, and sicker of emetics,  
I'm sick of pulse, tardiness or quickness,  
I'm sick of blood, its thinness or its thickness, —  
In short, within a word, I'm sick of sickness!

*The Poetical Works of Thomas Campbell* (Volume 2)

Fragment (p. 424)

Wiley & Long. New York, New York, USA. 1836

**Jonson, Ben** 1573?–1637

English dramatist and poet

Take heed, sickness, what you do,  
I shall fear you'll surfeit too.  
Live not we, as all they stalls,  
Spittles, pest-house, Hospitals,  
Scarce will take our present store?

In Robert Bell

*The Poems of Robert Greene, Christopher Marlowe, and Ben Jonson*

The Forest, Viii. To Sickness

Hurst & Company. New York, New York, USA. ca. 1880

**Johnson, Samuel** 1696–1772

English critic, biographer, and essayist

... what can a sick man say, but that he is sick?

*Boswell's "Life of Samuel Johnson"*

August, 1784 (p. 1347)

Oxford University Press, Inc. Oxford, England. 1965

**Lamb, Charles** 1775–1834

English essayist and critic

How sickness enlarges the dimensions of a man's self to himself! he is his own exclusive object. Supreme selfishness is inculcated upon him as his only duty.

*Essays of Elia*

The Convalescent (p. 330)

Henry Altemus. Philadelphia, Pennsylvania, USA. 1893

If there be a regal solitude, it is a sick-bed. How the patient lords it there; what caprices he acts without control! how kinglike he sways his pillow-tumbling, and tossing, and shifting, and lowering, and thumping, and flattening, and molding it, to the ever-varying requisitions of his throbbing temples.

*Essays of Elia*

The Convalescent (p. 329)

Henry Altemus. Philadelphia, Pennsylvania, USA. 1893

**Luttrell, Henry** 1765–1851

English wit and writer

Come, come, for trifles never stick:  
Most servants have a failing;  
Yours, it is true, are sometimes sick,  
But mine are always ale-ing.

In William Davenport Adams

*English Epigrams*

On Ailing and Ale-ing, dclxxiii

G. Routledge. London, England. 1878

**Milton, John** 1608–74

English poet

...all maladies

Of ghastly Spasm, or racking torture, qualms  
Of heart-sick Agonie, all feverous kinds,  
Convulsions, Epilepsies, fierce Catarrhs,  
Intestine Stone and Ulcer, Colic pangs,  
Dropsies and Asthmas, and Joint-racking Rheums.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book XI, l. 480–485

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**O'Connor, Flannery** 1926–64

American author

I have never been anywhere but sick. In a sense sickness is a place, more instructive than a long trip to Europe, and it's always a place where there's no company, where nobody can follow. Sickness before death is a very appropriate thing and I think those who don't have it miss one of God's mercies.

*The Habit of Being*

Part II (p. 163)

Farrar, Straus & Giroux, Inc. New York, New York, USA. 1988

**Roy, Gabrielle** 1909–83

Canadian author

The Christian Scientists held that it was not God Who wanted sickness, but man who [put] himself in the way of suffering. If this were the case, though, wouldn't we all die in perfect health?

Translated by Harry Binsse

*The Cashier*

Chapter 3 (pp. 36–37)

Harcourt, Brace. New York, New York, USA. 1955

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

This sickness doth infect

The very life-blood of our enterprise.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The First Part of King Henry the Fourth

Act IV, Scene i, l. 28–29

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

What, is Brutus sick,

And will he steal out of his wholesome bed,

To dare the vile contagion of the night?

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Julius Caesar

Act II, Scene i, l. 263–265

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Sickness is catching.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
 A Midsummer-Night's Dream  
 Act I, Scene i, l. 186  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

My long sickness

Of health and living now begins to mend,

And nothing brings me all things.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Timon of Athens  
 Act V, Scene i, l. 189–191  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sterne, Laurence** 1713–68

English novelist and humorist

I am sick as a horse...

*The Life and Opinions of Tristram Shandy, Gentleman, and A Sentimental Journey Through France and Italy* (Volume 2)  
 Book VII, Chapter II (p. 66)  
 Macmillan & Company Ltd. London, England. 1900

**Swift, Jonathan** 1667–1745

Irish-born English writer

Poor Miss, she's sick as a Cushion...

*The Prose Works of Jonathan Swift* (Volume the Fourth)  
 Polite Conversation, Dialogue I (p. 153)  
 Printed at the Shakespeare Head Press. Oxford, England. 1939–1968

**Weingarten, Violet**

Writer

Sickness, like sex, demands a private room, or at the very least, a discrete curtain around the ward bed.

*Intimations of Mortality* (p. 3)  
 Alfred A. Knopf. New York, New York, USA. 1978

**Wolfe, Thomas** 1900–38

American novelist

Most of the time we think we're sick it's all in the mind.

*Look Homeward, Angel*  
 Part I, Chapter I (p. 11)  
 Simon & Schuster. New York, New York, USA. 1995

## SIGHT

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

I refer to the use of dioptric media which correct the diminished refracting power of the humors of the eye, — in other words, spectacles. I don't use them. All I ask is a large, fair type, a strong daylight or gas-light, and one yard of focal distance, and my eyes are as good as ever.

*The Autocrat of the Breakfast-Table*  
 Chapter VII (p. 173)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Marsh, George Perkins** 1801–82

American scholar, author, and statesman

Sight is a faculty; seeing, an art.

*The Earth as Modified by Human Action: A New Edition of Man and Nature*

Chapter I (p. 12)  
 Scribner, Armstrong & Company. New York, New York, USA. 1874

**Plato** 428 BCE–347 BCE

Greek philosopher

The sight in my opinion is the source of the greatest benefit to us, for had we never seen the stars, and the sun, and the heaven, none of the words which we have spoken about the universe would ever have been uttered. But now the sight of day and night, and the months and the revolutions of the years, have created number, and have given us a conception of time, and the power of enquiring about the nature of the universe...

In *Great Books of the Western World* (Volume 7)  
*Timaeus*  
 Section 40 (p. 455)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## SIMPLICITY

**Bailey, Janet**

No biographical data available

It is an article of faith in physics that the world's bewildering mask of complexity hides an ultimate simplicity.

*The Good Servant: Making Peace with the Bomb at Los Alamos*  
 Chapter 4 (p. 110)  
 Simon & Schuster. New York, New York, USA. 1995

**Chandrasekhar, Subrahmanyan** 1910–95

Indian-born American astrophysicist

The simple is the seal of the true and beauty is the splendor of truth.

*Nobel Lectures, Physics 1981–1990*  
 Nobel lecture for award received in 1983  
 On Stars, Their Evolution and Their Stability (p. 163)  
 World Scientific Publishing Company. Singapore. 1993

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

We study the complex in the simple; and only from the intuition of the lower can we safely proceed to the intellection of the higher degrees. The only danger lies in the leaping from low to high, with the neglect of the intervening gradations.

*Hints Towards the Formation of a More Comprehensive Theory of Life*  
 Physiology of Life (p. 41)  
 Lea & Blanchard. Philadelphia, Pennsylvania, USA, 1848

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Whether mathematical simplicity is God's affair or our, the fact remains that this feature more than any other remains the mainspring of progress in the physical sciences.

*The Edge of Infinity: Where the Universe Came from and How It Will End*

Chapter 9 (p. 188)

Simon & Schuster. New York, New York, USA. 1981

### **Davy, Sir Humphry** 1778–1829

English chemist

Complexity almost always belongs to the early epochs of every science; and the grandest results are usually obtained by the most simple means.

*The Collected Works of Sir Humphry Davy* (Volume 4 )

Elements of Chemical Philosophy

Part I, Introduction (p. 41)

Smith, Elder & Company. London, England. 1839–1840

The more the phenomena of the universe are studied, the more distinct their connection appears, the more simple their causes, the more magnificent their design, and the more wonderful the wisdom and power of their author.

*The Collected Works of Sir Humphry Davy* (Volume 4 )

Elements of Chemical Philosophy

Part I, Introduction (p. 42)

Smith, Elder & Company. London, England. 1839–1840

Have you ever thought... about whatever man builds, that all of man's industrial efforts, all his calculations and computations, all the nights spent over working draughts and blueprints, invariably culminate in the production of a thing whose sole and guiding principle is the ultimate principle of simplicity?

*Wind, Sand and Stars*

Chapter 3 (p. 65)

Reynal & Hitchcock. New York, New York, USA. 1939

In any thing at all, perfection is finally attained, not when there is no longer anything to add, but when there is no longer anything to take away.

*Wind, Sand and Stars*

Chapter 3 (p. 66)

Reynal & Hitchcock. New York, New York, USA. 1939

### **du Noüy, Pierre Lecomte** 1883–1947

French scientist

The complex is not always profound; but the profound is not necessarily simple.

*The Road to Reason*

Chapter 5 (p. 115)

Longmans, Green & Company. London, England. 1949

### **Einstein, Albert** 1879–1955

German-born physicist

Control by experiment...is, of course, an essential prerequisite of the validity of any theory. But one can't possibly test everything. That is why I am so interested in

your remarks about simplicity. Still, I should never claim that I really understood what is meant by the simplicity of natural laws.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 5 (p. 69)

Harper & Row, Publishers. New York, New York, USA. 1971

In every important advance the physicist finds that the fundamental laws are simplified more and more as experimental research advances. He is astonished to notice how sublime order emerges from what appeared to be chaos. And this cannot be traced back to the workings of his own mind but is due to a quality that is inherent in the world of perception. Leibniz well expressed this quality by calling it a pre-established harmony.

In Max Planck

*Where Is Science Going?*

Prologue (p. 11)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Nothing is more simple than greatness; indeed, to be simple is to be great.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures (p. 100)

The Library of America. New York, New York, USA. 1983

### **Feynman, Richard P.** 1918–88

American theoretical physicist

Perhaps a thing is simple if you can describe it fully in several different ways without immediately knowing that you are describing the same thing.

*Nobel Lectures, Physics 1963–1970*

Nobel lecture for award received in 1965

The Development of the Space-Time View of Quantum Electrodynamics  
Elsevier Publishing Company. Amsterdam, Netherlands. 1972

The answer to all these questions may not be simple. I know there are some scientists who go about preaching that Nature always takes on the simplest solutions. Yet the simplest solution by far would be nothing, that there should be nothing at all in the universe. Nature is far more inventive than that, so I refuse to go along thinking it always has to be simple.

*Feynman Lectures on Gravitation*

Lecture 13 (p. 186)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1995

### **Fuller, Thomas** 1608–61

English clergyman and author

Generally nature hangs out a sign of simplicity in the face of a fool.

*The Holy and Profane State*

Book III, Chapter XII, Maxim I

Maxim I (p. 171)

Printed for Thomas Tegg. London, England. 1841

**Gibran, Kahlil** 1883–1931  
Lebanese-American philosophical essayist

The obvious is that which is never seen until someone expresses it simply.

*Sand and Foam: A Book of Aphorisms* (p. 54)  
Alfred A. Knopf. New York, New York, USA. 1959

**Goodman, Nelson** 1906–98  
American philosopher

All scientific activity amounts to the invention of and the choice among systems of hypotheses. One of the primary considerations guiding this process is that of simplicity. Nothing could be much more mistaken than the traditional idea that we first seek a true system and then, for the sake of elegance alone, seek a simple one.

The Test of Simplicity  
*Science*, Volume 128, 1958 (p. 1064)

**Gore, George** 1826–1909  
English electrochemist

Simplicity, whether truthful or not, is often attractive to unphilosophical minds, because it requires less intellectual exertion.

*The Art of Scientific Discovery*  
Chapter IV (p. 29)  
Longmans, Green & Company. London, England. 1878

**Grimaux, L. E.**  
No biographical data available

**Gerhardt, C.**  
No biographical data available

The chemist must always compare the results of his experiments with those which precede them; for it is by this comparison alone that little by little we arrive at general laws, and consequently at the simplification of science.

In Russell McCormmach (ed.)  
*Historical Studies in the Physical Sciences* (Volume 6)  
In John Hedley Brooke  
Laurent, Gerhardt, and the Philosophy of Chemistry (p. 424)  
Princeton University Press. Princeton, New Jersey, USA. 1975

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

In scientific thought we adopt the simplest theory which will explain all the facts under consideration and enable us to predict new facts of the same kind. The catch in this criterion lies in the word “simplest.” It is really an aesthetic canon such as we find implicit in our criticisms of poetry or painting. The layman finds such a law as  $x/t = k(2x/y^2)$  less simple than “it oozes,” of which it is the mathematical statement. The physicist reverses this judgment.

*On Being the Right Size and Other Essays*  
Science and Theology as Art-Forms (pp. 33–34)  
Oxford University Press, Inc. Oxford, England. 1985

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

You [to Einstein] must have felt this too: the frightening simplicity and wholeness of the relationships which nature suddenly spreads out before us and for which none of us was in the least prepared.

*Physics and Beyond: Encounters and Conversations*  
Chapter 5 (p. 69)  
Harper & Row, Publishers. New York, New York, USA. 1971

You may object that by speaking of simplicity and beauty I am introducing aesthetic criteria of truth, and I frankly admit that I am strongly attracted by the simplicity and beauty of the mathematical schemes which nature presents us. You must have felt this too: the almost frightening simplicity and wholeness of the relationships, which nature suddenly spreads out before us...

*Physics and Beyond: Encounters and Conversations*  
Chapter 5 (pp. 68–69)  
Harper & Row, Publishers. New York, New York, USA. 1971

**Hoagland, Mahlon** 1921–  
American biochemist

It is often the scientist’s experience that he senses the nearness of truth when such connections are envisioned. A connection is a step toward simplification, unification. Simplicity is indeed often the sign of truth and a criterion of beauty.

*Toward the Habit of Truth: A Life in Science*  
Preface (p. xxiii)  
W.W. Norton & Company, Inc. New York, New York, USA. 1990

**Hoffer, Eric** 1902–83  
American longshoreman and philosopher

It is not at all simple to understand the simple.

*The Passionate State of Mind, and Other Aphorisms*  
No. 230  
Harper & Brothers. New York, New York, USA. 1955

**Hoffmann, Hans** 1848–1904  
German novelist

The ability to simplify means to eliminate the unnecessary so that the necessary may speak.

In Bradley Efron and Robert J. Tibshirani  
*An Introduction to the Bootstrap*  
Preface (p. xiv)  
Chapman & Hall. New York, New York, USA. 1993

**Jevons, William Stanley** 1835–82  
English economist and logician

Simplicity is naturally agreeable to a mind of limited powers, but to an infinite mind all things are simple.

*The Principles of Science: A Treatise on Logic and Scientific Method*  
Book V, Chapter XXVII (p. 625)  
Macmillan & Company. London, England. 1887



**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

It would be simple enough, if only simplicity were not the most difficult of all things.

Translated by R.F.C. Hull

*Alchemical Studies*

Modern Psychology Offers a Possibility of Understanding (p. 16)  
Princeton University Press. Princeton, New Jersey, USA. 1967

**Lavoisier, Antoine Laurent** 1743–94

French chemist

In performing experiments, it is a necessary principle, which ought never to be deviated from, that they be simplified as much as possible, and that every circumstance capable of rendering their results complicated be carefully removed.

*Elements of Chemistry in a New Systematic Order*

Translated by Kerr (p. 103)

W. Creech. Edinburgh, Scotland. 1790

**Lindley, Dennis V.** 1923–

American statistician

I believe that almost all important, useful ideas are simple. Peter Whittle has recently put it nicely in an autobiographical essay. “If a piece of work is heavy and complicated then it is wrong. . . .” Some writers feel that to express their ideas in simple terms is degrading. Some use complexity to disguise the paucity of their material. In fact, simplicity is a virtue and when, as here, it is both original and useful, it can represent a real advance in knowledge.

Simplicity

*RSS News*, April 1995 (p. 1)**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

The point is to simplify and to order knowledge. The profession I’m part of has as its whole function the rendering of the physical world understandable and beautiful. Otherwise, you have only tables and statistics.

With Oppenheimer on an Autumn Day

*Look*, Volume 30, Number 26, 27 December 1966 (p. 63)**Percy, Walker** 1916–90

American writer

It is not merely the truth of science that makes it beautiful, but its simplicity.

*Signposts in a Strange Land*

From Fact to Fiction (p. 187)

Farrar, Straus &amp; Giroux. New York, New York, USA. 1991

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

...it is because simplicity, because grandeur, is beautiful that we preferably seek simple facts, sublime facts,

that we delight now to follow the majestic courses of the stars, now to examine with the microscope that prodigious littleness which is also grandeur, now to seek in geologic time the traces of a past which attracts because it is far away.

*The Foundations of Science*

Science and Method, Book I

Chapter I (p. 367)

The Science Press. New York, New York, USA. 1913

**Rainich, G. Y.** 1886–1968

Ukrainian mathematical physicist

...the really fundamental things have a way of appearing to be simple once they have been stated by a genius. . . .

Analytic Function and Mathematical Physics

*Bulletin of the American Mathematical Society*, October 1931 (p. 700)**Reid, Thomas** 1710–96

Scottish philosopher

Men are often led into errors by the love of simplicity, which disposes us to reduce things to few principles, and to conceive a greater simplicity in nature than there really is.

*Essays on the Intellectual Powers of Man*

Essay VI, Chapter VIII (p. 656)

Printed for John Bell. London, England. 1785

**Schumacher, Ernst Friedrich** 1911–77

German-born English economist

...it is rather more difficult to recapture directness and simplicity than to advance in the direction of ever more sophistication and complexity. Any third-rate engineer or researcher can increase complexity; but it takes a certain flair of real insight to make things simple again.

*Small Is Beautiful*

Part II, Chapter 5 (p. 146)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

**Slobodkin, Lawrence B.**

American ecologist and evolution scientist

The awkward richness of possibilities seems to shatter any possible coherent theory of simplicity...

*Simplicity and Complexity in Games of the Intellect*

Chapter 10 (p. 204)

Harvard University Press. Cambridge, Massachusetts, USA. 1992

**Smith, George Otis** 1871–1944

American geologist

I am convinced that, at its best, science is simple — that the simplest arrangement of facts that sets forth the truth best deserves the term scientific. So the geology I plead for is that which states facts in plain words — in language understood by the many rather than only by the few. Plain geology needs little defining, and I may state my case best by trying to set forth the reasons why we have strayed so far away from the simple type.

Plain Geology

*Economic Geology*, Volume 17, Number 1, 1922 (p. 34)

### Stone, David

No biographical data available

One man's "simple" is another man's "huh?"

*OMNI Magazine*, May 1979

### Teague, Jr., Freeman

No biographical data available

Nothing is so simple it cannot be misunderstood.

*OMNI Magazine*, May 1979

### Teller, Edward 1908–2003

Hungarian-born American nuclear physicist

### Sylvester, James Joseph 1814–97

English mathematician

No endeavor that is worthwhile is simple in prospect; if it is right, it will be simple in retrospect.

*The Pursuit of Simplicity*

Chapter Five (p. 152)

Pepperdine University Press, Malibu. 1981

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

Simplify. Simplify.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter II (p. 144)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

It's as simple as tit-tat-toe, three-in-a-row, and as easy as playing hooky. I should hope we can find a way that's a little more complicated than that...

*The Adventures of Huckleberry Finn*

Chapter XXXIV (p. 298)

Grosset & Dunlap Publishers. New York, New York, USA. 1948

### Wright, Frank Lloyd 1867–1959

American architect

To know what to leave out and what to put in; just where and just how, ah, that is to have been educated in knowledge of simplicity...

*Frank Lloyd Wright: An Autobiography*

Simplicity (p. 144)

Duell, Sloan & Pearce. New York, New York, USA. 1943

## SIMULTANEITY

### Bridgman, Percy Williams 1882–1961

American physicist

Einstein, in thus analyzing what is involved in making a judgment of simultaneity, and in seizing on the act of the observer as the essence of the situation, is actually adopting a new point of view as to what the concepts of physics should be, namely, the operational view.

*The Logic of Modern Physics*

Chapter I (p. 8)

The Macmillan Company. New York, New York, USA. 1927

### Medawar, Sir Peter Brian 1915–87

Brazilian-born English zoologist

Simultaneous discovery is utterly commonplace, and it was only the rarity of scientists, not the inherent improbability of the phenomenon, that made it remarkable in the past. Scientists on the same road may be expected to arrive at the same destination, often not far apart.

*The Act of Creation*

*New Statesman*, 19 June 1964

## SINGULARITY

### Barrow, John D. 1952–

English theoretical physicist

In recent years cosmologists have begun to discuss the spontaneous creation of the Universe as a problem in physics. Those who do this assume that a future synthesis of quantum theory and relativity which reveals how gravity behaves when matter is enormously compressed will evade the predictions of a real singularity of the type required by the singularity theorems. Although the assumptions of the singularity theorems are not expected to hold near the singularity, we do not know whether to expect a singularity or not as yet. But even in the absence of this singularity to denote the beginning of the Universe, it has been speculated that the application of quantum theory to the whole Universe may allow physical content to be given to the concept of "creation of the Universe out of Nothing." The goal of this research is to show that the creation of an expanding universe is inevitable. The reason there is something rather than nothing is that "nothing" is unstable.

*The World within The World* (p. 230)

Clarendon Press. Oxford, England. 1988

### Hawking, Stephen William 1942–

English theoretical physicist

We showed that if general relativity is correct, any reasonable model of the universe must start with a singularity. This would mean that science could predict that the universe must have had a beginning, but that it could not predict how the universe should begin: For that, one would have to appeal to God... Now, as a result of the singularity theorems, nearly everyone believes that the universe began with a singularity, at which the laws of

physics broke down. However, I now think that although there is a singularity, the laws of physics can still determine how the universe began.

*Black Holes and Baby Universes and Other Essays*  
Chapter Nine (p. 91)  
Bantam Books. New York, New York, USA. 1987

## SITE

**Bagnold, Ralph A.** 1896–1990  
English officer and engineer

There is an unfailing joy in identifying oneself with the actual sites where great things happened long ago. It appeals to a very human trait in all of us.

*Libyan Sands: Travel in a Dead World*  
Chapter III (p. 74)  
Hodder & Stoughton. London, England. 1941

**Woolley, Sir Charles Leonard** 1880–1960  
English archaeologist

If the field archaeologist had his will, every ancient capital would have been overwhelmed by the ashes of a conveniently adjacent volcano. It is with green jealousy that the worker on other sites visits Pompeii and sees the marvelous preservation of its buildings, the houses standing up to the second floor, the frescoes on the walls and all the furniture and household objects still in their places as the owners left them as they fled from the disaster.

*Digging Up the Past*  
Chapter I (p. 19)  
Charles Scribner's Sons. New York, New York, USA. 1931

## SIZE

**Hardy, Thomas** 1840–1928  
English poet and regional novelist

There is a size at which dignity begins; further on there is a size at which grandeur begins; further on there is a size at which solemnity begins; further on, a size at which awfulness begins; further on, a size at which ghastliness begins. That size faintly approaches the size of the stellar universe.

*Two on a Tower*  
Chapter IV (p. 35)  
Harper & Brothers. New York, New York, USA. No date

The vastness of the field of astronomy reduces every terrestrial thing to atomic dimensions.

*Two on a Tower*  
Chapter XXXIV (p. 258)  
Harper & Brothers. New York, New York, USA. No date

**Scott Cary**  
Fictional character

The unbelievably small and the unbelievably vast eventually meet — like the closing of a gigantic

circle. I looked up, as if somehow I would grasp the heavens. The universe, worlds beyond number, God's silver tapestry spread across the night. And in that moment, I knew the answer to the riddle of the infinite. I had thought in terms of man's own limited dimension. I had presumed upon nature. That existence begins and ends in man's conception, not nature's. And I felt my body dwindling, melting, becoming nothing. My fears melted away. And in their place came acceptance. All this vast majesty of creation, it had to mean something. And then I meant something, too. Yes, smaller than the smallest. I meant something, too. To God there is no zero. I still exist!

*The Incredible Shrinking Man*  
Film (1957)

**Shapley, Harlow** 1885–1972  
American astronomer

The atomically small leads directly to the size really immense.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1946*

On the Astronomical Dating of the Earth's Crust (p. 140)  
Government Printing Office. Washington, D.C. 1947

## SKELETON

**Selzer, Richard** 1928–  
American physician and essayist

What man does not ponder the whereabouts of his skeleton — the place where it will lie? Say what you will, all sanitary and pragmatic considerations aside, these jaunty saunterers that have held us upright, have stiffened us against the grate and grind of life, are dear to us. What stands closer to a man all his days than his bones?

*Mortal Lessons*  
Bone (pp. 54–55)  
Simon & Schuster. New York, New York, USA. 1976

## SKEPTICISM

**Darwin, Charles Robert** 1809–82  
English naturalist

I am not very skeptical — a frame of mind which I believe to be injurious to the progress of science. A good deal of skepticism in a scientific man is advisable to avoid too much loss of time, but I have met with not a few men, who, I feel sure, have often thus been deterred from experiment or observations which would have proved directly or indirectly serviceable.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Chapter II (p. 83)  
D. Appleton & Company. New York, New York, USA. 1896

**Gould, Stephen Jay** 1941–2002

American paleontologist, evolutionary biologist, and historian of science

Skepticism or debunking often receives the bad rap reserved for activities — like garbage disposal — that absolutely must be done for a safe and sane life, but seem either unglamorous or unworthy of overt celebration. Yet the activity has a noble tradition, from the Greek coinage of “skeptic” (a word meaning “thoughtful”) to Carl Sagan’s...The Demon-Haunted World.... Skepticism is the agent of reason against organized irrationalism — and is therefore one of the keys to human social and civic decency.... Skepticism’s bad rap arises from the impression that, however necessary the activity, it can only be regarded as a negative removal of false claims. Not so.... Proper debunking is done in the interest of an alternate model of explanation, not as a nihilistic exercise. The alternate model is rationality itself, tied to moral decency — the most powerful joint instrument for good that our planet has ever known.

In Michael Shermer

*Why People Believe Weird Things: Pseudoscience, Superstition, and Other Confusions of Our Time*

Foreword (pp. ix–xii)

Henry Holt & Company, New York, New York, USA. 2002

**Raymo, Chet** 1936–

American physicist and science writer

Skepticism is a critical reluctance to take anything as absolute truth, even one’s own most cherished beliefs. Astonishment is the ability to be dazzled by the commonplace. At first glance these two qualities might seem opposed. The Skeptic is often thought to lack passionate commitment. The easily astonished person is sometimes thought of as gullible. In fact reasoned skepticism does not preclude passionate belief, and astonishment is enhanced by knowledge.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Fourteen (pp. 252–253)

Walker & Company, New York, New York, USA. 1998

The difference between Skeptics and True Believers is not that Skeptics believe what is sensible and obvious, while True Believers accept what is fanciful and far-fetched. Often, it is the other way around.

*Skeptics and True Believers: The Exhilarating Connection Between Science and Religion*

Chapter Two (p. 27)

Walker & Company, New York, New York, USA. 1998

**Sagan, Carl** 1934–96

American astronomer and author

...science requires the most vigorous and uncompromising skepticism, because the vast majority of ideas are simply wrong, and the only way to winnow the wheat from the chaff is by critical experiment and analysis.

*The Demon-Haunted World: Science as a Candle in the Dark*  
Chapter 17 (p. 305)

Random House, Inc. New York, New York, USA. 1995

Finding the occasional straw of truth awash in a great ocean of confusion and bamboozle requires vigilance, dedication, and courage. But if we don’t practice these tough habits of thought, we cannot hope to solve the truly serious problems that face us — and we risk becoming a nation of suckers, a world of suckers, up for grabs by the next charlatan who saunters along.

*The Fine Art of Baloney Detection*

*Parade*, February 1, 1987

**Schrödinger, Erwin** 1887–1961

Austrian theoretical physicist

Skepticism alone is a cheap and barren affair. Skepticism in a man who has come nearer to the truth than anyone before, and yet clearly recognizes the narrow limits of his own mental construction, is great and fruitful, and does not reduce but doubles the value of the discoveries.

*Nature and the Greeks*

Chapter II (p. 31)

At The University Press. Cambridge, England. 1954

**SKIN****Levi, Primo** 1919–87

Italian writer and chemist

I live in my house as I live inside my skin: I know more beautiful, more ample, more sturdy and more picturesque skins: but it would seem to me unnatural to exchange them for mine.

*Other People’s Trades*

My House

Summit Books, New York, New York, USA. 1989

**Selzer, Richard** 1928–

American physician and essayist

I sing of skin, layered fine as baklava, whose colors shame the dawn, at once the scabbard upon which is writ our only signature, and the instrument by which we are thrilled, protected, and kept constant in our natural place. Here is each man bagged and trussed in perfect amiability.

*Mortal Lessons*

Skin (p. 105)

Simon & Schuster, New York, New York, USA. 1976

**SKY****Astronomy Survey Committee**

Nature offers no greater splendor than the starry sky on a clear, dark night. Silent, timeless, jeweled with the constellations of ancient myth and legend, the night sky has inspired wonder throughout the ages.

*Astronomy and Astrophysics for the 1980s*  
Volume 1, Report to the Astronomy Survey Committee (p. 3)

**Brahe, Tycho** 1546–1601  
Danish astronomer

*O crassia ingenia, O coecos coeli spectatores.*  
O thick wits. Oh blind watchers of the sky.  
*De Nova Stella*  
Preface

**Brandt, John C.**  
No biographical data available

**Chapman, Robert D.**  
No biographical data available

... each step forward in unraveling the mystery of comets (or any other natural phenomenon) brings great pleasure to all who look to the sky as a source of beauty and intellectual challenge.

*Introduction to Comets*  
Chapter 10 (p. 226)  
Cambridge University Press. Cambridge, England. 1981

**Browning, Robert** 1812–89  
English poet

Sky — what a scowl of cloud  
Till, near and far,  
Ray on ray split the shroud  
Splendid, a star!  
*The Poems and Plays of Robert Browning*  
The Two Poets of Croisic  
The Modern Library. New York, New York, USA. 1934

**Bunch, Sterling**  
American poet and editor

In starry skies, long years ago,  
I found my Science. Heart aglow  
I watched each night unfold a maze  
Of mystic suns and worlds ablaze,  
That spoke: “Know us and wiser grow.”  
In *Starry Skies*  
*Popular Astronomy*, Volume 34, 1926 (p. 288)

**de Saint-Exupéry, Antoine** 1900–44  
French aviator and writer

A sky as pure as water bathed the stars and brought them out.  
*Southern Mail*  
Chapter I (p. 3)  
Harcourt, Brace & Company New York, New York, USA. 1971

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The sky is the daily bread of the eyes.  
In *Edward Waldo Emerson* (ed.)  
*Journals of Ralph Waldo Emerson 1841–1844*  
25 May 1843 (p. 410)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Flammarion, Camille** 1842–1925  
French astronomer and author

Better than the spectacle of the sea calm or agitated, grander than the spectacle of mountains adorned with forests or crowned with perpetual snow, the spectacle of the sky attracts us, envelops us, speaks to us of the infinite, gives us the dizziness of the abyss; for more than any other, it seizes the contemplative mind and appeals to it, being the truth, the infinite, the eternal, the all.  
*Popular Astronomy: A General Description of the Heavens*  
Book VI, Chapter I (p. 554)  
Chatto & Windus. London, England. 1894

**Friedman, Herbert** 1916–2000  
American space scientist and astrophysicist

It is impossible for any sensitive person to look at a star-filled sky without being stirred by thoughts of creation and eternity. The mystery of the origin and destiny of the universe haunts us throughout our lives.  
*The Amazing Universe*  
Chapter 7 (p. 166)  
National Geographic Society. Washington, D.C. 1980

**Kreymborg, Alfred** 1883–1966  
American poet and anthologist

The sky is that beautiful old parchment in which the sun and the moon keep their diary.  
In Louis Untermeyer (ed.)  
*Modern American Poetry*  
Old Manuscript  
Harcourt, Brace & Company. New York, New York, 1936

**Lowell, Amy** 1874–1925  
American poet

A wise man,  
Watching the stars pass across the sky,  
Remarked:  
In the upper air the fireflies move more slowly.  
*The Complete Poetical Works of Amy Lowell*  
Meditation  
Houghton Mifflin. Boston, Massachusetts, USA. 1955

**Manilius, Marcus** fl. 10 AD  
Roman poet

It is my delight to traverse the very air and spend my life touring the boundless skies, learning of the constellations and the contrary motions of the planets.  
*Astronomica*  
Book I  
Publisher undetermined

**Maunder, Edward Walter** 1851–1928  
English astronomer

The oldest picture book in our possession is the *Midnight Sky*.  
The Oldest Picture-Book of All

*Nineteenth Century*, Volume 48, Number CCLXXXIII, September 1900 (p. 451)

**Moulton, Forest Ray** 1872–1952

American astronomer

It is doubtful whether there is in the whole range of human experience any more awe-inspiring spectacle than that presented by the sky on a clear and moonless night. Under the vault of the sparkling heavens one is raised, if ever, to an actual realization of the fact that the earth beneath his feet is a relatively tiny mass in comparison with the infinite cosmos spread out above.

*Astronomy*

Chapter II (p. 14)

The Macmillan Company. New York, New York, USA. 1931

**Schaefer, Bradley E.**

American professor of physics

The sky is beautiful and vast and harbors many secrets.

Inventory of Cosmic Mysteries

*Sky & Telescope*, Volume 94, Number 4, October 1994 (p. 68)

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

My soul is in the sky.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

A Midsummer-Night's Dream

Act V, Scene I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shore, Jane** 1947–

American poet

Each night the sky splits open like a melon

its starry filaments

the astronomer examines with great intensity.

*Eye Level*

An Astronomer's Journal (p. 31)

The University of Massachusetts Press. Amherst, Massachusetts, USA. 1977

**Smoot, George** 1945–

American astrophysicist

**Davidson, Keay**

American science writer

There is something about looking at the night sky that makes a person wonder.

*Wrinkles in Time*

Chapter I (p. 1)

William Morrow & Company, Inc. New York, New York, USA. 1993

**Swings, Pol** 1906–63

Belgian astrophysicist

The sky belongs to everyone, with stars to spare for all.

In Henry Margenau and David Bergamini (eds.)

*The Scientist* (p. 116)

Time Inc. New York, New York, 1964

**The Bible**

He stretches out the sky like a curtain, spreads them out like a tent to live in...

*The Revised English Bible*

Isaiah 40:22

Oxford University Press, Inc. Oxford, England. 1989

**Thomas, Lewis** 1913–93

American physician and biologist

Taken all in all, the sky is a miraculous achievement. It works, and for what it is designed to accomplish it is infallible as anything in nature. I doubt whether any of us could think of a way to improve on it, beyond maybe shifting a local cloud from here to there on occasion.

*The Lives of a Cell: Notes of a Biology Watcher*

The World's Biggest Membrane (p. 148)

The Viking Press. New York, New York, USA. 1974

**Uppgren, Arthur**

No biographical data available

A dark sky filled with stars has always been one of our most cherished sights. This wonder need not and must not fade into the baleful orange glare above our cities; let the stars continue to twinkle with the fireflies along country lanes. Those stars come from one shared legacy of all people around the world, and it is by the heavens they define that we all ultimately find our way.

*Night Has a Thousand Eyes: A Naked-Eye Guide to the Sky, Its Science, and Lore*

Afterword (p. 275)

Plenum Trade. New York, New York, USA. 1998

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Over all the sky — the sky! Far, far out of reach, studded, breaking out, the eternal stars.

*Complete Poetry and Collected Prose*

Bivouac on a Mountain Side

The Library of America. New York, New York, USA. 1982

**SLEEP**

**Aristotle** 384 BCE–322 BCE

Greek philosopher

The vigorous are no better than the lazy during one half of life, for all men are alike when asleep.

In *Great Books of the Western World* (Volume 8)

*Eudemian Ethics*

Book II Chapter I

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**SNOW**

**Bentley, Wilson** 1865–1931

American photographer of snowflakes

Besides combining her greatest skill and artistry in the production of snowflakes, Nature generously fashions the most beautiful specimens on a very thin plane so that they are specially adapted for photomicrographical study.

Photographing Snowflakes

*Popular Mechanics Magazine*, Volume 37, 1922 (p. 309)

**Longfellow, Henry Wadsworth** 1807–82

American poet

Out of the bosom of the Air,  
Out of the cloud-folds of her garments shaken,  
Over the woodlands brown and bare  
Over the harvest-fields forsaken,  
Silent and soft and slow  
Descends the snow.

*The Poetical Works of Henry Wadsworth Longfellow*

Snow-Flakes

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Muir, John** 1838–1914

American naturalist

To lie out alone in the mountains of a still night and be touched by the first of these small silent messengers from the sky is a memorable experience, and the fineness of that touch none will forget.

*Steep Trails*

Chapter IV (p. 75)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

The faint lisp of snowflakes as they alight is one of the smallest sounds mortal can hear.

*Our National Parks*

Chapter IX (p. 274)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

The fertile clouds, descending, glide about and hover in brooding silence, as if thoughtfully examining the forests and streams with reference to the work before them...

*Our National Parks*

Chapter VIII (p. 249)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Small flakes or single crystals appear, glinting and swirling in zigzags and spirals; and soon the thronging feathery masses fill the sky and make darkness like night, hurrying wandering mountaineers to their winter quarters.

*Our National Parks*

Chapter VIII (p. 249)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

How full of creative genius is the air in which these are generated! I should hardly admire them more if real stars fell and lodged on my coat.

In Bradford Torrey and Francis H. Allen (eds.)

*The Journal of Henry D. Thoreau* (Volume 8)

January 5, 1856 (p. 87)

Houghton Mifflin Company, Boston, Massachusetts, USA. 1949

**SOIL**

**Burroughs, John** 1837–1921

American naturalist and writer

The youth of the earth is in the soil and in the trees and verdure that springs from it...

*Under the Apple-Trees*

Chapter II (p. 40)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1916

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Every plant is a manufacturer of soil.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

Society and Solitude

Chapter VI (p. 144)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Fuller, Wallace H.** 1915–2006

American geologist

A thin rind of loose material covering the continents of the earth is all that stands between life and lifelessness.

*Soils of the Desert Southwest*

A Word from the Author (p. xiii)

University of Arizona Press. Tucson, Arizona, USA. 1975

Grit and grime, crumbling rock and decaying organic residue-abrading by wind and water — weather into soil — Mother Earth. This soft and yielding earth lives and continually changes under the forces of climate, having formed through the ages as a result of meteorological, geological, and biological action on rock. The soil not only lives, but it continually renews life as well. Animal and plant residues decay into simpler constituents, and nutrient elements again are made available for new life in a perpetual cycle.

*Soils of the Desert Southwest*

A Word from the Author (p. xiii)

University of Arizona Press. Tucson, Arizona, USA. 1975

**Molloy, Les**

No biographical data available

...for only rarely have we stood back and celebrated our soils as something beautiful, and perhaps even mysterious. For what other natural body, worldwide in its distribution, has so many interesting secrets to reveal to the patient observer? The great events of long ago — volcanic eruptions, dust storms, floods and Ice Ages — have left their imprints as have the agricultural practices of earlier times.

*Soils in the New Zealand Landscape: The Living Mantle*

Mallison Rendel Publishers Ltd. Wellington, New Zealand. 1988

The soil can...tell us much about our present day environment. It is the home of millions of living things and a recycling factory for so much of the solar and geochemical energy that sustains life. In its form and properties it expresses the combined influences of local climate, shape of the land, and rocks and organisms that are broken down and incorporated into it.

*Soils in the New Zealand Landscape: The Living Mantle*  
Mallison Rendel Publishers Ltd. Wellington, New Zealand. 1988

### **Simonson, Roy**

American soil scientist

Be it deep or shallow, red or black, sand or clay, the soil is the link between the rock core of the earth and the living things on its surface. It is the foothold for the plants we grow. Therein lies the main reason for our interest in soils.

*USDA Yearbook of Agriculture*, 1957

## **SOLAR SYSTEM**

### **Burroughs, John** 1837–1921

American naturalist and writer

When I look up at the starry heavens at night and reflect upon what it is that I really see there, I am constrained to say, "There is no God." ...I see no lineaments of personality, no human traits, but an energy upon whose currents solar systems are but babbles.

*The Light of the Day: Religious Discussions and Criticisms from the Naturalist's Point of View* (p. 224)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

### **Carlyle, Thomas** 1795–1881

English historian and essayist

Did not the Boy Alexander weep because he had not two Planets to conquer; or a whole Solar System; or after that, a whole universe?

*Sartor Resartus*

Book II, Chapter VIII (p. 165)  
Ginn & Company. Boston, Massachusetts, USA. 1897

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

The Solar System is rather a large place, though whether it will be large enough for so quarrelsome an animal as *Homo sapiens* remains to be seen.

*The Challenge of the Spaceship*

The Challenge of the Spaceship (p. 8)  
Harper & Brothers. New York, New York, USA. 1959

The Solar System, comprising the nine known worlds of our Sun and their numerous satellites, is a relatively compact structure, a snug little celestial oasis in an endless desert.

*The Challenge of the Spaceship*

The Planets Are Not Enough (p. 54)  
Harper & Brothers. New York, New York, USA. 1959

### **Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

The secret of our success on planet Earth is space. Lots of it. Our solar system is a tiny island of activity in an ocean of emptiness.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*

Chapter I (p. 4)

Basic Books, Inc. New York, New York, USA. 1994

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The solar system is not the typical product of development of a star; it is not even a common variety of development; it is a freak.

*Man's Place in the Universe*

*Harper's Magazine*, October 1928 (p. 574)

### **Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The solar system has no anxiety about its reputation...

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Worship (p. 1055)

The Library of America. New York, New York, USA. 1983

### **Flammarion, Camille** 1842–1925

French astronomer and author

Like a shower of stars the worlds whirl, borne along by the winds of heaven, and are carried down through immensity, suns, earths, satellites, comets, shooting stars, humanities, cradles, graves, atoms of the infinite, seconds of eternity, perpetually transform beings and things.

*Popular Astronomy: A General Description of the Heavens*

American Book Company. New York, New York, USA. 1899

### **Hey, Nigel S.** 1936–

American science writer

Naturally their [men and women] writings deal with spaceflight, the solar system, and the Cosmos...reveal the profoundly human aspects of this great adventure, from the excitement of solving the problems of spacecraft that are millions of miles distant to the self-examination that occurs when considering whether we might someday send robots, and not people, as our ambassadors to distant star systems. Some of the nobility of the human condition, so often obscured, shines through their words.

*Solar System*

Introduction (p. 8)

Weidenfield & Nicolson. London, England. 2002

Our explorations of the solar system are the first halting steps in a journey that will transform our kind into a species that knowingly lives among the stars, in mind and possibly in body. Our destiny awaits in the planets



and their moons, in this star system and in the galaxy beyond. Without exaggeration this journey is epochal in its significance to the human race.

*Why People Need Space*

Lecture, National Space Centre, October 2002

**Horowitz, Norman H.** 1915–2005

American geneticist

If the exploration of the solar system in our time bring home to us a realization of the uniqueness of our small planet and thereby increase our resolve to avoid self-destruction, [it] will have contributed more than just science to the human future.

*To Utopia and Back: The Search For Life in the Solar System*

Chapter Eight (p. 146)

W.H. Freeman & Company. San Francisco, California, USA. 1986

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

Damn the solar system. Bad light; planets too distant; pestered with comets; feeble contrivance; could make a better one myself.

In John D. Barrow

*The Artful Universe* (p. 34)

Clarendon Press. Oxford, England. 1995

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

Nothing is more simple than the plan of the Solar System...

Translated by James Jacque

*The System of the World*

Part I, Chapter I (p. 1)

Printed for Vernor & Hood. London, England. 1800

**Lowell, Percival** 1855–1916

American astronomer

Now when we think that each of these stars is probably the center of a solar system grander than our own, we cannot seriously take ourselves to be the only minds in it all.

*Mars*

Chapter I (p. 5)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Maclennan, Hugh** 1907–99

Canadian author and professor of English

We have just reached the outer fringes of the Solar System. Can any sane man possibly argue that we should stop there?

*Scotchman's Return and Other Essays*

Remembrance Day, 2010 A.D. (p. 89)

Charles Scribner's Sons. New York, New York, USA. 1960

**Patten, W.**

No biographical data available

A solar system has attributes and powers that can not be defined or measured in terms of its members, or of its ultimate chemical elements, for a solar system is not merely an aggregate, or the algebraic sum of its various elements and qualities.... It is a system, a new type of individuality, with special creative powers of its own.

*The Grand Strategy of Evolution* (p. 34)

Richard G. Badger. Boston, Massachusetts, USA. 1920

**Peterson, Ivars**

Mathematics and computer writer and editor

We can...be thankful that the solar system in which we live has been unreasonably kind throughout the long history of human efforts to understand its dynamics and to extend that knowledge to the rest of the universe. At each step along the way, it has served as a perspicacious teacher, posing questions just difficult enough to prompt new observations and calculations that have led to fresh insights, but not so difficult that any further study becomes mired in a morass of confusing detail.

*Newton's Clock: Chaos in the Solar System*

Chapter 12 (p. 286)

W.H. Freeman & Company. New York, New York, USA. 1993

**Pliny (C. Plinius Secundus)** 23–79

Roman savant and author

Most men are not acquainted with a truth known to the founders of the science from their arduous study of the heavens, that what when they fall to earth are termed thunderbolts are the fires of the three upper planets, particularly those of Jupiter, which is in the middle position — possibly because it voids in this way the charge of excessive moisture from the upper circle (of Saturn) and of excessive heat from the circle below (of Mars); and that this is the origin of the myth that thunderbolts are the javelins hurled by Jupiter. Consequently heavenly fire is spit forth by the planet as crackling charcoal flies from a burning log, bringing prophecies with it. And this is accompanied by a very great disturbance of the air, because moisture collected causes an overflow or because it is disturbed by the birth-pangs so to speak of the planet in travail.

*Natural History*

Volume 1, Book II, sec 84

Harvard University Press. Cambridge, Massachusetts, USA. 1947

**Sagan, Carl** 1934–96

American astronomer and author

The emerging picture of the early Solar System does not resemble a stately progression of events designed to form the Earth. Instead, it looks as if our planet was made, and survived, by mere lucky chance, amid unbelievable violence. Our world does not seem to have been sculpted by a master craftsman. Here, too, there is no hint of a Universe made for us.

*Pale Blue Dot: A Vision of the Human Future in Space*  
Chapter 17 (p. 295)  
Random House, Inc. New York, New York, USA. 1994

**Somerville, Mary** 1780–1872  
English mathematician

Yonder starry sphere  
Of planets and of fix'd, in all her wheels,  
Resembles nearest mazes intricate,  
Eccentric, intervolved, yet regular,  
Then most, when most irregular they seem.

*The Connexion of the Physical Sciences* (9<sup>th</sup> edition)

Section III (p. 23)

John Murray. London, England. 1858

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935  
Russian research scientist

Should man penetrate the solar system, should he learn  
to comport himself there as the mistress in her home —  
would the secrets of the world then open for him? Not in  
the least. Not anymore that inspecting a pebble or shell  
would reveal to him the secrets of the ocean.

Compiled by V.V. Vorontsov

*Words of The Wise: A Book of Russian Quotations*

Translated by Vic Schneerson

Progress Publishers. Moscow, Russia. 1979

## SOLID STATE

**Updike, John** 1932–  
American novelist, short story writer, and poet

Textbooks & Heaven only are Ideal;  
Solidity is an imperfect state,  
Within the cracked and dislocated Real  
Nonstoichiometric crystals dominate.  
Stray Atoms sully and precipitate;  
Strange holes, excitons, wander loose; because  
Of Dangling Bonds, a chemical Substrate  
Corrodes and Catalyzes — surface Flaws  
Help Expitazial Growth to fix absorptive claws.

*Midpoint and Other Poems*

The Dance of the Solids

Stanza 9

Fawcett Publications, Inc. Greenwich, Connecticut, USA. 1970

## SOLUBILITY

**Witt, Otto N.** 1853–1915  
German chemist

In the strictly scientific sense of the word insolubility  
does not exist, and even those substances characterized  
by the most obstinate resistance to the solvent action of  
water may properly be designated as extraordinarily diffi-  
cult of solution, not as insoluble.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 13 (p. 177)  
Longmans, Green & Company Ltd. London, England. 1967

## SOLUTION

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Every great and deep difficulty bears in itself its own  
solution. It forces us to change our thinking in order to  
find it.

In Brian VanDeMark

*Pandora's Keepers*

Chapter 1 (p. 29)

Little, Brown & Company. Boston, Massachusetts, USA. 2003

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

In science we sometimes have convictions as to the right  
solution of a problem which we cherish but cannot jus-  
tify; we are influenced by some innate sense of the fitness  
of things.

*The Nature of the Physical World*

Chapter XV (p. 337)

The Macmillan Company. New York, New York, USA. 1930

**Heisenberg, Werner Karl** 1901–76  
German physicist and philosopher

...the genuine solution of a difficult problem is neither  
more nor less than a glimpse of the wider context, a  
glimpse that helps us to clear away other difficulties as  
well, including many whose existence we do not even  
suspect.

*Physics and Beyond: Encounters and Conversations*

Chapter 8 (p. 102)

Harper & Row, Publishers. New York, New York, USA. 1971

**Kosko, Bart** 1960–  
American electrical engineer

A solution has a way of bubbling up out of your uncon-  
scious if you brood about a problem long enough.

*Fuzzy Thinking*

Chapter 3 (p. 61)

Hyperion. New York, New York, USA. 1993

**MacCready, Paul** 1925–?  
American aeronautical engineer

When you do dome up with a solution, you can always  
explain it logically, even though it's the absurd approach  
that gave you the solution.

In Kenneth A. Brown

*Inventors at Work*

Paul MacCready (p. 11)

Microsoft Press. Redmond, Washington, USA. 1988

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

...there is always a well-known solution to every human problem — neat, plausible, and wrong.

*Prejudices: Second Series*

The Divine Afflatus (p. 158)

Alfred A. Knopf. New York, New York, USA. 1922

**Szilard, Leo** 1898–1964

Hungarian-born American nuclear physicist

Once a man has missed the solution to a problem when he passes by, it is less likely he will find it the next time.

In Editors of International Science and Technology

*The Way of the Scientist: Interviews from the World of Science and Technology*

Leo Szilard (p. 28)

Simon & Schuster. New York, New York, USA. 1966

## SOUL

**Russell, Sir Edward John** 1872–1965

British agriculturalist and writer

Those young people of today, who will be the leaders of thought and of action tomorrow, are faced with the problem of enduring that, in gaining control over Nature, man does not lose his own soul.

*Science and Modern Life* (p. 101)

Philosophical Library. New York, New York, USA. 1955

## SOUND

**Hooke, Robert** 1635–1703

English physicist

‘Tis not impossible to hear a whisper a furlong’s distance, it having been already done; and perhaps the nature of the thing would not make it more impossible, though that furlong should be ten times multiply’d...for that [air] that is not the only medium, I can assure the Reader, that I have, by the help of a distended wire, propagated the sound to a very considerable distance in an instant, or with as seemingly quick a motion as that of light, at least, incomparably swifter then that, which at the same time was propagated through the Air...

*Micrographia*

Preface

Printed for Jo. Martyn and Ja. Allestry. London, England. 1665

## SPACE

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Space...is big, really big...You may think it’s a long way down the street to the chemists’ but that’s just peanuts to space.

*The Ultimate Hitchhiker’s Guide to the Galaxy*

The Hitchhiker’s Guide to the Galaxy

Chapter 8 (p. 53)

The Ballantine Book Company. New York, New York, USA. 2002

**Alfven, Hannes** 1908–95

Swedish physicist

Having probes in space was like having a cataract removed.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 45)

Random House, Inc. New York, New York, USA. 1991

**Bailey, Philip James** 1816–1902

English poet

Unimaginable space,

As full of suns as is earth’s sun of atoms.

*Festus: A Poem*

Scene IV (p. 61)

George Routledge & Sons, Ltd. London, England. 1893

**Barnes, Bishop**

Bishop of San Bernardino

It is fairly certain that our space is finite though unbounded. Infinite space is simply a scandal to human thought.

In Joseph Silk

*The Big Bang* (p. 81)

W.H. Freeman & Company. San Francisco, California, USA. 1980

**Bergaust, Erik** 1925–95

American writer and journalist

As far as man on Earth is concerned, space begins at the high border of the Earth’s atmosphere and extends to infinity.

*Wernher von Braun*

Are Flying Saucers Real? (p. 546)

National Space Institute. Washington, D.C. 1976

**Bergson, Henri** 1859–1941

French philosopher

For it is scarcely possible to give any other definition of space: space is what enables us to distinguish a number of identical and simultaneous sensations from one another; it is thus a principle of differentiation, and consequently it is a reality with no quality.

Translated by F.L. Pogson

*Time and Free Will: An Essay on the Immediate Data of Consciousness*

Chapter II (p. 95)

George Allen & Unwin Ltd. London, England. 1950

**Bradbury, Ray** 1920–

American writer

Man does not need escape so much as he needs release into a new spirit, a transcendent knowledge of himself that only Space can give him.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and

Walter Sullivan

*Mars and the Mind of Man*

Foreword (p. XI)

Harper & Row, Publishers. New York, New York, USA. 1973

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

A sea whose shores no eyes have ever seen, whose depth no instrument can fathom, whose waters no scientist can analyze — such is the sea of space. Nothing can be as empty and cold as the gulf wherein our destinies are immersed.

*Parade of the Living*  
Part I, Chapter I (p. 3)  
Coward-McCann, Inc. New York, New York, USA. 1930

**Bruno, Giordano** 1548–1600  
Italian philosopher and pantheist

There are countless constellations, suns and planets; we see only the suns because they give light; the planets remain invisible, for they are small and dark. There are also numberless earths circling around their suns, no worse and no less than this globe of ours.

*On the Infinite Universe and Worlds*  
Henry Schuman, Inc. New York, New York, USA. 1950

There is a single general space, a single vast immensity which we may freely call Void: in it are innumerable globes like this on which we live and grow; this space we declare to be infinite, since neither reason, convenience, sense-perception nor nature assign it a limit.

In Joseph Silk  
*The Big Bang* (p. 81)  
W.H. Freeman & Company. San Francisco, California, USA. 1980

**Captain Kirk**  
Fictional character

Space, the final frontier...

Opening lines  
*Star Trek*  
Television series

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

Go out beneath the stars on a clear winter night, and look up at the Milky Way spanning the heavens like a bridge of glowing mist. Up there, ranged one beyond the other to the end of the Universe, suns without number burn in the loneliness of space. Down to the south hang the brilliant, unwinking lanterns of other worlds — the electric blue of Jupiter, the glowing ember of Mars. Across the zenith, a meteor leaves a trail of fading incandescence, and a tiny voyager of space has come to a flaming end.

In Neil McAleer  
*Odyssey: The Authorized Biography of Arthur C. Clarke* (p. 34)  
Victor Gollancz. London, England. 1993

The sea which beats against the coasts of Earth, which seems so endless and so eternal, is as the drop of water on the slide of a microscope compared with the shoreless sea of space.

*The Challenge of the Spaceship*  
Across the Sea of Stars (p. 128)  
Harper & Brothers. New York, New York, USA. 1959

In space there are no horizons; the questing eye reaches out forever, in all directions, and finds no fixed point at which to rest.

*The Challenge of the Spaceship*  
Which Way Is Up? (p. 143)  
Harper & Brothers. New York, New York, USA. 1959

**Collins, Billy** 1941–  
American poet

Here's to the wind blowing against this lighted house and to the vast, windless spaces between the stars.

*The Art of Drowning*  
Chapter XXXIII, Cheers  
University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1995

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

For those who think of space as emptiness, the assignment of an adjective, especially one as enigmatic as “curved”, might be regarded as cryptic.

*The Encyclopaedia of Ignorance: Everything You Ever Wanted to Know About the Unknown*  
Curved Space (p. 78)  
Pergamon Press. Oxford, England. 1977

**Deudney, Daniel**  
American political scientist

Space is only 80 miles from every person on earth — far closer than most people are to their own national capitals...

*Space: The High Frontier in Perspective*  
Introduction (p. 6)  
Worldwatch Institute. Washington, D.C. 1982

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

To put the conclusion rather crudely — space is not a lot of points close together; it is a lot of distances interlocked.

*The Mathematical Theory of Relativity*  
Chapter I, Section 1 (p. 10)  
At The University Press. Cambridge, England. 1930

**Empson, William** 1906–84  
English literary critic and poet

Space is like earth, rounded, a padded cell;  
Plumb the stars' depth, your lead bumps you behind...

*The Complete Poems of William Empson*  
The World's End (p. 13)  
University Press of Florida. Gainesville, Florida, USA. 2001

**Ferris, Timothy** 1944–  
American science writer

While walking with Heisenberg, the physicist Felix Bloch, who had just read Weyl's *Space, Time and Matter*,

felt moved to declare that space is simply the field of linear equations. Heisenberg replied, "Nonsense. Space is blue and birds fly through it." "What he meant, Bloch writes, "was that it was dangerous for a physicist to describe Nature in terms of idealized abstractions too far removed from the evidence of actual observation."

*The Whole Shebang: A State-of-The Universe's Report*

Notes, 3 (p. 320)

Simon & Schuster. New York, New York, USA. 1996

### **Frost, Robert** 1874–1963

American poet

Space ails us moderns: we are sick with space.

Its contemplation makes us out as small

As a brief epidemic of microbes.

*Complete Poems of Robert Frost*

The Lesson for Today

Henry Holt & Company. New York, New York, USA. 1949

### **Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

We must confess in all humility that, while number is a product of our mind alone, space has a reality beyond the mind whose rules we cannot completely prescribe.

In Charles W. Misner et al.

*Gravitation*

Part III, Chapter 8 (p. 195)

W.H. Freeman & Company. San Francisco, California, USA. 1973

### **Gibran, Kahlil** 1883–1931

Lebanese-American philosophical essayist

Space is not space between the earth and the sun to one who looks down from the windows of the Milky Way.

*Sand and Foam: A Book of Aphorisms* (p. 7)

Alfred A. Knopf. New York, New York, USA. 1959

### **Glenn, Jr., John** 1921–

American astronaut and politician

In space one has the inescapable impression that here is a virgin area of the universe in which civilized man, for the first time, has the opportunity to learn and grow without the influence of ancient pressures. Like the mind of a child, it is yet untainted with acquired fears, hate, greed, or prejudice.

In Kevin W. Kelley

*The Home Planet*

With Plate 136

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1988

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Space is blue and birds fly through it.

In Harald Fritzsch

Translated by Jean Steinberg

*The Creation of Matter: The Universe from Beginning to End*

Chapter 1 (pp. 12–13)

Basic Books, Inc. New York, New York, USA. 1984

### **Hey, Nigel S.** 1936–

American science writer

People...regardless of their educational, religious, or economic background, are blessed with the ability to look into the sky and marvel at the greatness of all that is out there. . . . It transports us beyond ourselves and our artifacts. It is another way in which we are able to emerge from our self-centered psychological neighborhoods, to explore a multidimensional realm where self is of no particular significance. It is one path among many through which individual people may comprehend the close community of all life and all humanity, and, with the accession of humility, the rightness of compassion and peace.

*Solar System*

Introduction (pp. 7–8)

Weidenfield & Nicolson. London, England. 2002

### **Hubble, Edwin Powell** 1889–1953

American astronomer

The outstanding feature, however, is the possibility that the velocity-distance relation may represent the de Sitter effect, and hence that numerical data may be introduced into discussions of the general curvature of space.

A Relation Between Distance and Radial Velocity Among

Extra-Galactic Nebulae

*Proceedings of the National Academy of Science*, Volume 15, 1929

(p. 168)

### **Jammer, Max** 1915–

Israeli physicist and philosopher

Like all science, the science of space must still be classed as unfinished business.

*Concepts of Space: The History of Theories of Space in Physics*

Chapter V (p. 190)

Harvard University Press. Cambridge, Massachusetts, USA. 1954

### **Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The immensity of space is paralleled by that of time.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1928*

The Wider Aspects of Cosmogony (p. 171)

Government Printing Office. Washington, D.C. 1929

...space, regarded as a receptacle for radiant energy, is a bottomless pit.

Supplement to "Nature"

*Nature*, Volume 122, Number 3079, November 3, 1928 (p. 698)

### **Kant, Immanuel** 1724–1804

German philosopher

Space is not a conception which has been derived from outward experiences. For, in order that certain sensations may relate to something without me (that is, to something which occupies a different part of space from that in which I am); in like manner, in order that I may represent

them not merely as without, of, and near to each other, but also in separate places, the representation of space must already exist as a foundation. Consequently, the representation of space cannot be borrowed from the relations of external phenomena through experience; but, on the contrary, this external experience is itself only possible through the said antecedent representation.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

First Part, Of Space, Metaphysical Exposition of this Conception, 1  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Leonov, Aleksei** 1934–

Soviet cosmonaut

What struck me most was the silence. It was a great silence, unlike any I have encountered on Earth, so vast and deep that I began to hear my own body: my heart beating, my blood vessels pulsing, even the rustle of my muscles moving over each other seemed audible. There were more stars in the sky than I had expected. The sky was deep black, yet at the same time bright with sunlight.

The View from Out There: In Words and Pictures

*Life*, Volume 11, Number 13, November 1988 (p. 197)

**Lewis, Gilbert Newton** 1875–1946

American chemist

...when we analyze the highly refined concept of space used by mathematicians we find it to be quite similar to the concept of number.

*The Anatomy of Science*

Chapter II (p. 29)

Yale University Press. New Haven, Connecticut, USA. 1926

**Macvey, John W.**

No biographical data available

The land lies sleeping under the enveloping mantle of night. Bright stars gleam like jewels from out the velvet darkness of the moonless sky. Beyond these points of celestial beauty, in depths frightening in their sheer immensity, lies realms powdered in stellar glory.

*Whispers from Space*

Chapter 1

Macmillan Publishing Company. New York, New York, USA. 1973

**Maxwell, James Clerk** 1831–79

Scottish physicist

...the aim of the space-crumplers is to make its curvature uniform everywhere, that is over the whole of space whether that whole is more or less than  $\tilde{N}$ . The direction of the curvature is not related to one of the  $x y z$  more than another or to  $-x -y -z$  so that as far as I understand we are once more on a pathless sea, starless, windless and poleless...

*The Scientific Letters and Papers of James Clerk Maxwell: Volume 2, 1862–1873*

Postcard to Peter Guthrie Tait, 11 November, 1874 (p. 137)

Clarendon Press. Oxford, England. 1988

**Murray, Bruce** 1932–

American professor of planetary science and geology

Space...is a colorful thread intimately woven into the enormous tapestry of human existence and experience.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Bruce Murray (p. 47)

Harper & Row, Publishers. New York, New York, USA. 1973

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

Absolute space, in its own nature, without relation to anything external, remains always similar and immovable.

*Mathematical Principles of Natural Philosophy*

Scholium, II

E.P. Dutton & Company. New York, New York, USA. 1922

**Ockels, Wubbo** 1946–

Dutch astronaut and aerospace engineer

Space is so close: It took only eight minutes to get there and twenty to get back.

The View from Out There: In Words and Pictures

*Life*, Volume 11, Number 13, November 1988 (p. 198)

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

Space is only a word that we have believed a thing.

*The Foundations of Science*

Author's Preface to Translation (p. 5)

The Science Press. New York, New York, USA. 1913

**Siegel, Eli** 1902–78

American philosopher, poet, critic and founder of Aesthetic Realism

Space won't keep still, and it won't budge either: so give up trying.

*Damned Welcome*

Aesthetic Realism, Maxims, Part Two, #396 (p. 153)

Definition Press. New York, New York, USA. 1972

**Smith, Logan Pearsall** 1865–1946

American author

So gazing up on hot summer nights at the London stars, I cool my thoughts with a vision of the giddy, infinite, meaningless waste of Creation, the blazing Suns, the Planets and frozen Moons, all crashing blindly forever across the void of space.

*Trivia*

Book II, Mental Vice (p. 97)

Doubleday, Page & Company. Garden City, New York, USA. 1917

I think of Space, and the unimportance in its unmeasured vastness, of our toy solar system; I lose myself in speculations of the lapse of Time, reflecting how at the best

our human life on this minute and perishing planet is as brief as a dream.

*Trivia*

Book II, Self-Analysis (pp. 121–122)

Doubleday, Page & Company. Garden City, New York, USA. 1917

### **Sylvester, James Joseph** 1814–97

English mathematician

Space is the Grand Continuum from which, as from an inexhaustible reservoir, all the fertilizing ideas of modern analysis are derived...

*The Collected Mathematical Papers of James Joseph Sylvester*  
(Volume 2)

Presidential Address to the British Association

Exeter British Association Report (1869) (p. 659)

University Press. Cambridge, England. 1904–1912

### **Tennyson, Alfred (Lord)** 1809–92

English poet

... The clear galaxy

Shorn of its hoary lustre, wonderful,

Distinct and vivid with sharp point of light,

Blaze within blaze, an unimagin'd depth

And harmony of planet-girded suns

And moon — encircled planets, wheel in wheel,

Arch'd the wan sapphire. Nay, the hum of men.

Or other things talking in unknown tongues,

And notes of busy life in distant worlds

Beat like a far wave on my anxious ear.

*Alfred Tennyson's Poetical Works*

Timbuctoo, I. 105–113

Oxford University Press, Inc. London, England. 1953

### **The X-Files**

MULDER: Hey, Scully, we send those men up into space to unlock the doors of the universe, and we don't even know what's behind them.

*The X-Files*

Space

Television program

Season 1, 1993

### **Thomson, J. Arthur** 1861–1933

Scottish biologist

There is grandeur in the spectacle of the star-strewn sky, so apparently crowded, but there are thousands of worlds unseen for every one our unaided eyes can image, and yet the astronomers tell us that the emptiness of space is its most striking characteristic.

*The System of Animate Nature* (Volume 1)

Lecture I (p. 30)

William & Norgate. London, England. 1920

### **Tsiolkovsky, Konstantin Eduardovich** 1857–1935

Russian research scientist

Man will not always stay on earth; the pursuit of light and space will lead him to penetrate the bounds of the

atmosphere, timidly at first, but in the end to conquer the whole of solar space.

In Herbert Friedman

*The Amazing Universe*

Chapter 1 (p. 28)

National Geographic Society. Washington DC. 1980

### **vas Dias, Robert**

Anglo-American poet and writer

The premise... is that outer space is as much a territory of the mind as it is a physical concept.

*Inside Outer Space: New Poems of the Space Age*

Introduction (p. xxxix)

Anchor Press. Garden City, New York, USA. 1970

### **von Bitter Rucker, Rudy** 1946–

American mathematician and science fiction writer

What is the shape of space? Is it flat, or is it bent? Is it nicely laid out, or is it warped and shrunken? Is it finite, or is it infinite? Which of the following does space resemble more: (a) a sheet of paper, (b) an endless desert, (c) a soap bubble, (d) a doughnut, (e) an Escher drawing, (f) an ice cream cone, (g) the branches of a tree, or (h) a human body?

*The Fourth Dimension: Toward a Geometry of Higher Reality*

Chapter 7 (p. 91)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1984

### **von Braun, Wernher** 1912–77

German-American rocket science

... the progress of mankind here on Earth is directly linked to the future than man builds for himself in space.

In Erik Bergaust

*Wernher von Braun*

A Horse Named Susie (p. 373)

National Space Institute. Washington, D.C. 1976

... don't tell me that man doesn't belong out there. Man belongs wherever he wants to go — and he'll do plenty well when he gets there.

Reach for the Stars

*Time*, Volume 71, 17 February 1958 (p. 25)

### **Weyl, Hermann** 1885–1955

German mathematician

Nowhere do mathematics, natural sciences, and philosophy permeate one another so intimately as in the problem of space.

*Philosophy of Mathematics and Natural Science*

Part I, Chapter III (p. 67)

Princeton University Press. Princeton, New Jersey, USA. 1949

### **Wheeler, John Archibald** 1911–

American physicist and educator

### **Thorne, Kip S.** 1940–

American theoretical physicist

Space tells matter how to move...and matter tells space how to curve.

In Charles W. Misner et al

*Gravitation*

Part I, Chapter 1 (p. 23)

W.H. Freeman & Company. San Francisco, California, USA. 1973

...in essence, the curvature in space created by the electromagnetic field is the electromagnetic field; and this curvature can in principle be detected by purely geometric measurements.

*International Science and Technology*

The Dynamics of Space-Time, December 1963 (p. 72)

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

All space measurement is from stuff in space to stuff in space.

*The Aims of Education and Other Essays*

Chapter X (p. 233)

The Macmillan Company. New York, New York, USA. 1959

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Now while the great thoughts of space and eternity fill me I will measure myself by them. And now touch'd with the lives of other globes arrived as far long as those of the earth or waiting to arrive, or pass'd on farther than those of the earth, I henceforth no more ignore them than I ignore my own life.

*Complete Poetry and Collected Prose*

Night on the Prairies

The Library of America. New York, New York, USA. 1982

Every cubic inch of space is a miracle.

*Complete Poetry and Collected Prose*

Miracles

The Library of America. New York, New York, USA. 1982

**Winchell, Alexander** 1824–91

American geologist

In the midst of this universe of seething movements is our home. The mind, uplifted in the effort to contemplate them and grasp their method, grows giddy and impotent. How sublime these activities! To what a numerous and lofty companionship does our little planet belong! Hard it seems to be imprisoned here while the realm of the universe tempts us to its exploration. How can a human soul content itself to roll and whirl through space during its mortal days, and eat and sleep and trifle, like rats in a ship at sea, without wondering where we are and whither we are bound.

*World-Life or Comparative Geology*

Part I, Chapter II, Section 4.7 (p. 142)

S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**Zubrin, Robert** 1952–

Engineer

Like the philosophy of Greece, the paintings of the Renaissance and the music of the Enlightenment, the explosion of knowledge about our solar system and the surrounding universe will be remembered for thousands of years as the defining brilliance of our age. To destroy [the space] program for the sake of bean counting, or perhaps as part of some obscure political maneuver, is not tolerable. It is not just a mistake, it is a crime — an infamous crime against civilization that is comparable to the burning of the Library of Alexandria.

*Space News*, September 13, 1999

Americans are proud of our space exploration program, and rightly so. It is a statement that we continue to be a nation of explorers and pioneers. But more than that, it is a statement that we are a truly great nation, great not because of our military might...but because we do great things for all humanity and for all time. Killing our space exploration program amounts to nothing less than pulling some of the stars off our flag. This is a desecration we cannot allow.

*Space News*, September 13, 1999

## SPACE AGE

**Clarke, Arthur C.** 1917–

English science and science fiction writer

Across the gulf of centuries, the blind smile of Homer is turned upon our age. Along the echoing corridors of time, the roar of the rockets merges now with the creak of the wind-taut rigging. For somewhere in the world today, still unconscious of his destiny walks the boy who will be the first Odysseus of the Age of Space...

*The Challenge of the Spaceship*

Envoi (p. 213)

Harper & Brothers. New York, New York, USA. 1959

## SPACE EXPLORATION

**Armstrong, Neil A.** 1930–

American astronaut

The *Eagle* has landed.

*The Washington Post*, July 21, 1969 (p. 1)

**Arnold, James R.**

No biographical data available

Space is the empty place next to the full place where we live. I believe we will be true to our nature and go there.

The Frontier in Space. Will One Be True to Our Nature and Accept the Challenge of the Next Frontier?

*American Scientist*, Volume 68, Number 3, May–June 1980 (p. 304)

**Asimov, Isaac** 1920–92

American author and biochemist



Throughout the history of humanity, we have been extending our range until it is now planet-wide, covering all parts of the Earth's surface and reaching to the bottom of the ocean, to the top of the atmosphere, and beyond it to the Moon. We will flourish only as long as we continue to extend that range, and although the potential range is not infinite, it is incredibly vast even by present standards. We will eventually extend our range to cover the whole of the solar system, and then we will head outward to the stars.

In James Burke, Jules Bergman and Isaac Asimov  
*The Impact of Science on Society*  
Our Future in the Cosmos — Space (p. 79)  
National Aeronautics and Space Administration. Washington, D.C. 1985

Unless we are willing to settle down into a world that is our prison, we must be ready to move beyond Earth. ...

In James Burke, Jules Bergman and Isaac Asimov  
*The Impact of Science on Society*  
Our Future in the Cosmos — Space (p. 80)  
National Aeronautics and Space Administration. Washington, D.C. 1985

**Bernal, John Desmond** 1901–71

Irish-born physicist and x-ray crystallographer

On earth, even if we should use all the solar energy which we receive, we should still be wasting all but one two-billionths of the energy the sun gives out. Consequently, when we have learnt to live on this solar energy and also to emancipate ourselves from the earth's surface, the possibilities of the spread of humanity will be multiplied accordingly.... There will, from desire or necessity, come the idea of building a permanent home for men in space.... At first space navigators, and then scientists whose observations would be best conducted outside the earth, and then finally those who for any reason were dissatisfied with earthly conditions would come to inhabit these bases and found permanent spatial colonies.

*The World, the Flesh and the Devil: An Enquiry Into the Future of the Three Enemies of the Rational Soul*  
Chapter II (pp. 11–12)  
Indiana University Press. Bloomington, Indiana, USA. 1969

**Blagonravov, Anatoly A.** 1894–1975

Russian scientist

The exploration of the cosmos — the moon and the planets — is a noble aim. Our generation has the right to be proud of the fact that it has opened the space era of mankind.

In Mose L. Harvey  
The Lunar Landing and the US–Soviet Equation  
*Bulletin of the Atomic Scientists*, Volume 25, Number 7, September 1969 (p. 29)

**Bradbury, Ray** 1920–

American writer

Get along to Mars and beyond.

The journey is long, the end uncertain, and there is more dark along the way than light, but you can whistle. Come with me by the wall of the great tombyards of all time which lie a billion years ahead. What shall we whistle as we stroll in our rocket, hoping to make it by the vast darkness where shadows wait to seize and keep us?

Follow me.

I know a tune.

Here...listen.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Ray Bradbury (p. 143)

Harper & Row, Publishers. New York, New York, USA. 1973

...I would not see our candle blown out in the wind. It is a small thing, this dear gift of life handed us mysteriously out of immensity. I would not have that gift expire. ...What's the use of looking at Mars through a telescope, sitting on panels, writing books, if it isn't to guarantee, not just the survival of mankind, but mankind surviving forever!"

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan and Walter Sullivan

*Mars and the Mind of Man*

Ray Bradbury (p. 133)

Harper & Row, Publishers. New York, New York, USA. 1973

**Clarke, Arthur C.** 1917–

English science and science fiction writer

There are still some scientists who consider that there is no point in sending men into space, even when it becomes technically possible; machines, they argue, can do all that is necessary. Such an outlook is incredibly shortsighted; worse than that, it is stupid, for it completely ignores human nature.

Lecture

St Martin's Technical School on Charing Cross Road, October 5, 1946

Though the specific ideals of astronautics are new, the motives and impulses underlying them are old as the race — and in the ultimate analysis, they owe as much to emotion as to reason. Even if we could learn nothing in space that our instruments would not already tell us, we should go there just the same.

Lecture

St Martin's Technical School on Charing Cross Road, October 5, 1946

To find anything comparable with our forthcoming ventures into space, we must go back far beyond Columbus, far beyond Odysseus — far, indeed, beyond the first ape-man. We must contemplate the moment, now irrevocably lost in the mists of time, when the ancestor of all of us came crawling out of the sea.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 8 (p. 94)

Harper & Row, Publishers. New York, New York, USA. 1973

This [the sea] is where life began, and where most of this planet's life remains to this day, trapped in a meaningless cycle of birth and death. Only the creatures who dared the hostile, alien land were able to develop intelligence; now that intelligence is about to face a still greater challenge. It may even be that this beautiful Earth of ours is no more than a brief resting-place between the sea of salt where we were born, and the sea of stars on which we must now venture forth.

*Profiles of the Future: An Inquiry into the Limits of the Possible*  
Chapter 8 (p. 94)  
Harper & Row, Publishers. New York, New York, USA. 1973

With the landing of the first spaceship on Mars and Venus, the Childhood of our race was over and history as we know it began...

*The Exploration of Space*  
Chapter 18 (p. 195)  
Harper & Brothers. New York, New York, USA. 1951

The challenge of the great spaces between the worlds is a stupendous one; but if we fail to meet it, the story of our race is drawing to a close. Humanity will have turned its back upon the still untrodden heights and will be descending again the long slope that stretches, across a thousand million years of time, down to the shores of the primeval sea.

*Interplanetary Flight: An Introduction to Astronautics*  
Chapter 10 (p. 127)  
Harper & Row, Publishers. New York, New York, USA. 1960

Even if we never reach the stars by our own efforts, in the millions of years that lie ahead it is almost certain that the stars will come to us. Isolationism is neither a practical policy on the national or the cosmic scale. And when the first contact with the outer universe is made, one would like to think that Mankind played an active and not merely a passive role — that we were the discoverers, not the discovered.

*The Exploration of Space*  
Chapter 17 (p. 182)  
Harper & Brothers. New York, New York, USA. 1951

Long before the Sun's radiation has shown any measurable increase, Man will have explored all the Solar System and, like a cautious bather testing the temperature of the sea, will be making breathless little forays into the abyss that separates him from the stars.

*The Challenge of the Spaceship*  
The Challenge of the Spaceship (p. 4)  
Harper & Brothers. New York, New York, USA. 1959

Interplanetary travel is now the only form of "conquest and empire" compatible with civilization. Without it, the human mind, compelled to circle forever in its planetary goldfish bowl, must eventually stagnate.

*The Challenge of the Spaceship*  
The Challenge of the Spaceship (p. 7)  
Harper & Brothers. New York, New York, USA. 1959

...there is no way back into the past; the choice, as Wells once said, is the universe — or nothing. Though men and civilizations may yearn for rest, for the dream of the lotus-eaters, that is a desire that merges imperceptibly into death. The challenge of the great spaces between the worlds is a stupendous one; but if we fail to meet it, the story of our race will be drawing to its close.

*Interplanetary Flight: An Introduction to Astronautic*  
Chapter 10 (p. 127)  
Harper & Row, Publishers. New York, New York, USA. 1960

...who can guess what strange roads there may yet be on which we may travel to the stars?

*The Promise of Space*  
To the Stars (p. 299)  
Harper & Row, Publishers. New York, New York, USA. 1968

**Commoner, Barry** 1917–  
American biologist, ecologist, and educator

Explorations of space, like the earlier explorations, are great adventures because they are bold, and they are bold because they are hazardous.

*Science and Survival*  
Chapter 4 (p. 56)  
The Viking Press. New York, New York, USA. 1966

**Cousins, Norman** 1912–90  
American editor and author

The justification for exploring the cosmos rests not on tangible benefits, but on philosophical grounds and on our instinctive need to evolve.

*Rendezvous with Infinity*  
*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979 (p. 30)

**Deudney, Daniel**  
American political scientist

...for all our looking and probing of the universe, we have yet to find any place as habitable as the remotest, most forbidding parts of this planet. Space exploration has taught us just how rare and precious the earth is.

*Space: The High Frontier in Perspective*  
Toward an Earth-Oriented Space Program (p. 51)  
Worldwatch Institute. 1982

**Dyson, Freeman J.** 1923–  
American physicist and educator

When we are a million species spreading through the galaxy, the question "Can man play God and still stay sane?" will lose some of its terrors. We shall be playing God, but only as local deities and not as lords of the universe. There is safety in numbers. Some of us will become insane, and rule over empires as crazy as Doctor Moreau's island. Some of us will shit on the morning star. There will be conflicts and tragedies. But in the long run, the sane will adapt and survive better than the insane.

*Disturbing the Universe*

Chapter 21 (pp. 236–237)  
Basic Books, Inc. New York, New York, USA. 1979

Nature's pruning of the unfit will limit the spread of insanity among species in the galaxy, as it does among individuals on earth. Sanity is, in its essence, nothing more than the ability to live in harmony with nature's laws.

*Disturbing the Universe*  
Chapter 21 (pp. 236–237)  
Basic Books, Inc. New York, New York, USA. 1979

**Ferris, Timothy** 1944–  
American science writer

We who came down from out of the forest seek to grow a forest of knowing among the stars.

*The Mind's Sky: Human Intelligence in a Cosmic Context*  
It (p. 222)  
Bantam Books. New York, New York, USA. 1992

We don't know whether human music will mean anything to nonhuman intelligences on other planets. But any creature that comes across Voyager and recognizes the record as an artifact can realize that it was dispatched with no hope of return. That gesture may speak more clearly than music. It says: However primitive we seem, however crude this spacecraft, we knew enough to envision ourselves citizens of the cosmos. ... However small we were, something in us was large enough to want to reach out to discoverers unknown, in times when we shall have perished or changed beyond recognition. ... Whoever and whatever you are, we too once lived in this house of stars, and we thought of you.

*Murmurs of Earth: The Voyager Instellar Record*  
Voyager's Music  
Random House, Inc. New York, New York, USA. 1978

**Firsoff, Valdemar Axel** 1910–82  
English astronomer and author

Yet if we go into space, let us do so humbly, in the spirit of cosmic piety. We know very little. We are face to face with the great unknown and have no right to assume that we are alone in the Solar System.

*Exploring the Planets*  
Chapter XV (p. 160)  
Sidgwick & Jackson. London, England. 1964

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

Man as a physical being is but a microscopic part of the universe, yet his mind carries him ever upward, and with spirit bold and unconquerable he seeks to reach the summit of Mount Olympus. Infinite space remains to humble his pride in spite of the knowledge he has obtained of the starry heavens; yet he pursues his inquiries into the unknown, and his children's children will continue to search.

*Discovery; or, The Spirit and Service of Science*  
Chapter I (p. 21)  
Macmillan & Company Ltd. London, England. 1918

**Hale, George Ellery** 1868–1938  
American astronomer

Like buried treasures, the outposts of the universe have beckoned to the adventurous from immemorial times. Princes and potentates, political or industrial, equally with men of science, have felt the lure of the uncharted seas of space, and through their provision of instrumental means the sphere of exploration has rapidly widened...

*Possibilities of Large Telescopes*  
*Harper's Magazine*, April 1928 (p. 639)

**Hawking, Stephen William** 1942–  
English theoretical physicist

I don't think the human race will survive the next thousand years, unless we spread into space. There are too many accidents that can befall life on a single planet. But I'm an optimist. We will reach out to the stars.

By Roger Highfield, Science Editor  
Colonies in space may be only hope, says Hawking  
Telegraph, Filed: 16/10/2001

**Heinlein, Robert A.** 1907–88  
American science fiction writer

But space travel can't ease the pressure on a planet grown too crowded not even with today's ships and probably not with any future ships — because stupid people won't leave the slopes of their home volcano even when it starts to smoke and rumble. What space travel does do is drain off the best brains: those smart enough to see a catastrophe before it happens and with the guts to pay the price — abandon home, wealth, friends, relatives, everything — and go. That's a tiny fraction of one percent. But that's enough.

*Time Enough for Love*  
Chapter XIV (p. 413)  
G.P. Putnam's Sons. New York, New York, USA. 1973

**Heppenheimer, T. A.** 1947–  
Aviation writer

...if humanity persists and endures, in time we will come face to face with the evolution of our sun. In a few billion years its slow brightening will speed up as it swells into a red giant. Earth will then be uninhabitable, as will the inner regions of the Solar System. Yet there will be other more clement stars to which our descendants may wish to migrate. Certainly a society that has developed space flight and space colonization will have the advantage of never thereafter having to stand hostage to fortune.

*Toward Distant Suns*  
Chapter 13 (p. 244)  
Stackpole Books. Harrisburg, Pennsylvania, USA. 1979

**Hey, Nigel S.** 1936–

American science writer

Space scientists and engineers serve the intangible needs of humankind, and share common ground with the poet. It is self-deceptive to suppose that society is wholly bound up in supplying life-or-death needs. Humans are thinkers, explorers, wonderers, and dreamers. If we were not, we would not need space exploration; but then we would also lead a listless and uncreative existence.

*How We Will Explore the Outer Planets* (p. 142)

G.P. Putnam's Sons. New York, New York, USA. 1973

Most of our knowledge of this marvel-filled universe is due to astronomy, telescopes and to robotic spaceflight. It is impossible to think of any thing that more exquisitely embodies the technical genius of humankind, in so small a package, as the interplanetary spacecraft.

*Solar System*

Chapter 3 (p. 61)

Weidenfield & Nicolson. London, England. 2002

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Space isn't remote at all. It's only an hour's drive away if your car could go straight upwards.

*Observer*, September 9, 1979

The seemingly insuperable difficulties of deep-space travel suggest an intention to keep us fixed at home in our own solar system, and the physical nature of our part of the Universe, as well as the basic rules of physics and chemistry, have a warning look about them, like barriers designed to isolate intelligent life. This means that for us, unlike the situation for humble microorganisms, deep-space travel is probably a stark impossibility.

*The Intelligent Universe*

Chapter 6 (p. 156)

Holt, Rinehart & Winston. New York, New York, USA. 1983

**Hubble, Edwin Powell** 1889–1953

American astronomer

Thus the explorations of space end on a note of uncertainty. And necessarily so. We are, by definition, in the very center of the observable region. We know our immediate neighborhood rather intimately. With increasing distance, our knowledge fades, and fades rapidly. Eventually, we reach the dim boundary — the utmost limits of our telescopes. There, we measure shadows, and we search among ghostly errors of measurement for landmarks that are scarcely more substantial.

The search will continue. Not until the empirical resources are exhausted, need we pass on to the dreamy realms of speculation.

*The Realm of the Nebulae*

Chapter VIII (p. 202)

Dover Publications, Inc. New York, New York, USA. 1958

The exploration of space has swept outward in successive waves, first, through the system of the planets, then, through the stellar system, and finally, into the realm of the nebulae. Today we study a region of space so vast and so homogeneous that it may well be a fair sample of the universe. At any rate, we are justified in adopting the assumption as a working hypothesis and attempting to infer the nature of the universe from the observed characteristics of the sample.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1942*

The Problem of the Expanding Universe (p. 119)

Government Printing Office. Washington, D.C. 1943

**Johnson, Lyndon B.** 1908–7336<sup>th</sup> president of the United States

No national sovereignty rules in outer space. Those who venture there go as envoys of the entire human race. Their quest, therefore, must be for all mankind, and what they find should belong to all mankind.

News Conference

Johnson City, Texas, 29 August, 1965

**Kennedy, John F.** 1917–6335<sup>th</sup> president of the United States

We choose to go to the Moon in this decade and do the other things, not because they are easy — but because they are hard!

Speech, Rice University, 12 September, 1962

I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth. No single space project in this period will be more impressive to mankind, or more important in the long-range exploration of space; and none will be so difficult or expensive to accomplish.

Announcement to American Congress

25 May, 1961

**Kepler, Johannes** 1571–1630

German astronomer

Provide ship or sails adapted to the heavenly breezes, and there will be some who will not fear even that void.... So, for those who will come shortly to attempt this journey, let us establish the astronomy: Galileo, you of Jupiter, I of the moon.

In John Lear

*Kepler's Dream*

Introduction and Interpretation, I (p. 3)

University of California Press. Berkeley, California, USA. 1965

**Lewis, John S.**

American professor of planetary science

It is in the interests of all the residents of Earth to see exploration continue and to see our realm of competence

expand to fill the Solar System. Like our ancient ancestors at the time of their emergence from the sea onto the land, we are challenged by events to master this great new environment, to drink of its knowledge, and to feast on its boundless resources. Let us not squander this golden opportunity.

In John S. Lewis

*Physics and Chemistry of the Solar System*

Chapter XII (p. 517)

Academic Press. San Diego, California, USA. 1995

### **Lowell, Percival** 1855–1916

American astronomer

From time immemorial travel and discovery have called with strange insistence to him who, wandering on the world, felt adventure in his veins. The leaving familiar sights and faces to push forth into the unknown has with magnetic force drawn the bold to great endeavor and fired the thought of those who stayed at home.

*Mars and Its Canals*

Chapter I (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

### **Lucretius** ca. 99 BCE–55 BCE

Roman poet

...he passed far beyond the flaming walls of the world and traversed throughout in mind and spirit the immeasurable universe...

In *Great Books of the Western World* (Volume 12)

*The Nature of the Universe*

Book I, 62 (p. 2)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Makarov, Oleg** 1933–2003

Soviet cosmonaut

You keep returning to the thought that only very thin walls separate you from the deathly cold and incomprehensible emptiness of space, which can extinguish life instantly and piteously.

The View from Out There: In Words and Pictures

*Life*, Volume 11, Number 13, November 1988 (p. 198)

### **Martin, Charles-Noël** 1923–

French nuclear physicist

As men travel further and further into space they are bound to meet sights beyond their wildest expectations.

Translated by A.J. Pomerans

*The Role of Perception in Science*

Chapter 4 (p. 92)

Hutchinson of London. London, England. 1963

### **Moulton, Forest Ray** 1872–1952

American astronomer

...there is not the slightest possibility of [travel to other worlds]. There is not in sight any source of energy that would...be necessary to get us beyond the gravitative

control of the earth; there is not theory that would guide us through interplanetary space to another world even if we could control our departure from the earth; there is no means of carrying the large amount of oxygen, water, and food that would be necessary for such a long journey; and there is no known way of easing our ether ship down onto the surface of another world, if we could get there at low enough speed to avoid destruction.

*Consider the Heavens*

Chapter VII

Chapter II (p. 107)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1935

### **Nixon, Richard M.** 1913–94

37<sup>th</sup> president of the United States

We must see our space effort, then, not only as an adventure of today but also as an investment in tomorrow. We did not go to the Moon merely for the sport of it. To be sure, those undertakings have provided an exciting adventure for all mankind and we are proud that it was our nation that met this challenge. But the most important thing about man's first footsteps on the Moon is what they promise for the future.

Statement by President Nixon on the Space Program

Released from the Office of the White House

Press Secretary, Key Biscayne, Florida, 7 March 1970

From time immemorial, man has insisted on venturing into the unknown despite his inability to predict precisely the value of any given exploration. He has been willing to take risks, willing to be surprised, willing to adapt to new experiences. Man has come to feel that such quests are worthwhile in and of themselves — for they represent one way in which he expands his vision and expresses the human spirit. A great nation must always be an exploring nation if it wishes to remain great.

Statement by President Nixon on the Space Program

Released from the Office of the White House

Press Secretary, Key Biscayne, Florida, 7 March 1970

As we enter a new decade, we are conscious of the fact that man is also entering a new historic era. For the first time, he has reached beyond his planet; for the rest of time, we will think of ourselves as men from the planet Earth. It is my hope that as we go forward with our space program, we can plan and work in a way which makes us proud both of the planet from which we come and of our ability to travel beyond it.

Statement by President Nixon on the Space Program

Released from the Office of the White House

Press Secretary, Key Biscayne, Florida, 7 March 1970

### **Oberth, Hermann** 1894–1989

German mathematician and physicist

This is the goal:

To make available for life every place where life is possible.

To make inhabitable all worlds as yet uninhabitable, and all life purposeful.

Translated by G.P.H. de Freville

*Man into Space: New Projects for Rocket and Space Travel*

Chapter VIII (p. 167)

Harper & Brothers. New York, New York, USA. 1957

**O'Neill, Gerard K.** 1927–92

American physicist

Clearly our first task is to use the material wealth of space to solve the urgent problems we now face on Earth: to bring the poverty-stricken segments of the world up to a decent living standard, without recourse to war or punitive action against those already in material comfort; to provide for a maturing civilization the basic energy vital to its survival.

*The High Frontier*

Bantam Dell Doubleday Publishing Group. New York, New York, USA. 1978

**Purcell, Edward** 1912–97

American physicist

All this stuff about traveling around the universe... belongs back where it came from, on the cereal box.

In A.G.W. Cameron (ed.)

*Interstellar Communication; A Collection of Reprints and Original Contributions*

Radio Astronomy and Communication Through Space (p. 143)

W.A. Benjamin, Inc. New York, New York, USA. 1963

**Reade, Winwood** 1838–75

English philosopher and historian

A time will come when science will transform [our bodies] by means which we cannot conjecture.... And then, the earth being small, mankind will migrate into space, and will cross the airless Saharas which separate planet from planet, and sun from sun. The earth will become a Holy Land which will be visited by pilgrims from all quarters of the universe.

*The Martyrdom of Man*

Chapter IV (pp. 459, 460)

E.P. Dutton & Company. New York, New York, 1926

**Roddenberry, Gene** 1921–91

American television producer and writer

Let me end with an explanation of why I believe the move into space to be a human imperative. It seems to me obvious in too many ways to need listing that we cannot much longer depend upon our planet's relatively fragile ecosystem to handle the realities of the human tomorrow. Unless we turn human growth and energy toward the challenges and promises of space, our only other choice may be the awful risk, currently demonstrable, of stumbling into a cycle of fratricide and regression which could end all chances of our evolving further or of even surviving.

Hailing Frequencies Open!

*Planetary Report*, Volume 1, April/May 1981 (p. 3)

**Russen, David**

No biographical data available

Since Springiness is a cause of forcible motion; and a Spring will, when bended and let loose, extend its self to its length; could a Spring of well-tempered steel be framed, whose basis being fastened to the Earth, and on the other end placed a Frame or Seat, wherein a Man with other necessaries could abide in safety, this Spring being with Cords, Pullies, or other Engines bent, and then let loose by degrees by those who manage the Pullies, the other end...reach the Moon, where the Person who ascended landing, the Spring might again be bent, till the end touching the earth, should discharge the passenger again in safety.

In Noel Deisch

The Navigation of Space in Early Speculation and in Modern Research

*Popular Astronomy*, Volume 38, Number 2, February 1930 (p. 81)

**Sagan, Carl** 1934–96

American astronomer and author

Since, in the long run, every planetary civilization will be endangered by impacts from space, every surviving civilization is obliged to become spacefaring — not because of exploratory or romantic zeal, but for the most practical reason imaginable: staying alive.... If our long-term survival is at stake, we have a basic responsibility to our species to venture to other worlds.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 21 (p. 371)

Random House, Inc. New York, New York, USA. 1994

Centuries hence, when current social and political problems may seem as remote as the problems of the Thirty Years' War are to us, our age may be remembered chiefly for one fact: It was the time when the inhabitants of the earth first made contact with the vast cosmos in which their small planet is embedded.

The Solar System

*Scientific American*, Volume 233, Number 3, 1975 (p. 30)

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

...perchance, coming generations will not abide the dissolution of the globe, but, availing themselves of future inventions in aerial locomotion, and the navigation of space, the entire race may migrate from the earth, to settle some vacant and more western planet.... It took but little art, a simple application of natural laws, a canoe, a paddle, and a sail of matting, to people the isles of the Pacific, and a little more will people the shining isles of space. Do we not see in the firmament the lights carried along the shore by night, as Columbus did? Let us not despair or mutiny.

*The Maine Woods*

Paradise (to Be) Regained (p. 58)

Houghton Mifflin Company. New York, New York, USA. 1893

**Tipler, Frank** 1947–

American physicist

If the human species, or indeed any part of the biosphere, is to continue to survive, it must eventually leave the Earth and colonize space. For the simple fact of the matter is, the planet Earth is doomed.... Let us follow many environmentalists and regard the Earth as Gaia, the mother of all life (which indeed she is). Gaia, like all mothers, is not immortal. She is going to die. But her line of descent might be immortal... Gaia's children might never die out — provided they move into space. The Earth should be regarded as the womb of life — but one cannot remain in the womb forever.

*The Physics of Immortality: Modern Cosmology, God and the Resurrection of the Dead*

Chapter II (p. 18, 18–19)

Doubleday & Company, Inc. New York, New York, USA. 1994

**van der Riet Wooley, Sir Richard** 1906–1986

British Astronomer Royal

...the whole procedure [of shooting rockets into space]... presents difficulties of so fundamental a nature, that we are forced to dismiss the notion as essentially impracticable, in spite of the author's insistent appeal to put aside prejudice and to recollect the supposed impossibility of heavier-than-air flight before it was actually accomplished.

x

Rockets in Space

*Nature*, Supplement, March 14, 1936 (p. 442)

It's utter bilge. I don't think anybody will ever put up enough money to do such a thing... What good would it do us? If we spend the same amount of money on preparing first-class astronomical equipment we would learn much more about the universe... It is all rather rot.

Utter Bilge

*Time*, January 16, 1956 (p. 42)

**Verne, Jules** 1828–1905

French novelist

...I repeat that the distance between the earth and her satellite is a mere trifle, and undeserving of serious consideration. I am convinced that before twenty years are over one-half of our earth will have paid a visit to the moon.

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter XIX (p. 99)

A.L. Burt Company. New York, New York, USA. 1890

In spite of the opinions of certain narrow-minded people, who would shut up the human race upon this globe, as within some magic circle which it must never outstep, we shall one day travel to the moon, the planets, and the

stars, with the same facility, rapidity, and certainty as we now make the voyage from Liverpool to New York.

*From the Earth to the Moon and Round the Moon*

From Earth to the Moon, Chapter XIX (p. 97)

A.L. Burt Company. New York, New York, USA. 1890

**von Braun, Wernher** 1912–77

German-American rocket scientist

[Space travel] will free man from his remaining chains, the chains of gravity which still tie him to this planet. It will open to him the gates of heaven.

The Jupiter People

*Time*, February 10, 1958 (p. 18)

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

All this world is heavy with the promise of greater things, and a day will come, one day in the unending succession of days, when beings, beings who are now latent in our thoughts and hidden in our loins, shall stand upon this earth as one stands upon a footstool and laugh and reach out their hands amidst the stars.

The Discovery of the Future

*Nature*, Volume 65, Number 1684, February 6, 1902 (pp. 326–331)

**Whipple, Fred L.** 1906–2004

American comet research pioneer

In conquering space, man will take his greatest single step forward in his ever-expanding struggle against the limitations set by nature. The scientist, by knowing more about the universe, may find paths that will lead to still further conquests of nature. And it may be truly said that man will no longer be limited to seeing "as through a glass darkly." The universe will be spread out clearly before him.

In Cornelius Ryan (ed.)

*Across the Space Frontier*

The Heavens Open (p. 143)

The Viking Press. New York, New York, USA. 1952

**Wilkins, John** 1614–72

English writer

We see a great ship swims as well as a small cork, and an eagle flies in the air as well as a little gnat.... 'Tis likely enough that there may be means invented of journeying to the moon; and how happy they shall be that are first successful in this attempt.

*A Discourse Concerning a New World and Another Planet*

Book 1, Chapter 14

J. Maynard. London, England. 1640

**Wren, Sir Christopher** 1632–1723

English mathematician and architect

A time would come when Men should be able to stretch out their Eyes... they should see the Planets like our Earth.

Inauguration Speech, Gresham College, 1657

## SPACE FLIGHT

**Burroughs, Edgar Rice** 1875–1950  
American writer

I knew that I had ample room in which to wander, since science has calculated the diameter of space to be eighty-four thousand million light years, which, when one reflects that light travels at the rate of one hundred eighty-six thousand miles a second, should satisfy the wanderlust of the most inveterate roamer.

*Pirates of Venus*

Chapter Two (p. 19)

University of Nebraska Press. Lincoln, Nebraska, USA. 2001

...man is an artifact designed for space travel. He is not designed to remain in his present biologic state any more than a tadpole is designed to remain a tadpole.

*The Adding Machine: Selected Essays*

Civilian Defense (p. 82)

Seaver Books. New York, New York, USA. 1986

**Clarke, Arthur C.** 1917–

English science and science fiction writer

It has often been said — and though it is becoming platitudinous it is nonetheless true — that only through space-flight can mankind find a permanent outlet for its aggressive and pioneering instincts. The desire to reach the planets is only an extension of the desire to see what is over the next hill.

*The Exploration of Space*

Pocket Books. New York, New York, USA. 1979

**Cousins, Norman** 1912–90

American editor and author

What was most significant about the first lunar voyage was not that men set foot on the moon, but that they set eye on earth.

*Rendezvous with Infinity*

*Cosmic Search Magazine*, Volume 1, Number 1, January 1, 1979 (p. 31)

**Dyson, Freeman J.** 1923–

American physicist and educator

There are three reasons, ...apart from scientific considerations, mankind needs to travel in space. The first...is garbage disposal; we need to transfer industrial processes into space so that the earth may remain a green and pleasant place for our grandchildren to live in. The second...to escape material impoverishment: the resources of this planet are finite, and we shall not forego forever the abundance of solar energy and minerals and living space that are spread out all around us. The third...our spiritual need for an open frontier.

*Disturbing the Universe*

Chapter 10 (p. 116)

Basic Books, Inc. New York, New York, USA. 1979

When will the third romantic age in the history of space-flight begin? The third romantic age will see little model sailboats spreading their wings to the sun in space...

*Disturbing the Universe*

Chapter 10 (p. 116)

Basic Books, Inc. New York, New York, USA. 1979

**Feynman, Richard P.** 1918–88

American theoretical physicist

[Regarding space shuttle concept] It appears that there are enormous differences of opinion as to the probability of a failure with loss of vehicle and of human life. The estimates range from roughly 1 in 100 to 1 in 100,000. The higher figures come from the working engineers, and the very low figures from management.... For a successful technology, reality must take precedence over public relations, for nature cannot be fooled.

*Roger's Commission Report on the Space Shuttle Challenger Accident*

Personal observations on the reliability of the Shuttle, Appendix

**Haber, Heinz** 1868–1934

German physical chemist

The conquest of space hinges on man's survival in space. And the crews of rocket ships and space stations, while they can never be completely protected against hazards such as meteors, will probably be safer than pedestrians crossing a busy street at a rush hour.

In Cornelius Ryan (ed.)

*Across the Space Frontier*

Can We Survive in Space? (p. 97)

The Viking Press. New York, New York, USA. 1952

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Space flights are merely an escape, a fleeing away from oneself, because it is easier to go to Mars or to the moon than it is to penetrate one's own being.

In Miguel Serrano

*C.G. Jung and Hermann Hesse*

The Farewell (p. 102)

Schocken Books. New York, New York, USA. 1966

**Kepler, Johannes** 1571–1630

German astronomer

There will certainly be no lack of human pioneers when we have mastered the art of flight. Who would have thought that navigation across the vast ocean is less dangerous and quieter than in the narrow, threatening gulfs of the Adriatic, or the Baltic, or the British straits? Let us create vessels and sails adjusted to the heavenly ether, and there will be plenty of people unafraid of the empty wastes. In the meantime, we shall prepare, for the brave sky travelers, maps of the celestial bodies — I shall do it for the moon, you, Galileo, for Jupiter.

In Arthur Koestler

*The Watershed — A Biography of Johannes Kepler*



Letter from Kepler to Galileo  
 April 1610 (p. 195)  
 Doubleday & Company, Inc. Garden City. New York, New York, USA.  
 1960

**Mallove, Eugene F.** 1947–2004  
 American physicist

Starflight is not just very hard, it is very, very, very hard.  
*Starflight Handbook*  
 Introduction (p. 5)  
 John Wiley & Sons, Inc. New York, New York, USA. 1989

**von Braun, Wernher** 1912–77  
 German-American rocket scientist

With our present knowledge, we can respond to the challenge of stellar space flight solely with intellectual concepts and purely hypothetical analysis. Hardware solutions are still entirely beyond our reach and far, far away.  
 Can We Ever Go to the Stars?  
*Popular Science*, Volume 183, Number 1, July 1963 (p. 170)

## SPACE SETTLEMENT

**Wolfe, Steven**  
 No biographical data available

Remember, the space settlement dream was born in you so that you would strive for its fulfillment in this generation, not defer it to the next. It was, and is, a call to you to take some action in this lifetime; and if you are not meant to see it through to completion, than you must at least lay a foundation on which those who will follow can build.  
 Space Settlement: The Journey Inward  
*Ad Astra*, Jan/Feb/Mar 2004

## SPACE-TIME

**Barnett, Lincoln** 1909–79  
 Science writer

...the universe is not a rigid and inimitable edifice where independent matter is housed in independent space and time; it is an amorphous continuum, without any fixed architecture, plastic and variable, constantly subject to change and distortion. Wherever there is matter and motion, the continuum is disturbed. Just as a fish swimming in the sea agitates the water around it, so a star, a comet, or a galaxy distorts the geometry of the space-time through which it moves.  
*The Universe and Dr. Einstein*  
 Chapter 11 (pp. 81–82)  
 William Sloane Associates. New York, New York, USA. 1948

**Berlinski, David** 1942–  
 American mathematician

Yet everything has a beginning, everything comes to an end, and if the universe actually began in some dense explosion, thus creating time and space, so time and space are themselves destined to disappear, the measure vanishing with the measured, until with another ripple running through the primordial quantum field, something new arises from nothingness once again.  
*A Tour of the Calculus*  
 Chapter 26 (p. 309)  
 Pantheon Books. New York, New York, USA. 1995

**Bohr, Niels Henrik David** 1886–1962  
 Danish physicist

We must, therefore, be prepared to find that further advance into this region will require a still more extensive renunciation of features which we are accustomed to demand of the space time mode of description.  
*Atomic Theory and the Description of Nature*  
 Introductory Survey (p. 14)  
 Cambridge University Press. Cambridge, England. 1934

**Carlyle, Thomas** 1795–1881  
 English historian and essayist

Deepest of all illusory Appearances, for hiding Wonder, as for many other ends, are your two grand fundamental world-enveloping Appearances, Space and Time.  
*Sartor Resartus*  
 Chapter VIII  
 Ginn & Company. Boston, Massachusetts, USA. 1897

**Clarke, Arthur C.** 1917–  
 English science and science fiction writer

Through all the ages, man has fought against two great enemies — time and space. Time he may never wholly conquer, and the sheer immensity of space may also defeat him when he has ventured more than a few light-years from the Sun. Yet on this little Earth, at least, he may one day claim a final victory.  
*Profiles of the Future: An Inquiry into the Limits of the Possible*  
 Chapter 8 (p. 81)  
 Harper & Row, Publishers. New York, New York, USA. 1973

**Cole, K. C.** 1946–  
 American science writer

...Space and time are us...  
*The Hole in the Universe: How Scientists Peered Over the Edge of Emptiness and Found Everything*  
 Chapter 5 (p. 109)  
 Harcourt, Inc. New York, New York, USA. 2001

**de Beaugard, Costa**  
 No biographical data available

There can no longer be any objective and essential... division of space-time between “events which have already occurred” and “events which have not yet occurred.”...Relativity is a theory in which everything

is “written” and where change is only relative to the perceptual mode of living beings.

In J.T. Fraser

*The Voices of Time: A Cooperative Survey of Man's Views of Time as Expressed by the Sciences and by the Humanities*

Time in Relativity Theory: Arguments for a Philosophy of Being (p. 429)

G. Braziller. New York, New York, USA. 1966

### **de Broglie, Louis** 1892–1987

French physicist

In space-time, everything which for each of us constitutes the past, the present, and the future is given in block, and the entire collection of events, successive for us, which form the existence of a material particle is represented by a line, the world-line of the particle. Each observer, as his time passes, discovers, so to speak, new slices of space-time which appear to him as successive aspects of the material world, though in reality the ensemble of events constituting space-time exist prior to his knowledge of them.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

A General Survey of the Scientific Work of Albert Einstein (p. 114)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

### **Dixon, William MacNeile** 1866–1946

English author and scholar

Everything lies within space, and everything happens within time.

*The Human Situation* (p. 328)

Longmans, Green & Company. London, England. 1937

### **Dyson, Freeman J.** 1923–

American physicist and educator

Not only is Space from the point of view of life and humanity empty, but Time is empty also. Life is like a little glow, scarcely kindled yet, in these void immensities.

*Infinite in All Directions*

Part One, Chapter One (p. 9)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

It [the physical world is a *thing*; not like space, which is a mere negation; nor like time, which is — Heaven knows what!

*The Nature of the Physical World*

Introduction (p. ix)

The Macmillan Company. New York, New York, USA. 1930

### **Einstein, Albert** 1879–1955

German-born physicist

Time and space are modes by which we think and not conditions in which we live.

In Alyesa Forsee

*Albert Einstein, Theoretical Physicist* (p. 81)

The Macmillan Company. New York, New York, USA. 1963

### **Ferris, Timothy** 1944–

American science writer

Newton viewed space and time as separate and absolute. As conceived by Einstein they are united in a flexible continuum that responds to the presence of matter. The stars and planets wrap the spacetime continuum around themselves, in a sense, each sitting in the center of a sort of spacetime whirlpool.

*The Red Limit: The Search for the Edge of the Universe*

Chapter 3 (p. 71)

William Morrow & Company, Inc. New York, New York, USA. 1977

[Einstein explained] the commerce we call gravity occurs because objects follow the easiest, most efficient course over the undulations of the continuum. Earth in its orbit glides along inside the sun's spacetime vortex like a roulette ball whirling above the wheel, balancing its velocity against its tendency to slide toward the sun. That tendency is equivalent to gravity, but no “force” of gravity is postulated. Light beams also follow the dips and hills of the continuum. They trace trajectories we call “bent,” though that is just three-dimensional parochialism talking; they are going just as straight as the shape of spacetime allows.

*The Red Limit: The Search for the Edge of the Universe*

Chapter 3 (p. 71)

William Morrow & Company, Inc. New York, New York, USA. 1977

### **Hawking, Stephen William** 1942–

English theoretical physicist

The theory of relativity does, however, force us to change fundamentally our ideas of space and time. We must accept that time is not completely separate from and independent of space, but is combined with it to form an object called space-time.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 2 (p. 123)

Bantam Books. Toronto, Ontario, Canada. 1988

### **Hoffmann, Banesh** 1906–86

Mathematician and educator

What is it that pulls the apple to the ground, bends the circling moon to the earth and makes the planets captive of the sun? ... It is intangible time and space themselves, acting in awesome concert as curved space-time holding sway over all things in the universe.

*Relativity and Its Roots*

Chapter 6 (pp. 156–157)

W.H. Freeman & Company. New York, New York, USA. 1983

### **John Shade**

Fictional character

Space is a swarming of the eyes, and Time a singing in the ears.

In Vladimir Nabokov  
*Ada or Ardor: A Family Chronicle*  
Part Four (p. 542)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

**Joubert, Joseph** 1754–1824

French moralist

There is something divine about the ideas of space and eternity which is wanting in those of pure duration and simple extension.

Translated by H.P. Collins  
*Pensées and Letters of Joseph Joubert*  
Chapter XII (p. 90)  
Books for Libraries Press. Freeport, New York, USA. 1972

**Lamb, Charles** 1775–1834

English essayist and critic

Nothing puzzles me more than time and space; and yet nothing troubles me less, as I never think about them.

Quoted by James R. Newman  
*The World of Mathematics* (Volume 1)  
Letter to Thomas Manning, January 2, 1806 (p. 552)  
Simon & Schuster. New York, New York, USA. 1956

**MacLeish, Archibald** 1892–1982

American poet and Librarian of Congress

Spacetime has no beginning and no end.  
It has no door where anything can enter.  
How break and enter what will only bend?

*Songs for Eve*  
Reply to Mr. Wordsworth (p. 39)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1954

**Maeterlinck, Maurice** 1862–1949

Belgian playwright and poet

To attempt to explain space by time and time by space is to seek to explain the night by darkness and the darkness by the night; it is to revolve hopelessly in the circle of the unknowable.

Translated by Bernard Miall  
*The Life of Space*  
The Fourth Dimension, XXIX (pp. 96–97)  
Dodd, Mead & Company. New York, New York, USA. 1928

Space is the present made visible. Time is space that is on the move and becoming the future or the past. Space is time extended; it is horizontal time; time is space perpendicular, vertical space. Space is time that endures; time is space that flies.

Translated by Bernard Miall  
*The Life of Space*  
The Fourth Dimension, XXIX (p. 97)  
Dodd, Mead & Company. New York, New York, USA. 1928

**Maxwell, James Clerk** 1831–79

Scottish physicist

March on, symbolic host! with step sublime,  
Up to the flaming bounds of Space and Time!  
There pause, until by Dickenson depicted,  
In two dimensions, we the form may trace  
Of him whose soul, too large for vulgar space,  
In  $n$  dimensions flourished unrestricted.

In Lewis Campbell and William Garnett  
*The Life of James Clerk Maxwell with Selections from his Correspondence and Occasional Writings*  
To the Committee of the Cayley Portrait Fund (p. 637)  
Macmillan & Company. London, England. 1882

**Minkowski, Hermann** 1864–1909

German mathematician

From this hour on, space as such and time as such shall recede to the shadows and only a kind of union of the two retain significance.

In A.P. French  
*Einstein: A Centenary Volume*  
Chapter 12 (p. 231)  
Harvard University Press. Cambridge, Massachusetts, USA. 1979

The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. Henceforth space by itself and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality.

*Space and Time*  
80<sup>th</sup> Assembly of German Natural Scientists and Physicians, September 21, 1908

The objects of our perception invariably include places and times in combination. Nobody has ever noticed a place except at a time, or a time except at a place. But I still respect the dogma that both space and time have independent significance. A point of space at a point of time, that is a system of values  $x, y, z, t$ , I will call a world-point.

*The Principle of Relativity: A Collection of Original Memoirs on the Special and General Theory of Relativity*  
Space and Time (p. 76)  
Dover Publications, Inc. New York, New York, USA. 1952

**Murchie, Guy** 1907–97

American biologist

...the key to comprehending space-time is the obvious (to me) fact that space is the relationship between things and other things while time is the relationship between things and themselves.

*The Seven Mysteries of Life: An Exploration of Science and Philosophy*  
Part Three, Chapter 12 (p. 331)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1978

**Pope, Alexander** 1688–1744

English poet

Ye Gods! annihilate but space and time,  
And make two lovers happy.

*The Complete Poetical Works*

Martinus Scriblerus of The Art of Sinking in Poetry, 11  
Houghton Mifflin Company. New York, New York, USA. 1903

**Reichenbach, Hans** 1891–1953

German philosopher of science

It appears that the solution of the problem of time and space is reserved to philosophers who, like Leibnitz, are mathematicians, or to mathematicians who, like Einstein, are philosophers.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

The Philosophical Significance of the Theory of Relativity, IV (p. 307)  
The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

**Stenger, Victor J.** 1935–

American physicist

Great physicists from Galileo to Einstein have clarified the meanings of space and time for us, not overthrown their basic conceptions nor declared them obsolete.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 13 (p. 295)

Prometheus Books. Buffalo, New York, USA. 1990

**Synge, John L.** 1897–1995

Irish mathematician and physicist

Anyone who studies relativity without understanding how to use simple space-time diagrams is as much inhibited as a student of functions of a complex variable who does not understand the Argads diagram.

*Relativity: The Special Theory* (p. 63)

North-Holland Publishing Company. Amsterdam, Netherlands. 1965

**Taylor, Edwin F.**

American physicist

**Wheeler, John Archibald** 1911–

American physicist and educator

Never make a calculation until you know the answer: Make an estimate before every calculation, try a simple physical argument (symmetry! invariance! conservation!) before every derivation, guess the answer to every puzzle. Courage: no one else needs to know what the guess is. Therefore make it quickly, by instinct. A right guess reinforces this instinct. A wrong guess brings the refreshment of surprise. In either case, life as a spacetime expert, however long, is more fun!

*Spacetime Physics*

Chapter 1 (p. 60)

W.H. Freeman & Company. San Francisco, California, USA. 1966

**Thorne, Kip S.** 1940–

American theoretical physicist

...spacetime is like a piece of wood impregnated with water. ...the wood represents space, the water represents time.... [W]ood and water; space and time...are tightly

interwoven, unified. The singularity and the laws of quantum gravity that rule it are like a fire into which the water impregnated wood is thrown. The fire boils the water out of the wood, leaving the wood alone and vulnerable; in the singularity, the laws of quantum gravity destroy time, leaving space alone and vulnerable. The fire then converts the wood into a froth of flakes and ashes; the laws of quantum gravity then convert space into a random, probabilistic froth.

*Black Holes and Time Warps: Einstein's Outrageous Legacy*

Chapter 13 (p. 477)

W.W. Norton & Company, Inc. New York, New York, USA. 1994

...Space and time, unified as spacetime, do not merely witness great masses struggling to bend the motion of other masses. Like the gods of ancient Greece, spacetime helps guide the battle and itself participates.... The scope and power of this century's new view of gravity and spacetime is seen nowhere more dramatically than in its prediction of the expansion of the universe. To have predicted...against all expectation, a phenomenon so fantastic is the greatest token yet of our power to understand this strange and beautiful universe.

*A Journey into Gravity and Spacetime*

Chapter 1 (p. 2)

Scientific American Library. New York, New York, USA. 1990

**Valéry, Paul** 1871–1945

French poet and critic

Space is an imaginary body, as time is fictive movement.

When we say "in space" or "space is filled with" we are positing a body.

In Jackson Mathews (ed.)

*The Collected Works of Paul Valéry* (Volume 14)

Analects, CIX (p. 321)

Princeton University Press. Princeton, New Jersey, USA. 1971

## SPECIALIZATION

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

A man cannot be a professor of zoology on one day, and of chemistry on the next, and do good work in both. As in a concert all are musicians — one plays one instrument, and one another, but none all in perfection.

In Charles Frederick Holder

*Louis Agassiz: His Life and Work*

At Penikese (p. 174)

G.P. Putnam's Sons. New York, New York, USA. 1893

You cannot do without one specialty; you must have some base-line to measure the work and attainments of others.

In Charles Frederick Holder

*Louis Agassiz: His Life and Work*

At Penikese (p. 174)  
G.P. Putnam's Sons. New York, New York, USA. 1893

**Asimov, Isaac** 1920–92  
American author and biochemist

...the orchard of science is a vast globe-encircling monster, without a map, and known to no one man; indeed, to no group of men fewer than the whole international mass of creative scientists. Within it, each observer clings to his own well-known and well-loved clump of trees. If he looks beyond, it is usually with a guilty sigh.

*View from a Height*

Introduction (p. 7)

Avon Books. New York, New York, USA. 1975

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

To interrupt one's own researches in order to follow those of another is a scientific pleasure which most experts delegate to their assistants. Consequently, the confusion of tongues increases as the square of the number of talkers, until only ever more select coteries of narrow specialists really understand the refinements of their esoteric vocabularies.

*The Development of Mathematics* (p. 510)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Burnet, Frank Macfarlane** 1899–1985  
Australian immunologist and virologist

We may well find that the men who staff the hospitals of next century will include many who are much more mathematicians and biochemists than physicians as we know them today, but there will still be wide range of surgical and other specialists.... I fancy that those men will still need to be able to apply common sense, courage, and compassion in dealing with all the human difficulties that escape the machines.

*Changing Patterns: An Atypical Autobiography* (pp. 251–252)  
William Heineman. London, England. 1968

**Groen, Janny**  
No biographical data available

**Smit, Eefke**  
No biographical data available

Scientific information is essential, not only for the scientist. The politician, the entrepreneur and the public at large need to know about it too. The people in business find that neither the mass media nor the specialized scientific press are providing the information needed. General information is no longer enough, specialist information is only digestible for the learned. Who will bridge the gap?

*The Discipline of Curiosity: Science in the World*

Introduction (p. 4)

Elsevier Science. Amsterdam, Netherlands. 1990

**Heinlein, Robert A.** 1907–88  
American science fiction writer

A human being should be able to change a diaper, plan an invasion, butcher a hog, conn a ship, design a building, write a sonnet, balance accounts, build a wall, set a bone, comfort the dying, take orders, give orders, cooperate, act alone, solve equations, analyze new problems, pitch manure, program a computer, cook a tasty meal, fight efficiently, die gallantly.

Specialization is for insects.

*Time Enough for Love*

Intermission (pp. 265–266)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Morrow, Prince Albert** 1846–1913  
American dermatologist and sociologist

The genius of modern medical literature is clearly in the direction of division of labor and associated effort.

*A System of Genito-Urinary Diseases, Syphilology, and Dermatology*

Preface

D. Appleton & Company. New York, New York, USA. 1893–4

**Ortega y Gasset, José** 1883–1955  
Spanish philosopher

For the purpose of innumerable investigations it is possible to divide science into small sections, to enclose oneself in one of these, and to leave out of consideration all the rest. The solidity and exactitude of the methods allow...this temporary but...disarticulation of knowledge. The work...done under [such] methods [is] as with a machine, and in order to obtain quite abundant results it is not even necessary to have rigorous notions of their meaning and foundations.

*The Revolt of the Masses*

Chapter 12 (p. 111)

W.W. Norton & Company, Inc. New York, New York, USA. 1960

[The division of science into specialties means] the majority of scientists help the general advance of science while shut up in the narrow cell of their laboratory, like the bee in the cell of its hive, or the turnspit in its wheel.

*The Revolt of the Masses*

Chapter 12 (p. 111)

W.W. Norton & Company, Inc. New York, New York, USA. 1960

**Osler, Sir William** 1849–1919  
Canadian physician and professor of medicine

The extraordinary development of modern science may be her undoing. Specialism, now a necessity, has fragmented the specialties themselves in a way that makes the outlook hazardous. The workers lose all sense of proportion in a maze of minutiae.

*The Old Humanities and the New Science*

Chapter III (p. 49)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1920

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

It is my contention that specialization should be left to those who are not mentally gifted at generalization.

*An Almanac for Moderns*

September Twenty-First (p. 199)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Stevens, Rosemary** 1935–

No biographical data available

In the whole process of reassessment...of the medical profession...has come the recognition of medicine as an interdependent, not independent, profession and as one consisting of a complex of specialties rather than one general discipline.

*American Medicine and the Public Interest* (p. 413)

Yale University Press. New Haven, Connecticut, USA. 1971

**Vesalius, Andreas** 1514–64

Flemish physician and anatomist

Great harm is caused by too wide a separation of the disciplines which work toward the perfection of each individual art, and much more by the meticulous distribution of the practices of this art to different workers.

*The Fabric of the Human Body*

Preface

1543

**Weiner, Jonathan** 1953–

American fiction and non-fiction writer

Specialization has gotten out of hand. There are more branches in the tree of knowledge than there are in the tree of life. A petrologist studies rocks; a pedologist studies soils. The first one sieves the soil and throws away the rocks. The second one picks up the rocks and brushes off the soil. Out in the field, they bump into each other only like Laurel and Hardy, by accident, when they are both backing up.

*The Next One Hundred Years: Shaping the Fate of Our Living Earth*

Chapter 10 (pp. 198–199)

Bantam Books. New York, New York, USA. 1990

**SPECIES****Bessey, Charles E.** 1845–1915

American botanist

Nature produces individuals and nothing more

The Taxonomic Aspect of the Species Question

*The American Naturalist*, Volume 42, Number 496, April 1908 (p. 218)

**Blumenbach, Johann Friedrich** 1752–1840

German naturalist and anthropologist

What is species? We say that animals belong to one and the same species if they agree so well in form and

constitution that those things in which they differ may have arisen from degeneration... Now we come to the real difficulty, which is to set forth the characters by which in the natural world we may distinguish mere varieties from genuine species.

*The Anthropological Treatises of Johann Friedrich Blumenbach*

Section II (p. 188)

Longman, Green, Longman, Roberts & Green. London, England. 1865

**Darwin, Charles Robert** 1809–82

English naturalist

Unless we suppose the same species to have been created in two different countries, we ought not to expect any closer similarity between the organic beings on the opposite sides of the Andes than on shores separated by a broad strait of the sea.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter X (p. 365)

D. Appleton & Company. New York, New York, USA. 1896

Widely ranging species, abounding in individuals, which have already triumphed over many competitors in their own widely extended homes will have the best chance of seizing on new places, when they spread into new countries.

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter XII (p. 182)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

It is really laughable to see what different ideas are prominent in various naturalists' minds, when they speak of "species:" in some, resemblance seems to go for nothing, and Creation the reigning idea — in some, descent is the key, — in some, sterility an unfailling test, with others it is not worth a farthing. It comes, I believe, from trying to define the undefinable.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to J.D. Hooker, December 24, 1856 (p. 446)

D. Appleton & Company. New York, New York, USA. 1896

...I look at the term species as one arbitrarily given, for the sake of convenience, to a set of individuals closely resembling each other...

In *Great Books of the Western World* (Volume 49)

*The Origin of Species by Means of Natural Selection*

Chapter II (p. 29)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Falk, Donald**

American ecologist and biologist

We consider species to be like a brick in the foundation of a building. You can probably lose one or two or a dozen bricks and still have a standing house. But by the time you've lost 20 per cent of species, you're going to destabilize the entire structure. That's the way ecosystems work.

*Christian Science Monitor*, 26 May 1989

**Forbes, Edward** 1815–54  
English naturalist

...every true species presents in its individuals, certain features, specific characters, which distinguish it from every other species; as if the Creator had set an exclusive mark or seal on each type.

*The Natural History of the European Seas*  
Chapter I (p. 8)  
John Van Voorst. London, England. 1859

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

When scientific work is instituted solely with the object of securing commercial gain, its correlative selfishness; when it is confined to the path of narrow specialisation, it leads to arrogance; and when its purpose is materialistic domination, without regard for the spiritual needs of humanity, it is a social danger and may become an excuse for learned barbarity.

*Discovery: Or the Spirit and Service of Science*  
Preface (pp. v–vi)  
Macmillan & Company Ltd. London, England. 1918

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

It is not a futile purpose to decide definitely what we mean by the so-called species among living bodies, and to enquire if it is true that species are of absolute constancy, as old as nature, and have all existed from the beginning just as we see them today; or if, as a result of changes in their environment, albeit extremely slow, they have not in course of time changed their characters and shape.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter III (p. 35)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

What a swarm of mollusk shells are furnished by every country and every sea, eluding our means of distinction and draining our resources.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition With Regard to the Natural History of Animals*  
Chapter III (p. 38)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

The idea of bringing together under the name of species a collection of like individuals, which perpetuate themselves unchanged by reproduction and are as old as nature, involved the assumption that the individuals of one species could not unite in reproductive acts with individuals of another species.

Unfortunately, observation has proved and continues every day to prove that this assumption is unwarranted;

for the hybrids so common among plants, and the copulations so often noticed between animals of very different species, disclose the fact that the boundaries between these alleged constant species are not so impassable as had been imagined.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition With Regard to the Natural History of Animals*  
Chapter III (p. 39)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

**Leakey, Richard Erskine** 1944–  
Kenyan paleoanthropologist and politician

As a species, we are blessed with a curiosity about the world of nature and our place in it. We want to know — *need* to know — how we came to be as we are, and what our future is.

*The Origin of Humankind*  
Preface (p. xv)  
Basic Books, Inc. New York, New York, USA. 1994

**Locke, John** 1632–1704  
English philosopher and political theorist

...the boundaries of the species, whereby men sort them, are made by men.

In *Great Books of the Western World* (Volume 35)  
*An Essay Concerning Human Understanding*  
Book III, Chapter VI, Section 37 (p. 279)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lyell, Sir Charles** 1797–1875  
English geologist

...species are abstractions, not realities — are like genera. Individuals are the only realities. Nature neither makes nor breaks molds — all is plastic, unfixed, transitional, progressive, or retrograde. There is only one great resource to fall back upon, a reliance that all is for the best, trust in God, a belief that truth is the highest aim, that if it destroys some idols it is better that they should disappear, that the intelligent ruler of the universe has given us this great volume as a privilege, that its interpretation is elevating.

In Leonard G. Wilson (ed.)  
*Sir Charles Lyell's Scientific Journals on the Species Question*  
Journal II, July 10, 1856 (p. 121)  
Yale University Press. New Haven, Connecticut, USA. 1970

**Mayr, Ernst** 1904–2005  
German-born American biologist

We had an international conference in Rome in 1981 on the mechanisms of speciation. It was attended by many of the leading botanists, zoologists, paleontologists, geneticists, cytologists and biologists. The one thing on which they all agreed was that we still have no idea what happens genetically during speciation. That's a damning statement, but it's the truth.

*OMNI Magazine*

February, 1983 (p. 78)

It may not be exaggeration if I say that there are probably as many species concepts as there are thinking systematists and students of speciation.

*Systematics and the Origin of Species*

Chapter V (p. 115)

Harvard University Press. Cambridge, Massachusetts, USA. 1942

### **Morton, Ron L.**

No biographical data available

Species come,  
species go;

Some real fast,  
some real slow...

*Music of the Earth: Volcanoes, Earthquakes and Other Geological Wonders*

Chapter 10 (p. 267)

Plenum Press. New York, New York, USA. 1996

### **Nietzsche, Friedrich** 1844–1900

German philosopher

The species does not grow into perfection: the weak again and again get the upper hand of the strong, — their large number, and their greater cunning are the cause of it.

In Alexander Tille (ed.)

*The Works of Friedrich Nietzsche*

Volume 11, The Twilight of the Idols, Roving Expeditions of an Inopportune Philosopher, Section 14 (p. 174)

### **Terborgh, John** 1936 –

Species are the units of evolution.

*Diversity and the Tropical Rain Forest*

Chapter 1 (p. 6)

Scientific American Library. New York, New York, USA. 1992

### **Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

The rule...I have endeavored to adopt [in determining what is a species and what is a species variety] is, that when the difference between two forms inhabiting separate areas seems quite constant, when it can be defined in words, and when it is not confined to a single peculiarity only, I have considered such forms to be species. When... the individuals of each locality vary among themselves, so as to cause the distinctions between the two forms to become inconsiderable and indefinite, or where the differences, though constant, are confined to one particular only, such as size, tint, or a single point of difference in marking or in outline, I class one of the forms as a variety of the other.

On the Phenomena of Variation and Geographical Distribution as Illustrated by the Papilionidae of the Malayan Region  
*Transactions of the Linnean Society of London*, Volume 25, 1865 (p. 4)

Species are merely those strongly marked races or local forms which, when in contact, do not intermix, and when

inhabiting distinct areas are generally regarded to have had a separate origin, and to be incapable of producing a fertile hybrid offspring.

On the Phenomena of Variation and Geographical Distribution as Illustrated by the Papilionidae of the Malayan Region

*Transactions of the Linnean Society of London*, Volume 25, 1865 (p. 12)

[A]s the test of hybridity cannot be applied [to species identification] in one case in ten thousand, and even if it could be applied, would prove nothing, since it is founded on an assumption of the very question to be decided — and as the test of origin is in every case inapplicable — and as, further, the test of non-intermixture is useless, except in those rare cases where the most closely allied species are found inhabiting the same area, it will be evident that we have no means whatever of distinguishing so-called “true species” from the several modes of variation here pointed out, and into which they so often pass by an insensible gradation.

On the Phenomena of Variation and Geographical Distribution as Illustrated by the Papilionidae of the Malayan Region  
*Transactions of the Linnean Society of London*, Volume 25, 1865 (p. 12)

...The essential character of a species in biology is that it is a group of living organisms, separated from all other such groups by a set of distinctive characters, having relations to the environment not identical with those of any other group of organisms, and having the power of continuously reproducing its like. Genera are merely assemblages of a number of these species which have a closer resemblance to each other in certain important and often prominent characters than they have to any other species...

*Fortnightly Review*, Volume 57, New Series, 1895 (p. 441)

## **SPECIFICATION**

### **Alger, John R. M.**

American design engineer

### **Hays, Carl V.**

No biographical data available

Once a problem is recognized clearly and all the parties concerned have agreed on its nature, the development of detailed specifications becomes vital.

*Creative Synthesis in Design* (p. 15)

Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1964

A good engineer is adroit in negotiating changes in specifications or trade-offs...

*Creative Synthesis in Design* (p. 16)

Prentice-Hall. Englewood Cliffs, New Jersey, USA. 1964

### **Hoover, Herbert** 1874–1964

31<sup>st</sup> president of the United States

Specifications are the formulated, definite, and complete statements of what the buyer requires of the seller.



*National Directory of Commodity Specifications*  
M 65, Forward (p. 1)

### Matthews, J. A.

Good sense is highly desirable in writing specifications and is even more necessary in interpreting them. If they only contained the minimum number of requirements to define the character of material wanted...the matter would be greatly simplified. Rarely do they cover the only material suited to the purpose intended, and more rarely do they cover the best material for the purpose intended. Once written, they become as the laws of the Medes and Persians, which alter not. They acquire a sort of sanctity, like the Ten Commandments or the Constitution before the adoption of the Eighteenth Amendment. Present Tendencies in Engineering Materials  
*Mechanical Engineering*, Volume 48, Number 8, August 1926 (p. 792)

## SPECTROSCOPE

### Clerke, Agnes Mary 1842–1907

Irish astronomer

Custom can never blunt the wonder with which we must regard the achievement of compelling rays emanating from a source devoid of sensible magnitude through immeasurable distances, to reveal, by its distinctive qualities, the composition of that source.

*A Popular History of Astronomy During the Nineteenth Century*  
Part II, Chapter XII (p. 372)  
A. & C. Black. London, England. 1908

### Crookes, Sir William 1832–1919

English chemist and physicist

The spectroscope reveals that the elementary components of the stars and the earth are pretty much the same.

In Frederick Houk Law

*Science in Literature*

The Romance of the Diamonds (p. 111)

Harper & Brothers. New York, New York, USA. 1929

### Draper, John William 1811–82

American scientist, philosopher, and historian

And now, while we have accomplished only a most imperfect examination of objects that we find on earth, see how, on a sudden, through the vista that has been opened by the spectroscope, what a prospect lies beyond us in the heavens! I often look at the bright yellow ray emitted from the chromosphere of the sun, by that unknown element, Helium, as the astronomers have ventured to call it. It seems trembling with excitement to tell its story, and how many unseen companions it has. And if this be the case with the sun, what shall we say of the magnificent hosts of the stars? May not every one of them have special elements of its own? Is not each a chemical laboratory in itself?

Presidential Address

American Chemical Society, November 16, 1876

### Huggins, Sir William 1824–1910

English astronomer

One important object of this original spectroscopic investigation of the light of the stars and other celestial bodies, namely to discover whether the same chemical elements as those of our earth are present throughout the universe, was most satisfactorily settled in the affirmative; a common chemistry, it was shown, exists throughout the universe.

*The Scientific Papers of Sir William Huggins*

Spectra of the Fixed Stars (p. 49)

W. Wesley & Son. London, England. 1909

I looked into the spectroscope. No spectrum such as I expected! A single bright line only!...The riddle of the nebulae was solved. The answer, which had come to us in the light itself, read: Not an aggregation of stars, but a luminous gas. Stars after the order of our own sun, and of the brighter stars, would give a different spectrum; the light of this nebula had clearly been emitted by a luminous gas.

*The Scientific Papers of Sir William Huggins*

Historical Statement (p. 106)

W. Wesley & Son. London, England. 1909

### Maxwell, James Clerk 1831–79

Scottish physicist

The vast interplanetary and interstellar regions will no longer be regarded as waste places in the universe, which the Creator has not seen fit to fill with the symbols of the manifold order of His kingdom. We shall find them to be already full of this wonderful medium; so full, that no human power can remove it from the smallest portion of space, or produce the slightest flaw in its infinite continuity. It extends unbroken, from star to star; and when a molecule of hydrogen vibrates in the dog-star, the medium receives the impulses of these vibrations; and after carrying them in its immense bosom for three years, delivers them in due course, regular order, and full tale into the spectroscope...

In W.D. Niven (ed.)

*The Scientific Papers of James Clerk Maxwell* (Volume 2)

Action at a Distance (p. 322)

At The University Press. Cambridge, England. 1890

## SPECTRUM

### Thomson, James 1700–48

Scottish poet

First the flaming red Sprang vivid forth; the tawny orange next, And next delicious yellow; by whose side Fell the kind beams of all-refreshing green. Then the pure blue that swells autumnal skies, Ethereal play'd; and then,

of sadder hue Emerged the deeper indigo (as when The heavy-skirted evening droops with frost), While the last gleamings of refracted light Died in the fainting violet away.

*Poetical Works of James Thomson*

A Poem Sacred to the Memory of Sir Isaac Newton  
Reeves & Turner. London, England. 1895

## SPECTRUM ANALYSIS

**de la Rue, Warren** 1815–89

English astronomer and inventor

...if we were to go to the sun, and to bring away some portions of it and analyze them in our laboratories, we could not examine them more accurately than we can by this new mode of spectrum analysis....

*Chemical News*, Volume 4, 1861 (p. 130)

**Lockyer, Joseph Norman** 1836–1920

English astronomer and physicist

...we believe that each molecular vibration disturbs the ether; that spectra are thus begotten' each wavelength of light resulting from a molecular tremor of corresponding wavelength. The molecule is, in fact, the sender, the ether the wire, and the eye the receiving instrument, in this new telegraphy.

*Studies in Spectrum Analysis*

Chapter IV (pp. 118–119)

D. Appleton & Company. New York, New York, USA. 1878

**White, H. E.**

No biographical data available

That photographs are an extremely important feature of any book on atomic spectra may be emphasized by pointing out that, of all the theories and knowledge concerning atoms, the spectrum lines will remain the same for all time.

*Introduction to Atomic Spectra* (p. vii)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1934

## SPECULATION

**Comfort, Alex** 1920–2000

English gerontologist and author

Rash speculation does not bother the physicists — it has got them where they are today. And it is high time that the life sciences looked critically at the solidity of their tribal idols, including stochastic-genetic evolution, morphogenesis and the “mind-body problem” — while being mindful that, in the present climate, work on some quite unrelated matter may prove, incidentally and quite unwittingly, to have altered the entire face of the problem. Nor will the answers obtained lie within any existing frame of discourse.

On Physics and Biology: Getting Our Act Together

*Perspectives in Biology and Medicine*, Volume 29, Number 1, Autumn 1985 (p. 9)

**Darwin, Charles Robert** 1809–82

English naturalist

All young geologists have a great turn for speculation; I have burned my fingers pretty sharply in that way, and am now inclined to cavil at speculation when the direct and immediate effect of a cause in question cannot be shown.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 2)

Letter 487, Darwin to C.H.L. Wood, March 4, 1850 (p. 133)

D. Appleton & Company. New York, New York, USA. 1903

**Dr. Seuss (Theodor Seuss Geisel)** 1904–1991

American children's book author and illustrator

Some have two feet and some have four. Some have six feet and some have more. Where do they come from? I can't say. But I bet they have come a long long way.

*One Fish, Two Fish, Red Fish, Blue Fish* (p. 12)

Beginner Books Inc. New York, New York, USA. 1988

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

If we are not content with the dull accumulation of experimental facts, if we make any deductions or generalizations, if we seek for any theory to guide us, some degree of speculation cannot be avoided. Some will prefer to take the interpretation which seems to be most immediately indicated and at once adopted as an hypothesis; others will rather seek to explore and classify the widest possibilities which are not definitely inconsistent with the facts. Either choice has its dangers: the first may be too narrow a view and lead progress into a cul-de-sac; the second may be so broad that it is useless as a guide and diverge indefinitely from experimental knowledge.

The Internal Constitution of the Stars

*Observatory*, Volume 43, 1920 (p. 356)

**Einstein, Albert** 1879–1955

German-born physicist

I think that only daring speculation can lead us further and not accumulation of facts.

In Michele Besso

*Correspondence 1903–1955*

Letter to M. Besso, October 8, 1952 (p. 487)

Hermann. Paris, France. 1972

**Feuerbach, Ludwig** 1804–72

German philosopher

Speculation is philosophy intoxicated; let philosophy get sober again; it will then be to the mind what pure spring water is to the body.

In Ludwig Buchner

*Force and Matter*

Preface to the First Edition (p. xx)

Trubner &amp; Company. London, England. 1864

**Jeffreys, Sir Harold** 1891–1989

English astronomer and geophysicist

The problem of the origin and development of the solar system suffers from the label “speculative.” It is frequently said that as we were not there when the system was formed, we cannot legitimately arrive at any idea as to how it was formed.

In B. Gutenberg (ed.)

*Internal Constitution of the Earth*

The Origin of the Solar System

Dover Publications. New York, New York, USA. 1951

**Ramsay, Sir William** 1852–1916

English chemist

Speculation...has a deep fascination for many minds...

*Essays Biographical and Chemical*

Chemical Essays

What Is an Element? (p. 149)

Archibald Constable &amp; Company Ltd. London, England. 1908

Chemistry and physics are experimental sciences; and those who are engaged in attempting to enlarge the boundaries of science by experiment are generally unwilling to publish speculations; for they have learned, by long experience, that it is unsafe to anticipate events.

*Essays Biographical and Chemical*

Chemical Essays

Radium and Its Products (p. 179)

Archibald Constable &amp; Company Ltd. London, England. 1908

**Twain, Mark (Samuel Langhorne****Clemens)** 1835–1910

American author and humorist

Spectrum analysis enabled the astronomer to tell when a star was advancing head on, and when it was going the other way. This was regarded as very precious. Why the astronomer wanted to know, is not stated; nor what he could sell out for, when he did know. An astronomer's notions about preciousness were loose. They were not much regarded by practical men, and seldom excited a broker.

*Mark Twain's Fables of Man*

The Secret History of Eddypus

University of California Press. Berkeley, California, USA. 1972

**Whyte, A. Gowans**

Scottish writer

The Golden Age of speculation was the Stone Age of knowledge.

The Triumph of Physics

*The Rationalist Annual*, 1931 (p. 28)**Woodford, F. Peter**

American editor

Of course speculation is in order in a Discussion, but it must be reasonable, firmly founded on observation, and subject to test, if it is to get past a responsible editorial board.

*Scientific Writing for Graduate Students* (p. 29)

Council of Biology Editors. Bethesda, Maryland, USA. 1986

**SPIN****Goudsmit, Samuel A.** 1902–78

Dutch-born American physicist

It was a little over fifty years ago that George Uhlenbeck and I introduced the concept of spin. It is therefore not surprising that most young physicists do not know that spin had to be introduced. They think that it was revealed in Genesis or perhaps postulated by Sir Isaac Newton, which most young physicists consider to be about simultaneous.

In Anthony French and Edwin Taylor

*An Introduction to Quantum Physics* (p. 424)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1978

**SPIRAL ARMS****van de Hulst, H. C.** 1918–2000

Dutch astronomer

The discovery of spiral arms and — later — of molecular clouds in our Galaxy, combined with a rapidly growing understanding of the birth and decay process of stars, changed interstellar space from a stationary “medium” into an “environment” with great variations in space and time.

In A. Bonetti, J.M. Greenberg and S. Aiello (eds.)

*Evolution in Interstellar Dust and Related Topics* (p. 5)

North-Holland Publishing Company. Amsterdam, Netherlands. 1989

**SPONTANEOUS GENERATION****Urey, Harold Clayton** 1893–1981

American chemist

The common assumption is that the earth and its atmosphere have always been as they are now, but if this is assumed it is necessary to account for the present highly oxidized conditions by some processes taking place early in the earth's history. Briefly, the highly oxidized condition is rare in the cosmos.

On the Early Chemical History of the Earth and the Origin of Life

*Proceedings of the National Academy of Science USA*, Volume 38, 1952**Hacking, Ian** 1936–

Canadian-born philosopher of science

**STAMP COLLECTING****Alvarez, Luis Walter** 1911–88

American experimental physicist

Paleontologists...they're really not very good scientists. They're more like stamp collectors.

*New York Times*  
19 Jan 1988

**Birch, Arthur J.** 1915–1995  
Australian chemist

I have never been emotionally attracted by exactitude of detail, but rather by the broad sweep of ideas collected around philosophically defined examples that can be tested experimentally. I have never been a scientific “stamp collector”, although it takes all types to make the world and I have greatly benefited by the “collections” of others...

*To See the Obvious*

Why Chemistry? (pp. 13–14)

American Chemical Society. Washington, D.C. 1995

**Rutherford, Ernest** 1871–1937  
English physicist

All science is either physics or stamp collecting.

In J.B. Birks

*Rutherford at Manchester*

Memories of Rutherford (p. 108)

W.A. Benjamin Inc. New York, New York, USA. 1963

**Simpson, George Gaylord** 1902–84  
American paleontologist

Biology starts with biochemistry and goes on to neurophysiology and genetics. All else is stamp-collecting.

*This View of Life: The World of an Evolutionist*

Chapter Six (p. 108)

Harcourt, Brace & World, Inc. New York, New York, USA. 1964

## STANDARD

**Woll, Matthew** 1880–1956  
Luxembourg-born American photo engraver

I know very well that in a great many circles the man who does not enter with a neatly arranged plan, with a set of doctrines, with a rounded and sonorous formula, and with assurance about everything, is set down as something of an old fogey, perhaps reactionary, certainly not one of the elect who are “doing things” and providing guidance for the race. I must assume the risk. I have no formula. [But I shall resist] those who have the formula for so many things and who seek so avidly to force it down the throats of every one else.

Standardization

*Annals of the American Academy of Political and Social Science*, Volume 137, May 1928 (p. 47)

## STAR

**Acton, Loren** 1936–  
American astronaut and solar physicist

When you look out the other way toward the stars you realize it's an awful long way to the next watering hole.

In Kevin W. Kelley

*The Home Planet*

With Plate 84

Addison-Wesley. Reading, Massachusetts, USA. 1988

**Adams, George** 1750–95  
English instrument maker

New stars offer to the mind a phenomenon more surprising, and less explicable, than almost any other in the science of astronomy.

*Lectures on Natural and Experimental Philosophy* (Volume 4)

Chapter XLIV (p. 213)

Printed by R. Hindmarsh. London, England. 1794

**Aiken, Conrad** 1889–1973  
American poet, short story writer and novelist

Ice is the silent language of the peak; and fire is the silent language of the star.

*Collected Poems*

Sonnet 10

Oxford University Press, Inc. New York, New York, USA. 1970

**Alighieri, Dante** 1265–1321  
Italian poet and writer

...and thence we issued forth again to see the stars.

In *Great Books of the Western World* (Volume 21)

*The Divine Comedy of Dante Alighieri*

Hell, Canto XXXIV, l. 138–139

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Andreas, Brian** 1956–  
American artist, sculpture, and storyteller

We lay there & looked up at the night sky & she told me about stars called blue squares & red swirls & I told her I'd never heard of them. Of course not, she said, the really important stuff they never tell you. You have to imagine it on your own.

*Blue Squares*

**Aratus** 271 BCE–213 BCE  
Greek statesman

In his fell jaw

Flames a star above all others with searing beams

Fiercely burning, called by mortals Sirius.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter III (p. 42)

Harper & Brothers New York, New York, USA. 1908

**Aurelius Antoninus, Marcus** 121–180  
Roman emperor

The Pythagoreans bid us in the morning look to the heavens that we may be reminded of those bodies which continually do the same thing and in the same manner

perform their work, and also be reminded of their purity and nudity. For there is no veil over a star.

In *Great Books of the Western World* (Volume 12)  
*The Meditations of Marcus Aurelius*  
 Book XI, # 27 (p. 306)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Look around at the courses of the stars, as if thou wert going along with them; and constantly consider the changes of the elements into one another; for such thoughts purge away the filth of the terrene life.

In *Great Books of the Western World* (Volume 12)  
*The Meditations of Marcus Aurelius*  
 Book VII, #47 (p. 282)  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bailey, Philip James** 1816–1902  
 English poet

Surely the stars are images of love.

*Festus: A Poem*  
 Scene XXXI (p. 510)  
 George Routledge & Sons, Ltd. London, England. 1893

... the stars

As dewdrops countless on the aetherial fields  
 Of the skies...

*Festus: A Poem*  
 Scene I (p. 32)  
 George Routledge & Sons, Ltd. London, England. 1893

**Baudelaire, Charles** 1821–67  
 French poet

... those stars whose light speaks a known language...

*The Flowers of Evil*  
 Obsession (p. lxxix)  
 Wesleyan University Press. Middletown, Connecticut, USA. 1979

**Benét, William Rose** 1886–1950  
 American poet and editor

One speck within vast star-space lying  
 Awoke, arose, resumed its clothing,  
 And crawled another day toward dying.

*Animalcule*  
 Stanza 7  
 George H. Doran Company. New York, New York, USA. 1927

**Berry, Richard** 1946–  
 American amateur astronomer and author

It is a pity, in an age of rockets and space telescopes, that so few people have a direct acquaintance with the stars. Learning the stars and following their nightly courses across the sky brings a deep satisfaction, a satisfaction born of familiarity with something both ancient and ageless.

*Discover the Stars* (p. 2)  
 Harmony Books. New York, New York, USA. 1987

**Blake, William** 1757–1827  
 English poet, painter, and engraver

When the stars threw down their spears,  
 And water'd heaven with their tears,  
 Did he smile his work to see?

Did he who made the Lamb make thee?  
*The Complete Poetry and Prose of William Blake*  
 The Tyger  
 University of California Press. Berkeley, California, USA. 1982

**Borland, Hal** 1900–78  
 American writer

...it is the stars that lure man's mind to the endless immensity of a universe so broad that tangible reality can never span it.

*An American Year: Country Life and Landscapes Through the Seasons*  
 June (p. 46)  
 Simon & Schuster. New York, New York, USA. 1946

**Brecht, Bertolt** 1898–1956  
 German writer

SAGREDO [reluctant to go to the telescope]: I feel something not all that remote from fear, Galileo.

GALILEO: I'm about to show you one of the shining milkwhite clouds in the Milky Way. Tell me what it's made up of.

SAGREDO: Those are stars, innumerable stars.

Translated by John Willett  
*Life of Galileo*  
 Scene 3 (p. 26)  
 Arcade Publishing. New York, New York, USA. 1994

**Brewster, David** 1781–1868  
 English physicist

It is no ways probable that the Almighty, who always acts with infinite wisdom, and does nothing in vain, should create so many glorious suns, fit for so many important purposes, and place them at such distances from one another, without proper objects near enough to be benefited by their influences. Whoever imagines they were created only to give a faint glimmering light to the inhabitants of this globe, must have a very superficial knowledge of astronomy, and a mean opinion of the Divine wisdom: since, by an infinitely less exertion of creating power, the Deity would have given our earth much more light by one single additional moon.

*Ferguson's Astronomy, Explained upon Sir Isaac Newton's Principles*  
 (Volume 1)  
 Chapter I (p. 3)  
 Printed for the author. London, England. 1756

**Brood, William J.**  
 No biographical data available

A telescope in the void recently found cosmic "maternity wards" where clouds of interstellar gas and dust appear to be in various stages of giving birth to stars.

"Golden Age" of Astronomy Peers to the Edge of the Universe  
*New York Times*, C1, May 8, 1984

**Brown, Fredric** 1906–72

American writer of science fiction and mystery

Overhead and in the far distance are the lights in the sky that are stars. The stars they tell us we can never reach because they are too far away. They lie; we'll get there. If rockets won't take us, something will.

*The Lights in the Sky Are Stars* (p. 20)

**Browne, J. Stark**

No biographical data available

The stillness of the heavens is, however, apparent only, for commotion of the fiercest kind is raging on all sides. Stars are suns, and the suns are spheres of fire blazing with fury indescribable; scenes of activity so tremendous that no vehemence of tempest or tornado on earth can give the slightest idea of their fearfulness.

The Number and Distances of the Stars

*The Rationalist Annual*, 1931 (p. 61)

**Browning, Robert** 1812–89

English poet

All that I know  
of a certain star,  
Is, it can throw,  
(Like the angled spar)  
Now a dart of red,  
Now a dart of blue.

*The Poems and Plays of Robert Browning*

Dramatic Lyrics, My Star

The Modern Library. New York, New York, USA. 1934

**Bryant, William Cullen** 1794–1878

American poet

The sad and solemn night  
Hath yet her multitude of cheerful fires;  
The glorious host of light  
Walk the dark hemisphere till she retires;  
All through her silent watches, gliding slow,  
Her constellations come and climb the heavens and go.

In Parke Godwin (ed.)

*Poems*

Hymn to the North Star

D. Appleton & Company. New York, New York, USA. 1874

**Meredith, Owen (Edward Robert  
Bulwer-Lytton, 1<sup>st</sup> Earl Lytton)** 1831–91

English statesman and poet

When stars are in the quiet skies,  
Then most I pine for thee;  
Bend on me then thy tender eyes,  
As stars look on the sea.

*The Works of Edward Bulwer-Lytton* (Volume 6)

Night and Love (p. 59)

Peter Fenelon Collier. New York, New York, USA. 1892

**Bunting, Basil** 1900–85

English modernist poet

Furthest, fairest thing, stars, free of our humbug,  
each his own, the longer known, the more alone,  
wrapt in emphatic fire roaring out to a black flue...  
Then is Now. The star you steer by is gone.

*Collected Poems*

Briggflats, V (p. 58)

Oxford University Press, Inc. London, England. 1978

**Burke, Edmund** 1729–97

English statesman and philosopher

The starry heaven, though it occurs so very frequently to our view, never fails to excite an idea of grandeur. This cannot be owing to the stars themselves, separately considered. The number is certainly the cause. The apparent disorder augments the grandeur, for the appearance of care is highly contrary to our ideas of magnificence. Besides, the stars lie in such apparent confusion, as makes it impossible on ordinary occasions to reckon them. This gives them the advantage of a sort of infinity.

*A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful Magnificence* (p. 139)

University of Notre Dame Press. Notre Dame, Indiana, USA. 1968

**Burnet, Thomas** 1635–1715

English cleric and scientist

They lie carelessly scatter'd, as if they had been sown in the Heaven, like Seed, by handfuls; and not by a skilful hand neither. What a beautiful Hemisphere they would have made, if they had been plac'd in rank and order, if they had been all dispos'd into regular figures, and the little ones set with due regard to the greater. Then all finish and made up into one fair piece or great Composition, according to the rules of Art and Symmetry.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)

Book II, Chapter XI (p. 220)

Printed by R. Norton. London, England. 1691

**Burritt, Elijah H.** 1794–1838

American astronomer

These vast globes of light then, could never have been designed merely to diversify the voids of infinite space, nor to shed a few glimmering rays on our far distant world, for the amusement of a few astronomers, who, but for the most powerful telescopes, had never seen the ten thousandth part of them.

*The Geography of the Heavens*

Chapter XVI (p. 154)

Huntington & Savage, Mason & Law. New York, New York, USA. 1850

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Cry out upon the stars for doing  
Ill offices, to cross their wooing.

*The Poetical Works of Samuel Butler* (Volume 1)

Part III, Canto I, l. 17

Bell & Daldy. London, England. 1835

**Campbell, Thomas** 1777–1844  
Scottish poet

...the sentinel stars set their watch in the sky.

*The Complete Poetical Works*

The Soldier's Dream

Chadwyck-Healey. Cambridge, England. 1992

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Canopus shining-down over the desert, with its blue diamond brightness (that wild, blue, spirit-like brightness far brighter than we ever witness here), would pierce into the heart of the wild Ishmaelitic man, whom it was guiding through the solitary waste there.

*On Heroes and Hero Worship*

Lecture I (p. 13)

John B. Alden, Publisher. New York, New York, USA. 1887

...when I gazed into these Stars, have they not looked down on me as if with pity, from their serene spaces; like Eyes glistening with heavenly tears over the little lot of man! Thousands of human generations, all as noisy as our own, have been swallowed up of Time, and there remains no wreck of them any more; and Arcturus and Orion and Sirius and the Pleiades are still shining in their courses, clear and young, as when the Shepherd first noted them in the plain of Shinar.

*Sartor Resartus*

Book II, Chapter VIII (p. 165)

Ginn & Company. Boston, Massachusetts, USA. 1897

**Cernan, Eugene** 1934–  
American astronaut

I know the stars are my home. I learned about them, needed them for survival in terms of navigation. I know where I am when I look up at the sky. I know where I am when I look up at the Moon; it's not just some abstract romantic idea, it's something very real to me. See, I've expanded my home.

The View from Out There: In Words and Pictures

*Life*, Volume 11, Number 13, November 1988 (p. 198)

**Cicero (Marcus Tullius Cicero)** 106 BCE–43 BCE  
Roman orator, politician, and philosopher

No one regards things before his feet  
But views with care the regions of the sky.

Translated by William Armistead Falconer

*Cicero: De Senectute, De Amicitia, De Divinatione*

De Divinatione, II, XIII (p. 403)

Harvard University Press. Cambridge, Massachusetts, USA. 1938

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

No man who has lived all his life on the surface of a planet has ever seen the stars, only their feeble ghosts.

The Road to the Sea, Spring

*Fiction House Magazine*, Volume 1, Number 2, 1951

Overhead, without any fuss, the stars were going out.

*The Collected Stories of Arthur C. Clarke*

*The Nine Billion Names of God* (p. 422)

Tom Doherty Associates. New York, New York, USA. 2001

Sooner or later we will come to the edge of the Solar System and will be looking out across the ultimate abyss. Then we must choose whether we reach the stars — or whether we wait until the stars reach us.

*The Challenge of the Spaceship*

The Planets Are Not Enough (p. 65)

Harper & Brothers. New York, New York, USA. 1959

The thing's hollow — it goes on forever — and — oh my God! — it's full of stars.

*2001: A Space Odyssey*

V. The Moons of Saturn, Chapter 39 (p. 191)

New American Library, New York, New York, USA. 1968

**Clarke, M'Donald (The Mad Poet)** 1798–1842  
American poet

Whilst twilight's curtain spreading far,

Was pinned with a single star.

*Poems of M'Donald Clarke*

Death in Disguise, l. 227

J.W. Bell. New York, New York, USA. 1837

**Clegg, Johnny** 1953–  
English musician

...we are the scatterlings of Africa

On a journey to the stars...

*Scatterlings of Africa*

From the CD *Scatterlings of Africa*

**Cohen, Martin**

No biographical data available

To be a star is to know eternal stress. To live as a star is to walk a never ending tightrope, knowing that there can be only one outcome — your fall.

In Byron Preiss (ed.)

*The Universe*

Star Birth and Maturity (p. 68)

Bantam Books. Toronto, Ontario, Canada. 1987

**Cole, Thomas** 1627–97  
English theologian

How lovely are the portals of the night,  
When stars come out to watch the daylight die.

Twilight

Source undetermined

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

...the stars hang bright above her dwelling,

Silent as though they watched the sleeping Earth!

*The Complete Poetical Works of Samuel Taylor Coleridge* (Volume 1)

Dejection: An Ode, Stanza VIII

The Clarendon Press. Oxford, England. 1912

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

How dismal a universe it would be without the lights of the stars to probe its infinite blackness.

*The Endless Adventure*

The Early Days of May (p. 148)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Comte, Auguste** 1798–1857

French philosopher

We can imagine the possibility of determining the shapes of stars, their distances, their sizes, and their movements; whereas there is no means by which we will ever be able to examine their chemical composition, their mineralogical structure, or especially, the nature of organisms that live on their surfaces.... Our positive knowledge with respect to the stars is necessarily limited to their observed geometrical and mechanical behavior.

*The Positive Philosophy of Auguste Comte* (Volume 2) (p. 9)

John Chapman. London, England. 1853

On the subject of stars, all investigations which are not ultimately reducible to simple visual observations are... necessarily denied to us... We shall never be able by any means to study their chemical composition.

In Neil deGrasse Tyson

Over the Rainbow

*Natural History*, Volume 110, Number 7, September 2001 (p. 33)

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

...the first and highest of all is the sphere of the fixed stars, which comprehends itself and all things, and is accordingly immovable.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, Chapter 10 (p. 526)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Crane, Hart** 1899–1932

American poet

Stars scribble on our eyes the frosty sagas,  
The gleaming cantos of unvanquished space.

In Brom Weber (ed.)

*The Complete Poems and Selected Letters and Prose of Hart Crane*

Cape Hatteras

Anchor Books. Garden City, New York, USA. 1966

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

The stars have larger agendas in which the preoccupations of human pettiness do not figure.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*

Chapter 6 (p. 117)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

The universe we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil, no good, nothing but blind, pitiless indifference.

*River Out of Eden: A Darwinian View of Life*

Chapter 4 (p. 133)

Basic Books, Inc. New York, New York, USA. 1995

**de la Mare, Walter** 1873–1956

English poet and novelist

Wide are the meadows of night  
And daisies are shining there,  
Tossing their lovely dew,  
Lustrous and fair,  
And through these sweet fields go,  
Wanderers amid the stars —  
Venus, Mercury, Uranus, Neptune,  
Saturn, Jupiter, Mars.

*Peacock Pie: A Book of Rhymes*

The Wanderers

A. Constable & Company. London, England. 1913

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

All men have the stars...but they are not the same things for different people. For some, who are travelers, the stars are guides. For others they are no more than little lights in the sky. For others, who are scholars, they are problems. For my businessman they were wealth. But all these stars are silent. You — you alone — will have the stars as no one else has them...

Translated by Katherine Woods

*The Little Prince*

Chapter XXVI (p. 85)

Harcourt, Brace & Company. New York, New York, USA. 1943

**de Tabley, Lord** 1835–95

English literary scholar and botanist

The May-fly lives an hour,  
The star a million years;  
But as a summer flower,  
Or as a maiden's fears,  
They pass, and heaven is bare  
As tho' they never were.

*The Collected Poems of Lord de Tabley*

Hymn to Astarte

Chapman and Hall. London, England. 1903

**Dee, John** 1527–1609

English mathematician and occultist

The stars and celestial powers are like seals whose characters are imprinted differently by reason of differences in the elemental matter.

*John Dee on Astronomy*

XXVI (p. 135)

University of California Press. Berkeley, California, USA. 1978



**Dick, Thomas** 1600–80

Scottish theologian and philosopher

Come forth, O man! yon azure round survey,  
And view those lamps which yield eternal day.  
Bring forth thy glasses; clear thy wondering eyes;  
Millions beyond the former millions rise;  
Look further; — millions more blaze from yonder skies.

*The Works of Thomas Dick, LL.D.*

The Solar System, Volume 10, Chapter VIII (p. 197)

**Dickinson, Emily** 1830–86

American lyric poet

“Arcturus” is his other name —  
I’d rather call him “star.”

It’s very mean of Science

To go and interfere!

*The Complete Poems of Emily Dickinson*

No. 70 (p. 36)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Disraeli, Benjamin, 1<sup>st</sup> Earl of****Beaconsfield** 1804–81

English prime minister, founder of Conservative Party, and novelist

It shows you exactly how a star is formed; nothing can be  
so pretty! A cluster of vapor, the cream of the milky way,  
a sort of celestial cheese, churned into light...

*Tancred*

Book I, Chapter IX

H. Colburn. London, England. 1847

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Are you conscious of the restful influence which the  
stars exert? To me they are the most soothing things in  
Nature. I am proud to say that I don’t know the name  
of one of them. The glamour and romance would pass  
away from them if they were all classified and ticketed  
in one’s brain. But when a man is hot and flurried, and  
full of his own little ruffled dignities and infinitesimal  
misfortunes, then a star bath is the finest thing in the  
world.

*The Stark Munro Letters*

Letter VIII (p. 170)

D. Appleton & Company. New York, New York, USA. 1895

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

We are bits of stellar matter that got cold by accident, bits  
of a star gone wrong.

*New York Times Magazine*

October 9, 1932

We can now form some sort of picture of the inside of  
a star — a hurly burly of atoms, electrons and aether-  
waves. Disheveled atoms tear along at a hundred miles  
a second, their normal array of electrons being torn from

them in the scrimmage. The lost electrons are speeding a  
hundred times faster to find new resting places...

*Stars and Atoms*

Lecture I (p. 26)

Yale University Press. London, England. 1927

Our object in diving into the interior [of a star] is not  
merely to admire a fantastic world with conditions tran-  
scending ordinary experience; it is to get at the inner  
mechanism which makes stars behave as they do. If we  
are to understand the surface manifestations, if we are to  
understand why “one star differeth from another star in  
glory,” we must go below to the engine-room — to trace  
the beginning of the stream of heat and energy which  
pours out through the surface.

*Stars and Atoms*

Lecture I (p. 20)

Yale University Press. London, England. 1927

I am aware that many critics consider the conditions in  
the stars not sufficiently extreme...the stars are not hot  
enough. The critics lay themselves open to an obvious  
retort: we tell them to go and find a hotter place.

*Stars and Atoms*

Lecture III (p. 102)

Yale University Press. London, England. 1927

...it is reasonable to hope that in a not too distant future  
we shall be competent to understand so simple a thing  
as a star.

*The Internal Constitution of the Stars*

Chapter XIII (p. 393)

At The University Press. Cambridge, England. 1930

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

The stars are golden fruit upon a tree  
All out of reach.

*The Spanish Gypsy*

Book II

Blackwood and Sons. Edinburgh, Scotland. 1868

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The stars awaken a certain reverence, because though  
always present, they are inaccessible...

*The Complete Works of Ralph Waldo Emerson* (Volume 1)

Nature: Addresses and Lectures

Chapter I (p. 7)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

But every night comes out the envoys of beauty, and light  
the universe with their admonishing smile.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Nature (p. 9)

The Library of America. New York, New York, USA. 1983

If a man would be alone, let him look at the stars. The  
rays that come from those heavenly worlds, will separate

between him and what he touches. One might think the atmosphere was made transparent with this design, to give man, in the heavenly bodies, the perpetual presence of the sublime. Seen in the streets of cities, how great they are!

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses and Lectures

Nature (p. 9)

The Library of America. New York, New York, USA. 1983

If the stars should appear one night in a thousand years, how would men believe and adore and preserve for many generations the remembrance of the city of God which had been shown.

*Ralph Waldo Emerson: Essays and Lectures*

Nature: Addresses, and Lectures

Nature (p. 9)

The Library of America. New York, New York, USA. 1983

### **Flecker, James Elroy** 1884–1915

English poet and playwright

West of these out to seas colder than the Hebrides I must go

Where the fleet of stars is anchored and the young Star-captains glow.

*The Collected Poems of James Elroy Flecker*

The Dying Patriot

Martin Secker. London, England. 1916

### **Fraunhofer, Joseph von** 1787–1826

German optician and physicist

*Approximavit sidera*

He brought the stars closer

*Epitaph on his gravestone*

### **Frost, Robert** 1874–1963

American poet

They cannot scare me with their empty spaces

Between stars — on stars where no human race is.

*Complete Poems of Robert Frost*

Desert Places

Henry Holt & Company. New York, New York, USA. 1949

I could be worse employed

Than as a watcher of the void,

Whose part should be to tell

What star if any fell.

Suppose some seed-pearl sun

Should be the only one;

Yet still I must report

Some cluster one star short.

I should justly hesitate

To frighten church or state

By announcing a star down

From, say, the Cross or Crown.

To make sure what star I missed

I should have to check on my list

Every star in sight.

It might take me all night.

*Complete Poems of Robert Frost*

On Making Certain Anything Has Happened

Henry Holt & Company. New York, New York, USA. 1949

### **Gamow, George** 1904–68

Russian-born American physicist

Twinkle, twinkle, quasi-star

Biggest puzzle from afar

How unlike the other ones

Brighter than a billion suns

Twinkle, twinkle, quasi-star

How I wonder what you are.

In Louis Berman

*Exploring the Cosmos*

Chapter 14 (p. 311)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

Whereas all humans have approximately the same life expectancy, the life expectancy of stars varies as much as from that of a butterfly to that of an elephant.

*A Star Called the Sun* (p. 145)

The Viking Press. New York, New York, USA. 1964

### **Goddard, Robert H.** 1882–1945

American physicist

There can be no thought of finishing, for “aiming at the stars,” both literally and figuratively, is a problem to occupy generations, so that no matter how much progress one makes, there is always the thrill of just beginning.

In Eugene Mallove and Gregory Matloff

*The Starflight Handbook*

Letter to H.G. Wells, April 20, 1932 (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1989

### **Goodenough, Ursula** 1943–American biologist

I lie on my back under the stars and the unseen galaxies and I let their enormity wash over me. I assimilate the vastness of the distances, the impermanence, the fact of it all. I go all the way out and then I go all the way down, to the fact of photons without mass and gauge bosons that become massless at high temperatures. I take in the abstractions about forces and symmetries and they caress me, like Gregorian chants because the words are so haunting.

*The Sacred Depths of Nature*

Chapter I. Reflections (pp. 12–13)

Oxford University Press, Inc. New York, New York, USA. 1998

### **Greenstein, George** 1940–

American astronomer

Overhead, the stars are strewn across a darkness, a blackness so profound that for a moment, for the barest flicker of an instant, I can almost sense their inconceivable

distance. In a sudden; exalting burst of vertigo I fancy  
what it would be like to fly, to fall up and into that ocean.

*The Symbiotic Universe*

Prologue (p. 29)

William Morrow & Company, Inc. New York, New York, USA. 1988

### **Gronal, Florence Armstrong**

American astronomer and photographer

If all the diamonds in the world were melted into one  
huge magical jewel, its sparkling brilliance would pale  
beside Sirius, the diamond of the heavens.

*The Music of the Spheres: A Nature Lover's Astronomy*

Chapter VIII (p. 159)

The Macmillan Company. New York, New York, USA. 1926

...if all the wondrous phenomena of visible stars could  
be seen on but one of the nights of our long ride about  
the sun, the civilized world would spend its last cent on  
glasses and sit up until dawn to feast its eyes on the sub-  
limity of the spectacle.

*The Music of the Spheres: A Nature Lover's Astronomy*

Chapter II (p. 16)

The Macmillan Company. New York, New York, USA. 1926

### **Guiterman, Arthur** 1871–1943

Austrian-American poet

When the bat's on the wing and the bird's in the tree,  
Comes the starlighter, whom none may see.  
First in the West where the low hills are,  
He touches his wand to the Evening Star.  
Then swiftly he runs on his rounds on high,  
Till he's lit every lamp in the dark blue sky.

*Gaily the Troubadour*

The Starlighter (p. 190)

E.P. Dutton & Company, Inc. New York, New York, USA. 1936

While poets feign that, passing earthly bars,  
We Fireflies shall someday shine as Stars,  
Our scientists, more plausibly surmise  
That Stars are underdeveloped Fireflies.

*Gaily the Troubadour*

My Firefly Stars (p. 187)

E.P. Dutton & Company, Inc. New York, New York, USA. 1936

### **Habington, William** 1605–54

English poet

The starres, bright cent'nels of the skies.

*The Poems of William Habington*

Dialogue between Night and Araphil, l. 3

University Press of Liverpool. Liverpool, England. 1948

### **Hardy, Thomas** 1840–1928

English poet and regional novelist

The sky was clear — remarkably clear — and the twin-  
kling of all the stars seemed to be but throbs of one body,  
timed by a common pulse.

*Far from the Madding Crowd*

Chapter 2 (p. 9)

Harper & Row, Publishers. New York, New York, USA. No date

The sovereign brilliance of Sirius pierced the eye with a  
steely glitter, the star called Capella was yellow, Aldeba-  
ran and Betelgueseux shone with a fiery red. To persons  
standing alone on a hill during a clear midnight such as  
this, the roll of the world eastward is almost a palpable  
movement.

*Far from the Madding Crowd*

Chapter 2 (p. 9)

Harper & Row, Publishers. New York, New York, USA. No date

### **Harjo, Joy** 1951–

Native American poet

I can hear the sizzle of newborn stars, and know anything  
of meaning, of the fierce magic emerging here. I am wit-  
ness to flexible eternity, the evolving past, and I know we  
will live forever, as dust or breath in the face of stars, in  
the shifting pattern of winds.

*Secrets from the Center of the World* (p. 56)

The University of Arizona Press, Tucson, Arizona. 1989

### **Hearn, Lafcadio** 1850–1904

Greek-born American writer

The infinite gulf of blue above seems a shoreless sea,  
whose foam is stars, a myriad million lights are throbb-  
ing and flickering and palpitating...

In Elizabeth Bisland

*The Life and Letters of Lafcadio Hearn* (Volume 1)

Letter to H.E. Krehbiel, 1877 (p. 170)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

### **Hegel, Georg Wilhelm Friedrich** 1770–1831

German philosopher

The stars are not pulled this way and that by mechanical  
forces; theirs is a free motion. They go on their way, as  
the ancients said, like the blessed gods.

*Werke*

Bd. 7, Abt. I (p. 97)

Publisher undetermined

### **Hein, Robert**

No biographical data available

The stars are luminous dandruff from the deity's beard.

When the god-head combs his hair

A new star appears in the sky;

Yet God is not almost bald...

*Quest of the Singing Tree*

Stanzas on the Stars

H. Harrison. New York, New York, USA. 1938

### **Heine, Heinrich** 1797–1856

German poet

Perhaps the stars in the sky only appear to us to be so  
beautiful and pure because we are so far away from  
them and do not know their intimate lives. Up above  
there are certainly a few stars that lie and beg; stars that  
put on airs; stars that are forced to commit all possible

transgressions; stars that kiss and betray each other; stars that flatter their enemies and, what is even more painful, their friends, just as we do here below.

*The Romantic School and Other Essays*

The Romantic School, Book Two, Chapter III (p. 73)  
Continuum. New York, New York, USA. 1985

**Heppenheimer, T. A.** 1947–

American space aviation writer

From the stars has come the matter of our world and of our bodies, and it is to the stars that we will someday return.

*Toward Distant Suns*

Preface (p. 13)

Stackpole Books. Harrisburg, Pennsylvania, USA. 1979

**Herrick, Robert** 1591–1674

English poet

The starres of the night

Will lend thee their light

Like Tapers cleare without number.

In J. Max Patrick (ed.)

*The Complete Poetry of Robert Herrick*

The Night-Piece, to Julia, Stanza 3

W.W. Norton & Company, Inc. New York, New York, USA. 1968

**Herschel, Friedrich Wilhelm** 1738–1822

English astronomer

“We ought perhaps,” says [Sir John Frederick William]Herschel, “to look upon certain clusters of stars, and the destruction of a star now and then in some thousands of ages, as the very means by which the whole is preserved and renewed. These clusters may be the laboratories of the universe, wherein the most salutary remedies for the decay of the whole are prepared.”

*Philosophical Transactions of the Royal Society of London*, 1785 (p. 217)

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

The stars are the land-marks of the universe...

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

An Address

April 11, 1827 (p. 469)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

If it were not perhaps too hazardous to pursue a former surmise of a renewal in what I figuratively called the Laboratories of the universe, the stars forming these extraordinary nebulae, by some decay or waste of nature, being no longer fit for their former purposes, and having their projectile forces, if any such they had, retarded in each other's atmosphere, may rush at last together, and either in succession, or by one general tremendous shock, unite into a new body. Perhaps the extraordinary and sudden blaze of a new star in Cassiopeia's chair, in 1572, might possibly be of such a nature.

On the Construction of the Heavens

*Philosophical Transactions of the Royal Society of London*, Volume 75, 1785

**Hodgson, Ralph** 1871–1962

English poet

I stood and stared, the sky was lit,

The sky was stars all over it,

I stood, I knew not why,

Without a wish, without a will,

I stood upon that silent hill

And stared into the sky until

My eyes were blind with stars and still

I stared into the sky.

*Collected Poems*

The Song of Honour

Macmillan & Company Ltd. London, England. 1961

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

And Science lifts her still unanswered cry:

“Are all these worlds, that speed their circling flight,

Dumb, vacant, soulless — baubles of the night?”

...Or rolls a sphere in each expanding zone

Crowned with a life as varied as our own?

*The Poems of Oliver Wendell Holmes: With Numerous Illustrations*

The Secret of The Stars

Houghton Mifflin Company. Boston, Massachusetts, USA. 1887

**Hopkins, Gerard Manley** 1844–89

English poet and Jesuit priest

Look at the stars! look, look up at the skies!

O look at all the fire-folk sitting in the air!

In Norman H. MacKenzie (ed.)

*The Poetical Works of Gerard Manley Hopkins*

The Starlight Night

Clarendon Press. Oxford, England. 1990

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE

Roman philosopher and dramatic critic

With my head exalted I shall touch the stars.

*Carmina*

I, I, 36

Rupert Hart-Davis. London, England. 1963

**Hovey, Richard** 1864–1900

American composer, poet, and artist

The dawn is lonely for the sun,

And chill and drear;

The one lone star is pale and wan,

As one in fear.

*Along the Trail: A Book of Verse*

Chanson de Rosemonde

Small, Maynard & Company. Boston, Massachusetts, 1898

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

The stars are best seen as a spectacle, not from everyday surroundings where trees and buildings, to say nothing of street lighting, distract the attention too much, but from a steep mountainside on a clear night, or from a ship at sea. Then the vault of heaven appears incredibly large and seems to be covered by an uncountable number of fiery points of light.

*The Nature of the Universe*

Chapter 3 (p. 51)

The University Press. Cambridge. 1933

It is unlikely that stars die without a spectacular protest.

*Frontiers of Astronomy*

Chapter Nine (p. 160)

Harper & Row, Publishers. New York, New York, USA. 1955

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

An ant weighs upon the earth; a star can well weigh upon the universe.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 409)

The Heritage Press. New York, New York, USA. 1961

**Huxley, Julian** 1887–1975

English biologist, philosopher, and author

And all about the cosmic sky,  
The black that lies beyond our blue,  
Dead stars innumerable lie,  
And stars of red and angry hue  
Not dead but doomed to die.

*The Captive Shrew and Other Poems of a Biologist*

Cosmic Death

Harper & Brothers. New York, New York, USA. 1933

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

For if 25 years are required for a Bullet out of a Cannon, with its utmost Swiftmess, to travel from the Sun to us... such a Bullet would spend almost seven hundred thousand years in its Journey between us and the fix'd Stars. And yet when in a clear night we look upon them, we cannot think them above some few miles over our heads.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the*

*Planetary Worlds, Their Inhabitants and Productions* (pp. 154–155)

Printed for T. Childe. London, England. 1698

**Jacobson, Ethel** 1877–1965

New Zealand teacher, newspaper editor, and journalist

Crystal fish

Caught in the seine

Of the trawler, Night.

Stars

*Nature Magazine*, May 1958 (p. 260)

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

The ages of the stars are not the same thing as the age of the universe, nor even are they necessarily comparable with that age. The star may be likened to icebergs coming down from the North and melting as they drift into tropical waters. We can estimate the age of the icebergs within our vision, but we can not say for how long the stream of icebergs has been drifting down from the pole to equator nor for how long new icebergs will continue to form and come down to replace those that pass southward to their doom.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1926*

The New Outlook in Cosmogony (p. 159)

Government Printing Office. Washington, D.C. 1928

Empty Waterloo Station of everything except six specks of dust and it is still far more crowded with dust than space is with stars.

*The Universe Around Us*

Chapter I (p. 84)

The Macmillan Company. New York, New York, USA. 1929

Any small bit of the sky does not look very different from what it would if bright and faint stars had been sprinkled out of a celestial pepper pot.

*The Universe Around Us*

Chapter I (p. 37)

The Macmillan Company. New York, New York, USA. 1929

**Jeffers, Robinson** 1887–1962

American poet

We know the stars, hotter and more fatal than earth; we have learned lately the fire-wheel galaxies,  
Infinite in number or all but infinite, among which our great sun's galaxy's  
Flight is as a gnat's, one grain of sand in the Sahara: it is necessary to stretch our minds

To these dimensions...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 4)

Not Solid Earth (p. 538)

Stanford University Press. Stanford, California. USA. 1988

Antares reddens

The great one, the ancient torch, a lord among lost children,

The earth's orbit doubled would not girdle his greatness,  
one fire

Globed, out of grasp of the mind enormous; but to you  
O Night

What? Not a spark?...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

Night (p. 115)

Stanford University Press. Stanford, California. USA. 1988

**Joyce, James** 1882–1941

Irish expatriate writer and poet

...of the parallax or parallactic drift of so called fixed stars, in reality ever moving wanderers from immeasurably

remote eons to infinitely remote futures in comparison with which the years threescore and ten, of allotted life formed a parenthesis of infinitesimal brevity.

*Ulysses* (p. 683)

Random House, Inc. New York, New York, USA. 1946

**Keats, John** 1795–1821

English Romantic lyric poet

Bright star, would I were steadfast as thou art —  
Not in lone splendor hung aloft the night  
And watching, with eternal lids apart,  
Like Nature's patient, sleepless Eremite,  
The moving waters at their priest-like task  
Of pure ablution round earth's human shores.

*The Complete Poetical Works and Letters of John Keats*

Bright Star

Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

**Keill, John** 1671–1721

Scottish mathematician and natural philosopher

The fixed stars appear to be of different bignesses, not because they really are so, but because they are not all equally distant from us; those that are nearest will excel in Luster and Bigness; the more remote stars will give a fainter Light, and appear smaller to the Eye.

*An Introduction to the True Astronomy*

Lecture VI (p. 47)

Printed for Bernard Lintot. London, England. 1721

**Krutch, Joseph Wood** 1893–1970

American naturalist, conservationist, and writer

The stars are little twinkling rogues who light us home sometimes when we are drunk but care for neither you nor me nor any man.

*The Twelve Seasons*

June (p. 46)

W. Sloane Associates. New York, New York, USA. 1949

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

While we raise our eyes to the firmament, we see the whole of the stars attached, as it were, to the same vaulted surface; this, however, is an optical illusion; they are, in reality, at very different distances from us, as well as from the Sun, which is the fixed star of our system.

Translated by James Jacque

*Kosmologischen Brief*

1761

**Lee, Nathaniel** 1653?–92

English dramatist

The stars, heav'n sentry, wink and seem to die.

*Theodosius*

Printed for Tho. Chapman. London, England. 1692

**Levy, David H.** 1948–

Canadian astronomer and science writer

Our fondness for the stars has touched our souls. We all share the feeling of discovery, whether the object we have found is new to all or new only to us. The thrill penetrates our being, as we try to describe...how we have been changed by the universe sharing a secret with us.

*David Levy's Guide to the Night Sky*

A Miscellany (p. 322)

Cambridge University Press. Cambridge, England. 2000

...observing is an activity that can rapidly become your outlet to relax, your means to commune with the universe, and a vital key to knowing yourself...a voyage on a magic carpet that takes you to other places and other times. Even a casual look at the stars gives you a share in the company of timelessness that they represent. Look through your telescope thoughtfully...for it is more than starlight that the mirror will reflect. Through the vastness of space and time will return also a part of yourself.

*The Royal Astronomical Society of Canada*

The Joy of Gazing, 1982, Montreal Centre

**Longfellow, Henry Wadsworth** 1807–82

American poet

Silently one by one, in the infinite meadows of heaven Blossomed the lovely stars, the forget-me-nots of the angels.

*The Poetical Works of Henry Wadsworth Longfellow*

Evangeline, Part iii

Houghton, Mifflin Company. Boston, Massachusetts, USA. 1883

The stars arise, and the night is holy.

*The Poetical Works of Henry Wadsworth Longfellow*

Hyperion, Book I, Chapter 1

Houghton, Mifflin. Boston, Massachusetts, USA. 1883

**Lowell, Percival** 1855–1916

American astronomer

Bright points in the sky or a blow on the head will equally cause one to see stars.

*Mars*

Chapter IV (p. 159)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

**Macfie, Ronald Campbell** 1867–1931

Scottish poet and physician

One thing is certain, that space is full of millions and millions of shining suns, wherever they came from and however they were evolved, and that there are millions and millions more of dead, dark stars we cannot see. One is apt to forget the dead, dark stars, but they far outnumber those that shine — so much so that Sir Robert Ball says that luminous stars are but the glowworms and fireflies of the universe as compared with the myriads of other animals.

Science, Matter and Immortality

Chapter XI (p. 131)

William & Norgate. London, England. 1909

**Mandino, Og** 1923–96  
American sales guru and author

I will love the light for it shows me the way; yet I will  
love the darkness for it shows me the stars.

*The Greatest Salesman in the World*

Chapter Nine (p. 59)

Bantam Trade Edition. New York, New York, USA. 1985

**Milton, John** 1608–74  
English poet

Witness this new-made World, another Heav'n  
from Heaven Gate not farr, founded in view  
On the clear Hyaline, the Glassie Sea;  
Of amplitude almost immense, with starr's  
Numerous, and every Starr perhaps a World  
Of destined habitation.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book VII, l. 617–622

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

So sinks the day-star in the ocean-bed,  
And yet anon repairs his drooping head,  
And tricks his beams, and with new-spangled ore  
Flames in the forehead of the morning sky.

*Lycidas*, l. 168–171

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...the stars,  
That nature hung in heaven, and filled their lamps  
with everlasting oil, to give due light  
To the misled and lonely traveler.

In *Great Books of the Western World* (Volume 32)

*Comus*, l. 197–200

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mitchell, Maria** 1818–89  
American astronomer and educator

When we are chaffed and fretted by small cares, a look at  
the stars will show us the littleness of our own interests.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter VII (p. 138)

Lee & Shepard. Boston, Massachusetts, USA. 1896

We call the stars garnet and sapphire; but these are, at  
best, vague terms. Our language has not terms enough to  
signify the different delicate shades; our factories have  
not the stuff whose hues might make a chromatic scale  
for them.

In Phebe Mitchell Kendall

*Maria Mitchell: Life, Letters, and Journals*

Chapter XI (p. 235)

Lee & Shepard. Boston, Massachusetts, USA. 1896

**Moore, Thomas** 1779–1852  
Irish poet

Thus, when the lamp that lighted  
The traveler at first goes out,

He feels awhile benighted,  
And looks around in fear and doubt.

But soon, the prospect clearing,  
By cloudless starlight on he treads,  
And thinks no lamp so cheering  
As that light which Heaven sheds.

*The Poetical Works of Thomas Moore*

I'd Mourn the Hopes

Lee & Shepard. Boston, Massachusetts, USA. 1873

**Mullaney, James**

Astronomy writer, lecturer, and consultant

The telescope is not just another gadget or material pos-  
session, but a magical gift to humankind — a window  
on creation, a time machine, a spaceship of the mind that  
enables us to roam the universe in a way that is surely the  
next best thing to being out there.

Focal Point

*Sky & Telescope*, March 1990 (p. 244)

...metaphysical aspects of star gazing — its potential as a  
vehicle for therapeutic relaxation, meditation, and spiri-  
tual contact with the awesome creative power manifests  
in all of nature but is pinnacled in the stars.

Focal Point,

*Sky & Telescope*, March 1990 (p. 244)

**Noyes, Alfred** 1880–1958  
English poet

Could new stars be born?  
Night after night he watched that miracle  
Growing and changing colour as it grew...

*The Torch Bearers: Watchers of the Sky*

Tycho Brahe, IV (p. 57)

Frederick A. Stokes Company. New York, New York, USA. 1922

And all those glimmerings where the abyss of space  
Is powdered with a milky dust, each grain  
A burning sun, and every sun the lord  
Of its own darkling planets...

*The Torch Bearers: Watchers of the Sky*

Prologue (p. 8)

Frederick A. Stokes Company. New York, New York, USA. 1922

**Old Woman**

The stars I know and recognize and even call by name.  
They are my names, of course; I don't know what others  
call the stars. Perhaps I should ask the priest. Perhaps the  
stars are God's to name, not ours to treat like pets...

In Robert Coles

*The Old Ones of New Mexico*

Two Languages, One Soul (p. 10)

University of New Mexico Press. Albuquerque, New Mexico, USA. 1973

**Oort, Jan Hendrik** 1900–92  
Dutch astronomer

Man in the past couple of centuries has been in a position  
like that of a lookout watching the approach of an armada

of strange objects. The objects came into view first as dim fuzzy forms. As more powerful telescopes brought them closer and closer, they were identified as collections of stars, then distinguished into systems of varied shapes and types; today we can resolve the details of internal structure in many of them.

In Heinz Haber

*Stars, Men and Atoms*

Chapter 11 (p. 168)

Golden Press. New York, New York, USA. 1962

**Pagels, Heinz R.** 1939–88

American physicist and science writer

Stars are born, they live and they die. Filling the night sky like beacons in an ocean of darkness, they have guided our thoughts over the millennia to the secure harbor of reason.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 2 (p. 30)

Simon & Schuster. New York, New York, USA. 1985

Stars are like animals in the wild. We may see the young but never their actual birth, which is a veiled and secret event.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 2 (p. 44)

Simon & Schuster. New York, New York, USA. 1985

Stars are an image of eternity.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 3 (p. 54)

Simon & Schuster. New York, New York, USA. 1985

**Pasachoff, Jay M.** 1943–

American astronomer

Twinkle, twinkle, pulsing star

Newest puzzle from afar.

Beeping on and on you sing —

Are you saying anything?

Twinkle, twinkle more, pulsar,

How I wonder what you are.

Pulsars in Poetry

*Physics Today*, Volume 22, February 1969 (p. 19)

**Peltier, Leslie C.** 1900–80

American comet hunter

So clear and sparkling is this autumn night that, with averted vision, I can see quite readily the wraithlike wisps of nebulaosity that festoon and enmesh this entire little cluster.

*Starlight Nights*

Chapter 1 (p. 5)

Harper & Row, Publishers. New York, New York, USA. 1965

The skies were full of stars for me to learn.

*Starlight Nights*

Chapter 6 (p. 39)

Harper & Row, Publishers. New York, New York, USA. 1965

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

Star gazing is a common name for harmless futility.

*An Almanac for Moderns*

August Seventeenth (p. 161)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Piechowski, Otto Rushe**

Astronomy writer

For most of us stargazing remains a soothing balm and intellectual uplift — even if it isn't cutting edge science. It satisfies human needs. Sometimes out of embarrassment, we might shroud these deeper yearnings with scientific talk. But we shouldn't need such "covers." If our romantic encounters with stars reach some psychological, emotional, or spiritual level, so be it.

*Sky & Telescope*, February 1993

**Plato** 428 BCE–347 BCE

Greek philosopher

Vain would be the attempt of telling all the figures of them circling as in a dance, and their juxtapositions, and the return of them in their revolutions upon themselves, and their approximations...

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 40 (p. 452)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...he who has not contemplated the mind of nature which is said to exist in the stars, and gone through the previous training, and seen the connection of music with these things, and harmonized them all with laws and institutions, is not able to give a reason of such things as have a reason.

In *Great Books of the Western World* (Volume 7)

*Laws*

Book XII, 967 (p. 798)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49

American short story writer

Were the succession of stars endless, then the background of the sky would present us a uniform luminosity, like that displayed by the galaxy — since there could be absolutely no point, in all that background, at which would not exist a star. The only mode, therefore, in which, under such a state of affairs, we could comprehend the voids which our telescopes find in innumerable directions, would be by supposing the distance of the invisible background so immense that no ray from it has yet been able to reach us at all.

*Eureka*

Line 12 (p. 100)

Geo. P. Putnam. New York, New York, USA. 1848



Look down into the abysmal distances! — attempt to force the gaze down the multitudinous vistas of the stars, as we sweep slowly through them thus — and thus — and thus! Even the spiritual vision, is it not all points arrested by the continuous golden walls of the universe? — the walls of the myriads of the shining bodies that mere number has appeared to blend into unity?

In H. Beaver (ed.)

*The Science Fiction of Edgar Allan Poe*

The Power of Words (p. 171)

Penguin Books. Hammondsworth, England. 1976

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

The stars are majestic laboratories, gigantic crucibles, such as no chemist could dream.

*The Foundations of Science*

The Value of Science, Astronomy (p. 295)

The Science Press. New York, New York, USA. 1913

**Pope, Alexander** 1688–1744

English poet

The Dog-star rages!

*The Complete Poetical Works*

Epistle to Dr. Arbuthnot

Houghton Mifflin Company. New York, New York, USA. 1903

**Ptolemy** 85–165

Greek astronomer

I know that I am mortal and ephemeral. But when I search for the close-knit encompassing convolutions of the stars, my feet no longer touch the earth, but in the presence of Zeus himself I take my fill of ambrosia which the gods produce.

In Johannes Kepler

*Mysterium Cosmographicum*

Title page

**Raymo, Chet** 1936–

American physicist and science writer

We are not ruled by stars; we and the stars are one.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 21 (p. 196)

The Viking Press. New York, New York, USA. 1991

I weigh out nebulas. I dam up the Milky Way and use it to grind my grain. I put up summer stars like vegetables in jars for my delectation in winter. I have winter stars folded in boxes in the attic for cloudy summer nights.

Night Brought to Numbers

*Sky & Telescope*, Volume 71, Number 6, June 1966 (p. 555)

**Rhodes, Cecil** 1853–1902

British-born South African businessman, mining magnate, and politician

The world is nearly all parceled out, and what there is left of it is being divided up, conquered and colonized. To think of these stars that you see overhead at night, these

vast worlds which we can never reach. I would annex the planets if I could; I often think of that. It makes me sad to see them so clear and yet so far.

*The Last Will and Testament of Cecil John Rhodes: With Elucidatory Notes to Which Are Added Some Chapters Describing the Political and Religious Ideas of the Testator*

Part III (p. 190)

“Review of Reviewers” Office. London, England. 1902

**Rilke, Ranier Maria** 1875–1926

Czech-born German language poet and novelist

...between stars, what distances...

*Sonnets to Orpheus*

Second Part, XX

University of California Press. Berkeley, California, USA. 1977

**Russell, Peter** 1921–2003

British poet and editor

...The fixed stars

Are moving really, and the whole Galaxy turning

Round and round on its own axis agitatedly...

*All for the Wolves*

Elegiac

Black Swan Books. Redding Ridge, Connecticut, USA. 1971

**Sagan, Carl** 1934–96

American astronomer and science writer

It will not be we who reach Alpha Centauri and the other nearby stars. It will be a species very much like us, but with more of our strengths and fewer of our weaknesses, a species returned to circumstances more like those for which it was originally evolved, more confident, farseeing, capable, and prudent — the sorts of beings we would want to represent us in a Universe that, for all we know, is filled with species much older, much more powerful, and very different.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 19 (p. 329)

Random House, Inc. New York, New York, USA. 1994

If we long to believe that the stars rise and set for us, that we are the reason there is a Universe, does science do us a disservice by deflating our conceits?

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 1 (p. 12)

Random House, Inc. New York, New York, USA. 1995

**Sagan, Carl** 1934–96

American astronomer and science writer

**Druyan, Ann** 1949–

American author and television producer

Nothing lives forever, in Heaven as it is on Earth. Even the stars grow old, decay, and die. They die, and they are born. There was once a time before the Sun and Earth existed, a time before there was day or night, long, long before there was anyone to record the Beginning for those who might come after.

*Shadows of Forgotten Ancestors: A Search for Who We Are*  
Chapter 1 (p. 11)  
Random House, Inc. New York, New York, USA. 1992

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD  
Roman playwright

As long as the ordinary course of heaven runs on, custom robs it of its real size. Such is our constitution that objects of daily occurrence pass us unnoticed even when most worthy of our admiration. On the other hand, the sight even of trifling things is attractive if their appearance is unusual. So this concourse of stars, which paints with beauty the spacious firmament on high, gathers no concourse of the nation. But when there is any change in the wonted order, then all eyes are turned to the sky.

*Physical Science in the Time of Nero, Being a Translation of the Quæstiones Naturales of Seneca*  
Book VII, Chapter I (p. 271)  
Macmillan & Company Ltd. London, England. 1910

*Non est ad astra mollis e terris via.*

There is no easy way to the stars from the earth.

*Hercules Furens*  
Act II, 437

Cornell University Press. Ithaca, New York, USA. 1987

**Service, Robert William** 1874–1958  
Canadian poet and novelist

The waves have a story to tell me,  
As I lie on the lonely beach;  
Chanting aloft in the pine-tops,  
The wind has a lesson to teach;  
But the stars sing an anthem of glory  
I cannot put into speech.

*Collected Poems of Robert Service*  
The Three Voices

Dodd, Mead & Company New York, New York, USA. 1961

**Serviss, Garrett P.** 1851–1929  
American science fiction writer

Regarded in their broader relations and constraints, the stars as a whole possess a marvelous harmony of effect. It is the true music of the spheres, for who shall say that the universally felt influence of the star-bedight heavens does not arise from our instinctive, but as yet uneducated, perception of a concord which is not of “sweet sounds,” but of light and color, whose range of vibrations in the ether infinitely exceeds that of sonant oscillations in the atmosphere?

*Astronomy with the Naked Eye*  
Chapter I (p. 13)

Harper & Brothers. New York, New York, USA. 1908

The stars are the true landmarks which are never changed.

*Astronomy with the Naked Eye*  
Chapter I (p. 1)

Harper & Brothers. New York, New York, USA. 1908

It was the friendly stars that first led men round the globe. As long as those well-known sentinels shone, tranquil and steadfast overhead, they had courage to go on and on. If the stars had deserted, even Columbus would have lost heart.

*Astronomy with the Naked Eye*

Chapter I (p. 1)

Harper & Brothers. New York, New York, USA. 1908

As long as men have eyes to see and minds to think, it needs but a word, a hint, a glance, to turn them with rapt and ever increasing attention to the wonders overhead.

*Astronomy with the Naked Eye*

Chapter I (p. 15)

Harper & Brothers. New York, New York, USA. 1908

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Look, th’ unfolding star calls up the shepherd.

*In Great Books of the Western World (Volume 27)*

*The Plays and Sonnets of William Shakespeare (Volume 2)*

Measure for Measure

Act IV, Scene iii, l. 218

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But I am constant as the northern star,  
Of whose true-fix’d and resting quality  
There is no fellow in the firmament.  
The skies are painted with unnumber’d sparks,  
They are all fire and every one doth shine;  
But there’s but one in all doth hold his place.

*In Great Books of the Western World (Volume 26)*

*The Plays and Sonnets of William Shakespeare (Volume 1)*

Julius Caesar

Act III, Scene i, l. 60–65

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sherrod, P. Clay**

American astronomer and educator

Above us, the sparkling stars of the night skies stretch out like thousands of diamonds suspended on the curtain of space. Unfolding through the beauty and the mysteries of this seemingly endless expanse are patterns and answers familiar to those willing to study them...

There is an affinity for the eternity of space experienced by all mankind, a kind of motherhood in the stars to those who study space.

*A Complete Manual of Amateur Astronomy*

Preface (p. xii)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1981

**Smith, Logan Pearsall** 1865–1946

American author

“But what are they really? What do they say they are?”  
the young lady asked me. We were looking up at the Stars.

*Trivia*

Book I, The Starry Heaven (p. 51)  
Doubleday, Page & Company. Garden City, New York, USA. 1917

**Smythe, Daniel** 1908–81

American poet

The years of sky are now galactic,  
So deep that we have little trace.  
Our spectrographs, cool and emphatic,  
Betray the depths of stars and space.  
What do we seek on dizzying borders  
Or groups of systems we have classified?  
We cannot search in these huge orders  
And find the answers they have passed.

Strange Horizons

*Nature Magazine*, February 1958 (p. 101)

**Spenser, Edmund** 1552–99

English poet

He that strives to touch the stars  
Oft stumbles at a straw.

*The Complete Poetical Works of Edmund Spenser*

The Shepherdess Calendar

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Stapledon, Olaf** 1886–1950

English author

Very soon the heavens presented an extraordinary appearance, for all the stars directly behind me were now deep red, while those directly ahead were violet. Rubies lay behind me, amethysts ahead of me. Surrounding the ruby constellations there spread an area of topaz stars, and round the amethyst constellations an area of sapphires.

*Last and First Men, and Star Maker*

Chapter II (p. 262)

Dover Publications, Inc. New York, New York, USA. 1968

Great are the stars, and man is of no account of them.

*Last and First Men*

Chapter XVI (p. 303)

Jeremy P. Tarcher, Inc. Los Angeles, California, USA. 1988

**Tagore, Rabindranath** 1861–1941

Indian poet and philosopher

Kind Nature has held before our eyes the smoked glass of the night and of the distance. And what do we see through it? We see that the world of stars is still. For we see these stars in their relation to each other, and they appear to us like chains of diamonds hanging on the neck of some god of silence. But Astronomy like a curious child plucks out an individual star from that chain and then we find it rolling about.

*Personality*

The World of Personality (p. 59)

The Macmillan Company. New York, New York, USA. 1917

**Taylor, Anne** 1782–1866

English poet and children's author

Twinkle, twinkle, little star!  
How I wonder what you are.  
Up above the world so high,  
Like a diamond in the sky...

*Rhymes for the Nursery*

The Star

Printed and sold by Peter B. Gleason & Company. Hartford, Connecticut, USA. 1813

**Taylor, Bayard** 1825–78

American journalist and author

Each separate star  
Seems nothing, but a myriad scattered stars  
Break up the night, and make it beautiful.

*Lars: A Pastoral of Norway*

Book III, Conclusion

James R. Osgood & Company. Boston, Massachusetts, USA. 1873

**Teasdale, Sara** 1884–1933

American writer and poet

Stars over snow,  
And in the west a planet  
Swinging below a star —  
Look for a lovely thing and you will find it  
It is not far — It will never be far.

*The Collected Poems of Sara Teasdale*

Night (p. 197)

Collier Books. New York, New York, USA. 1966

**Tennyson, Alfred (Lord)** 1809–92

English poet

“The stars,” she whispers, “blindly run:  
A web is wov’n across the sky;  
From our waste places comes a cry,  
And murmurs from the dying sun.”

*Alfred Tennyson's Poetical Works*

In Memoriam A.H.H., Section III, Stanza II

Oxford University Press, Inc. London, England. 1953

Many a night I saw the Pleiades, rising  
thro’ the mellow shade,  
Glitter like a swarm of fireflies, tangled in  
a silver braid.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Stanza 5

Oxford University Press, Inc. London, England. 1953

...the fiery Sirius alters hue  
And bickers into red and emerald.

*Alfred Tennyson's Poetical Works*

The Princess, Part Fifth, l. 252–253

Oxford University Press, Inc. London, England. 1953

**The Bible**

Lift up your eyes to the heavens; consider who created these, led out their host one by one, and summoned each by name. Through his great might, his strength and power, not one is missing.

*The Revised English Bible*

Isaiah 40:26

Oxford University Press, Inc. Oxford, England. 1989

...the morning stars sang in chorus,  
and the sons of God all shouted for joy...

*The Revised English Bible*

Job 38:7

Oxford University Press, Inc. Oxford, England. 1989

Can you bind the cluster of Pleiades or loose Orion's  
belt?

*The Revised English Bible*

Job 38:31

Oxford University Press, Inc. Oxford, England. 1989

### The Hon. Mrs. Ward

No biographical data available

Stars — each, perhaps a sun! Far, far away from the earth  
and its troubles is the mind carried by such thoughts and  
remembrances.

*The Telescope*

Preface, Dedication to William Parsons, the Earl of Rosse 1870

### Thompson, Francis 1859–1907

English writer

Thou canst not stir a flower

Without troubling of a star.

*Complete Poetical Works of Francis Thompson*

The Mistress of Vision, Stanza XXII

Boni & Liveright, Inc. New York, New York, USA. 1923

### Thomson, James 1700–48

Scottish poet

But who can count the stars of Heaven?

*Seasons*

Winter, l. 528

Printed by John Mycall. Newburyport, Massachusetts, USA. 1790

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

Truly the stars were given for a consolation to man.

*The Writings of Henry David Thoreau* (Volume 9)

A Walk to Wachusett (p. 178)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

When I consider how, after sunset, the stars come out  
gradually in troops from behind the hills and woods, I  
confess that I could not have contrived a more curious  
and inspiring night.

*Journal* (Volume 11)

July 26, 1840 (p. 158)

Princeton University Press. Princeton, New Jersey, USA. 1981

When I look at the stars, nothing which the astronom-  
ers have said attaches to them, they are so simple and  
remote.

In Bradford Torrey and Francis H. Allen (eds.)

*The Journal of Henry D. Thoreau* (Volume 7)

September 29, 1854, The Red of the Young Oak (p. 60)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1949

The stars are the apexes of what wonderful triangles!  
What distant and different beings in the various man-  
sions of the universe are contemplating the same one at  
the same moment!

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter I (p. 19)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Thorne, Kip S. 1940–

American theoretical physicist

A star is only a glowing pause in the inescapable contrac-  
tion of a gas cloud to an uncertain, sometimes fantastic  
end.

*The Death of a Star*

*The Physics Teacher*, Volume 9, Number 6, June 1971 (p. 326)

### Travers, Pamela Lyndon 1899–1996

Australian-born English writer

[Jane] was watching Mrs. Corry splashing the glue on the  
sky and Mary Poppins sticking on the star...

“What I want to know,” said Jane, “is this: Are the stars  
gold paper or is the gold paper stars?”

There was no reply to her question and she did not expect  
one. She knew that only someone very much wiser than  
Michael could give her the right answer.

*Mary Poppins* (Revised edition)

Chapter 8 (p. 128)

Harcourt, Inc. San Diego, California, USA. 1981

### Trevelyan, George Macaulay 1876–1962

English historian

The stars out there rule the sky more than in England, big  
and lustrous with the honour of having shone upon the  
ancients and been named by them.

*Clio, A Muse, and Other Essays*

Walking

Longmans, Green & Company London, England. 1930

### Twain, Mark (Samuel Langhorne Clem- ens) 1835–1910

American author and humorist

There are too many stars in some places and not enough  
in others, but that can be remedied presently, no doubt.

*Eve's Diary*

Sunday (p. 7)

Harper & Brothers. New York, New York, USA. 1906

There's another trouble about theories: there's always a  
hole in them somewheres, sure, if you look close enough.  
It's just so with this one of Jim's. Look what billions and  
billions of stars there is. How does it come that there was  
just exactly enough star-stuff, and none left over? How  
does it come there ain't no sand-pile up there?

*The Complete Works of Mark Twain* (Volume 14)

Tom Sawyer Abroad (pp. 78–79)  
Harper & Brothers Publishers. New York, New York, USA. 1899

Stars are good, too. I wish I could get some to put in my hair. But I suppose I never can.

*Eve's Diary*

Saturday (p. 11)

Harper & Brothers. New York, New York, USA. 1906

The stars ain't so close together as they look to be.

*Collected Tales, Sketches, Speeches, & Essays 1891–1910*

Extract from Captain Stormfield's Visit to Heaven (pp. 829–830)

The Library of America. New York, New York, USA. 1992

It's lovely to live on a raft. We had the sky, up there, all speckled with stars, and we used to lay on our backs and look up at them, and discuss about whether they was made, or only just happened — Jim he allowed they was made, but I allowed they happened; I judged it would have took too long to make so many. Jim said the moon could have a laid them; well, that looked kind of reasonable, so I didn't say nothing against it because I've seen a frog lay most as many, so of course it could be done. We used to watch the stars that fell, too, and see them streak down. Jim allowed they'd got spoiled and was hove out of the nest.

*The Adventures of Huckleberry Finn*

Chapter XIX (pp. 153–154)

Grosset & Dunlap Publishers. New York, New York, USA. 1948

**Updike, John** 1932–

American novelist, short story writer, and poet

Welcome, welcome, little star

I'm delighted that you are

Up in Heaven's vast extent,

No bigger than a continent.

*Telephone Poles and Other Poems*

White Dwarf (p. 10)

Alfred A. Knopf. New York, New York, USA. 1969

When, on those anvils at the center of stars,  
and those even more furious anvils  
of the exploding supernovae,  
the heavy elements were beaten together  
to the atomic number 94...

*Facing Nature*

Ode to Crystallization

Alfred A. Knopf. New York, New York, USA. 1985

**van Gogh, Vincent Willem** 1853–90

Dutch painter

To express hope by some star, the eagerness of a soul by a sunset.

*The Complete Letters of Vincent Van Gogh with Reproductions of All the Drawings in the Correspondence* (Volume 3)

Letter 531 (p. 26)

New York Graphic Society. Greenwich, Connecticut, USA. 1958

One night I went for a walk by the sea along the empty shore. It was not gay, but neither was it sad — it was —

beautiful. The deep blue sky was flecked with clouds of a blue deeper than the fundamental blue of intense cobalt, and others of a clearer blue, like the blue whiteness of the Milky Way. In the blue depth the stars were sparkling, greenish, yellow, white, rose, brighter, flashing, more like jewels, than they do at home — even in Paris.

*The Complete Letters of Vincent Van Gogh with Reproductions of All the Drawings in the Correspondence* (Volume 2)

Letter 499 (p. 589)

New York Graphic Society. Greenwich, Connecticut, USA. 1958

That does not prevent me from having a terrible need of — shall I say the word? — of religion. Then I go out and paint the stars...

*The Complete Letters of Vincent Van Gogh with Reproductions of All the Drawings in the Correspondence* (Volume 3)

Letter 543 (p. 56)

New York Graphic Society. Greenwich, Connecticut, USA. 1958

Stars, you are unfortunate, I pity you,

Beautiful as you are, shining in your glory...

*Night Thoughts*

Printed by R. Nobels for R. Edwards. London, England. 1797

**Vaughan, Henry** 1621–95

English metaphysical poet

The Jewel of the Just,

Shining nowhere but in the dark;

What mysteries do lie beyond thy dust,

Could man outlook that mark!

*Poetry and Selected Prose*

Accession Hymn

Oxford University Press, Inc. London, England. 1963

**Weil, Simone** 1909–43

French philosopher and mystic

The stars, those marvelous, brilliant, inaccessible objects, at least as remote as the horizon, which we can neither change nor touch, and which in their turn, touch only our eyes, are what is furthest away from us and closest to us.

*On Science, Necessity, and the Love of God*

Classified Science and After (p. 40)

Oxford University Press, Inc. London, England. 1968

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

Looking at these stars suddenly dwarfed my own troubles and all the gravities of terrestrial life. I thought of their unfathomable distance, and the slow inevitable drift of their movements out of the unknown past into the unknown future.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine

Chapter Seven (p. 484)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

I believe a leaf of grass is no less than the journey-work  
of the stars.

*Complete Poems and Collected Prose*

Song of Myself

Section 31

The Library of America. New York, New York, USA. 1982

I was thinking the day most splendid till I saw what the  
not-day exhibited;

I was thinking of this globe enough till there sprang out  
so noiseless around me myriads of other globes.

*Complete Poetry and Collected Prose*

Night on the Prairies

The Library of America. New York, New York, USA. 1982

**Wilcox, Ella Wheeler** 1850–1919

American poet and journalist

Since Sirius crossed the Milky Way  
Full sixty thousand years have gone,  
Yet hour by hour and day by day  
This tireless star speeds on and on.

In Garrett P. Serviss

*Astronomy with the Naked Eye*

Chapter III (p. 43)

Harper & Brothers New York, New York, USA. 1908

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

LORD DARLINGTON: We are all in the gutter, but  
some of us are looking at the stars.

*The Works of Oscar Wilde* (Volume 5)

Lady Windermere's Fan

Act Three

Lamb Publishing Company. New York, New York, USA. 1909

**Williams, Sarah** 1837–68

American poet

I have loved the stars too fondly to be fearful of the  
night.

*The Best Loved Poems of the American People*

The Old Astronomer to His Pupil

Garden City publishing Company. Garden City, New York USA. 1936

**Wordsworth, William** 1770–1850

English poet

The stars are mansions built by Nature's hand,  
And, haply, there the spirits of the blest  
Dwell clothed in radiance, their immortal vest...

*The Complete Poetical Works of William Wordsworth*

Miscellaneous Sonnets, XXV

Crowell. New York, New York, USA. 1888

Look for the stars, you'll say that there are none;  
Look up a second time, and, one by one,  
You mark them twinkling out with silvery light,  
And wonder how they could elude the sight!

*The Complete Poetical Works of William Wordsworth*

Calm Is the Fragrant Air

Crowell. New York, New York, USA. 1888

**Yeats, William Butler** 1865–1939

Irish poet and playwright

Under the passing stars, foam of the sky

Live on this lonely face.

*The Collected Poems of W.B. Yeats*

The Rose of the World (p. 36)

The Macmillan Company. New York, New York, USA. 1956

**Young, Edward** 1683–1765

English poet and dramatist

How distant some of these nocturnal Suns?

So distant (says the Sage) 'twere not absurd

To doubt, if Beams, set out at Nature's Birth,

Are yet arriv'd at this so foreign World...

*Night Thoughts*

Night IX, l. 1226–1229

Printed by R. Nobels for R. Edwards. London, England. 1797

## STARLIGHT

**Hale, George Ellery** 1868–1938

American astronomer

Starlight is falling on every square mile of the earth's  
surface, and the best we can do at present is to gather up  
and concentrate the rays that strike an area 100 inches in  
diameter.

The Possibilities of Large Telescopes

*Harper's Weekly*, April 1928 (p. 640)

**Huggins, Sir William** 1824–1910

English astronomer

Within this unraveled starlight exists a strange cryptog-  
raphy. Some of the rays may be blotted out, others may  
be enhanced in brilliancy. Their differences, countless in  
variety, form a code of signals, in which is conveyed to  
us, when once we have made out the cipher in which it is  
written, information of the chemical nature of the celest-  
tial gases.... It was the discovery of this code of signals,  
and of its interpretation, which made possible the rise of  
the new astronomy.

In D.R. Danielson

*The Book of the Cosmos: Imaging the Universe from Heraclitus to  
Hawking*

Chapter 52 (p. 319)

Perseus Publishing. Cambridge, Massachusetts, USA. 2000

**Stein, Gertrude** 1874–1946

American writer

Star-light, what is star-light, star-light is a little light that  
is not always mentioned with the sun, it is mentioned  
with the moon and the sun, it is mixed up with the rest  
of the time.

*Three Lives & Tender Buttons*

Rooms (p. 295)

Penguin Putnam, Inc. New York, New York, USA. 2003

## STATISTICAL TEST

**Anscombe, Francis John** 1918–2001  
English-born American statistician

Rejection rules are not significance tests.  
Rejection of Outliers  
*Technometrics*, Volume 2, 1960 (p. 126)

**Chatfield, Christopher**  
British statistician

The result is that non-statisticians tend to place undue reliance on single “cookbook” techniques, and it has for example become impossible to get results published in some medical, psychological and biological journals without reporting significance values even if of doubtful validity. It is sad that students may actually be more confused and less numerate at the end of a “service course” than they were at the beginning, and more likely to over-look a descriptive approach in favor of some inferential method which may be inappropriate or incorrectly executed.

The Initial Examination of Data  
*Journal of the Royal Statistical Society*, Series A, Volume 148, 1985

**Clark, C. A.**  
No biographical data available

The null hypothesis of no difference has been judged to be no longer a sound or fruitful basis for statistical investigation.... Significance tests do not provide the information that scientists need, and, furthermore, they are not the most effective method for analyzing and summarizing data.

Hypothesis Testing in Relation to Statistical Methodology  
*Review of Educational Research*, Volume 33, 1963

**Cochran, William G.** 1909–80  
Scottish-born American statistician

**Cox, Gertrude M.** 1900–78  
American statistician

A useful property of a test of significance is that it exerts a sobering influence on the type of experimenter who jumps to conclusions on scanty data, and who might otherwise try to make everyone excited about some sensational treatment effect that can well be ascribed to the ordinary variation in his experiment.

*Experimental Designs* (2<sup>nd</sup> edition)  
Chapter 1 (p. 5)  
John Wiley & Sons, Inc. New York, New York, USA. 1992

**Cohen, Jacob** 1923–  
American behavioral psychologist and statistical analyst

After four decades of severe criticism, the ritual of null hypothesis significance testing — mechanical dichotomous decisions around a sacred .05 criterion — still

persist. This article reviews the problems with this practice.... What’s wrong with [null hypothesis significance testing]? Well, among many other things, it does not tell us what we want to know, and we so much want to know what we want to know that, out of desperation, we nevertheless believe that it does!

The Earth Is Round (p < .05)  
*American Psychologist*, Volume 49, December 1994 (p. 997)

A little thought reveals a fact widely understood among statisticians: The null hypothesis, taken literally (and that’s the only way you can take it in formal hypothesis testing), is always false in the real world.... If it is false, even to a tiny degree, it must be the case that a large enough sample will produce a significant result and lead to its rejection. So if the null hypothesis is always false, what’s the big deal about rejecting it?

Things I Have Learned (So Far)  
*American Psychologist*, December 1990 (p. 1308)

**Cox, Sir David Roxbee** 1924–  
English statistician

It has been widely felt, probably for thirty years and more, that significance tests are overemphasized and often misused and that more emphasis should be put on estimation and prediction. While such a shift of emphasis does seem to be occurring, for example in medical statistics, the continued very extensive use of significance tests is on the one hand alarming and on the other evidence that they are aimed, even if imperfectly, at some widely felt need.

Some General Aspects of the Theory of Statistics  
*International Statistical Review*, Volume 54, 1986

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

Under the usual teaching, the trusting student, to pass the course must forsake all the scientific sense that he has accumulated so far, and learn the book, mistakes and all.  
On Probability as Basis for Action  
*American Statistician*, Volume 29, Number 4, November 1975

Pencil and paper for construction of distributions, scatter diagrams, and run-charts to compare small groups and to detect trends are more efficient methods of estimation than statistical inference that depends on variances and standard errors, as the simple techniques preserve the information in the original data.

On Probability as Basis for Action  
*American Statistician*, Volume 29, Number 4, November 1975

**Devons, Ely** 1913–67  
English economist

I cannot oscillate a time series or properly analyze a variance...

*Essays in Economics*

Chapter 6 (p. 105)  
Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

**Fisher, Sir Ronald Aylmer** 1890–1962  
English statistician and geneticist

There is no more pressing need in connection with the examination of experimental results than to test whether a given body of data is or is not in agreement with any suggested hypothesis.

*Statistical Methods for Research Workers*  
Chapter VIII (p. 256)  
Oliver & Boyd, Edinburgh, Scotland. 1938

**McCloskey, D. N.**

Economist

**Ziliak, S. T.**

No biographical data available

The low and falling cost of calculation, together with a widespread though unarticulated realization that after all the significance test is not crucial to scientific questions, has meant that statistical significance has been valued at its cost. Essentially no one believes a finding of statistical significance or insignificance. This is bad for the temper of the field. My statistical significance is a “finding”; yours is an ornamented prejudice.

The Standard Error of Regressions  
*Journal of Economic Literature*, Volume 34, 1996

**Morrison, D. E.**

No biographical data available

**Henkel, R. E.**

No biographical data available

What do we do without the tests, then? What we do without the tests has always in some measure been done in behavioral science and needs only to be done more and better: the application of imagination, common sense, and informed judgment, and the appropriate remaining research methods to achieve the scope, form, process, and purpose of scientific inference.

*The Significance Test Controversy — A Reader*  
Significance Tests in Behavioral Research: Skeptical Conclusions and Beyond  
Aldine Publishing Company, Chicago, Illinois, USA. 1970

**Parkhurst, D. F.**

No biographical data available

Failing to reject a null hypothesis is distinctly different from proving a null hypothesis; the difference in these interpretations is not merely a semantic point. Rather, the two interpretations can lead to quite different biological conclusions.

Interpreting Failure to Reject a Null Hypothesis  
*Bulletin of the Ecological Society of America*, Volume 66, 1985

**Rozeboom, W. W.**

No biographical data available

The statistical folkways of a more primitive past continue to dominate the local scene.

The Fallacy of the Null-Hypothesis Significance Test  
*Psychological Bulletin*, Volume 57, 1960

**Salsburg, David S.**

No biographical data available

Most readers of this journal will recognize the limited value of hypothesis testing in the science of statistics. I am not sure that they all realize the extent to which it has become the primary tool in the religion of Statistics. Since the practitioners of that faith seem unable to cure their own folly, it is time we priests of the faith brought them around to realizing that there are more appropriate ways to get useful answers.

The Religion of Statistics as Practiced in Medical Journals  
*American Statistician*, Volume 39, 1985

**Schmidt, Frank L.**

American industrial and organizational psychology researcher

I believe that...false beliefs are a major cause of the addiction of researchers to significance tests. Many researchers believe that statistical significance testing confers important benefits that are in fact completely imaginary.

Statistical Significance Testing and Cumulative Knowledge in Psychology: Implications for Training of Researchers  
*Psychological Methods*, Volume 1, Number 2, 1996

If the null hypothesis is not rejected, [Sir Ronald] Fisher's position was that nothing could be concluded. But researchers find it hard to go to all the trouble of conducting a study only to conclude that nothing can be concluded.

Statistical Significance Testing and Cumulative Knowledge in Psychology: Implications for Training of Researchers  
*Psychological Methods*, Volume 1, Number 2, 1996

**Yates, Frances** 1899–1981

English historian

The most commonly occurring weakness in the application of Fisherian methods is, I think, undue emphasis on tests of significance, and failure to recognize that in many types of experimental work, estimates of the treatment effects, together with estimates of the error to which they are subject, are the quantities of primary interest.

Sir Ronald Fisher and the Design of Experiments  
*Biometrics*, Volume 20, 1964

## STATISTICIAN

**Bailey, W. B.** 1873–?

No biographical data available



**Cummings, John**

No biographical data available

While, therefore, tabulation is a final process, the formulation of the scheme of tabulation should be the initial process, preceding even the formulation of the schedule, which should be determined by the character of the tables to be produced. Failure to observe this fundamental principle in statistical practice, perhaps more than any other characteristic, distinguishes the work of the amateur from that of the expert, the work of the untrained social investigator from that of the experienced scientific statistician.

*Statistics* (p. 26)

A.C. McClurg & Company. Chicago, Illinois, USA. 1917

**Balchin, Nigel** 1908–70

English novelist

He divided people into statisticians, people who knew about statistics, and people who didn't. He liked the middle group best. He didn't like the real statisticians much because they argued with him, and he thought people who didn't know any statistics were just animal life.

*The Small Back Room* (p. 137)

Collins. London, England. 1943

**Belloc, Hilaire** 1870–1953

French-born poet and historian

The statistician was let loose.

*The Silence of the Sea*

On Statistics (p. 172)

Sheed & Ward. New York, New York, USA. 1940

**Bellow, Saul** 1915–

American novelist

An utterly steady, reliable woman, responsible to the point of grimness. Daisy was a statistician for the Gallup Poll.

*Herzog* (p. 221)

The Viking Press. New York, New York, USA. 1964

**Blodgett, James H.**

American statistician

The individual statistician must scan closely the authority on which he rests, and guard his statements with all the cautionary words which imperfect knowledge requires, or some mere child will point out the errors in his statements and his conclusions and set people wondering of what value the rest of his work may be.

Obstacles to Accurate Statistics

*Journal of the American Statistical Association*, New Series Number 41, March 1898 (p. 19)

**Bowley, Arthur L.** 1869–1957

English statistician and economist

Perhaps statisticians themselves have not always fully recognized the limitations of their work.

*Elements of Statistics*

Part I, Chapter I (p. 13)

P.S. King & Son Ltd. London, England. 1937

**Chernoff, H.** 1923–

American mathematician and statistician

**Moses, L. E.** 1921–

American statistician and social scientist

Years ago a statistician might have claimed that statistics deals with the processing of data...today's statistician will be more likely to say that statistics is concerned with decision making in the face of uncertainty.

*Elementary Decision Theory*

Introduction (p. 1)

John Wiley & Sons, Inc. New York, New York, USA. 1959

**Deming, William Edwards** 1900–93

American statistician, educator, and consultant

The minute a statistician steps into the position of the executive who must make decisions and defend them, the statistician ceases to be a statistician.

*Sample Design in Business Research* (p. 13)

John Wiley & Sons, Inc. New York, New York, USA. 1960

The statistician accepts in any engagement certain responsibilities and obligations to his client and to the people that he works with. In the first place, he is the architect of a survey or experiment. It is his business to fit the various skills together to make them effective. It is important that he clarify the various responsibilities at the outset of the study.

*Sample Design in Business Research* (p. 10)

John Wiley & Sons, Inc. New York, New York, USA. 1960

The only useful function of a statistician is to make predictions, and thus to provide a basis for action.

In W.A. Wallis

The Statistical Research Group

*Journal of the American Statistical Association*, 1942–1945, Volume 75, Number 370, June 1980 (p. 321)

It should be emphasized that the statistician is not necessarily abler at handling data than his colleagues trained in economics, sociology, engineering, physics, business, etc. However, because of the high transferability of the statistician's mathematical techniques, and because he acquires a broad knowledge in many fields, he is frequently adept at discovering and measuring errors in data and determining the source of the errors. He avoids drawing wrong conclusions from data whether the data be good or bad.

On the Classification of Statisticians

*The American Statistician*, Volume 2, Number 2, April 1948 (p. 16)

A statistician's responsibility is not confined to plans: he must also seek assurance of cooperation in field and

office, and maintain constant touch with the work, also with the interpretation of the results.

*Some Theory of Sampling* (p. 8)

John Wiley & Sons, Inc. New York, New York, USA. 1950

### Finney, D. J.

English biometric statistician

Too often, in many fields of science, the statistician is regarded as someone who comes on stage after data have been collected, performs standard calculations, delivers a verdict “Significant” or “Not Significant”, and then departs.

The Questioning Statistician

*Statistics in Medicine*, Volume 1, 1982 (p. 5)

### Fisher, Sir Ronald Aylmer 1890–1962

English statistician and geneticist

We have the duty of formulating, of summarizing, and of communicating our conclusions, in intelligible form, in recognition of the right of other free minds to utilize them in making their own decisions.

B, Statistical methods and scientific induction

*Journal of the Royal Statistical Society*, Volume 17, 1955

The statistician cannot evade the responsibility for understanding the process he applies or recommends.

*The Design of Experiments*

Introduction (p. 1)

Hafner Publishing Company. New York, New York, USA. 1971

The statistician cannot excuse himself from the duty of getting his head clear on the principles of scientific inference, but equally no other thinking man can avoid a like obligation.

*The Design of Experiments*

Introduction (p. 2)

Hafner Publishing Company. New York, New York, USA. 1971

### Fleiss, Joseph L.

American statistician

There was a statistician from Needham,  
Who was so bright, his clients would heed him.

Yet his embarrassed confession

Was that, in linear regression,

He'd never subtract an extra degree of freedom.

Letters to the Editor

*The American Statistician*, Volume 21, Number 4, October 1967 (p. 49)

There was a statistician from Knossus,

Who had a nonnormal neurosis.

With techniques of newness, He'd measure the skewness,

And also the data's kurtosis.

Letters to the Editor

*The American Statistician*, Volume 21, Number 4, October 1967 (p. 49)

There was a biometrician named Mabel,  
Who'd never look at populations unstable.

Using intricate relations,

She'd find life expectations,

From the lx's of the life table.

Letters to the Editor

*The American Statistician*, Volume 21, Number 4, October 1967 (p. 49)

### Forster, E. M. (Edward Morgan) 1879–1970

English novelist

We are not concerned with the very poor. They are unthinkable, and only to be appreciated by the statistician or the poet.

*Howards End*

Chapter VI (p. 45)

Vintage Books. New York, New York, USA. 1954

### Good, I. J. 1916–

English statistician and cryptographer

The mathematician, the statistician, and the philosopher do different things with a theory of probability. The mathematician develops its formal consequences, the statistician applies the work of the mathematician and the philosopher describes in general terms what this application consists in. The mathematician develops symbolic tools without worrying overmuch what the tools are for; the statistician uses them; the philosopher talks about them. Each does his job better if he knows something about the work of the other two.

Kinds of Probability

*Science*, Volume 129, Number 3347, February 20, 1959 (p. 443)

### Hooke, Robert 1635–1703

English physicist

It is commonly believed that anyone who tabulates numbers is a statistician. This is like believing that anyone who owns a scalpel is a surgeon.

*How to Tell the Liars from the Statisticians*

Chapter 1 (p. 1)

Marcel-Dekker, Inc. New York, New York, USA. 1983

### Hopkins, Harry

No biographical data available

Increasingly, we find ourselves caught up in the new contemporary dualism; there is the muddling-on, verbalizing, impressionistic, human old world down there, and there is that Other, Finer, Rational World to which the better statisticians have already been called. Communications between the two can be tenuous.

*The Numbers Game: The Bland Totalitarianism*

Chapter 6 (p. 134)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

### Kerridge, D. F.

No biographical data available

It is not primarily the responsibility of a statistician to make decisions for other people — not in general at any rate... It is for someone else to say what decisions should

be made with [inferential]...information. In other words, ideally, it is the statisticians job to inform not to decide.

Discussion on Paper by Dr. Marshall and Professor Olkin  
*Journal of the Royal Statistical Society, Series B, Volume 30, 1968*  
 (p. 440)

**Kruskal, William** 1919–2005

American mathematician and statistician

An occupational hazard to which we statisticians are exposed occurs in the context of a social occasion, perhaps a dinner party. I am, let us say, seated next to a charming lady whom I have just met, and, as an initial conversational ice-breaking, she turns to me with a winning smile and says: “Now tell me what is it you do?” We must tell the truth, of course, so I reply that I am a statistician. That usually ruins a fine conversation, for in 8.6 cases out of 10 the lady’s smile disappears, she turns to my rival on her other side, and I attack the fried chicken in lonely, misunderstood dignity.

Statistics, Moliere, and Henry Adams  
*American Scientist Magazine, 1967* (p. 416)

**Miksch, W. F.** 1861–1927

No biographical data available

A couple of government statisticians recently threw dust on the wedding ring business by coming right out with the fact that for every male there are 1.03 females. It’s about time they stop shoving the American taxpayer behind decimal points.

The Average Statistician  
*Collier’s, Volume 125 June 17, 1950* (p. 10)

**Moroney, M. J.**

American statistician

There is more than a germ of truth in the suggestion that, in all society where statisticians thrive, liberty and individuality are likely to be emasculated.

*Facts from Figures*  
 Statistics Undesirable (p. 1)  
 Penguin Books Ltd., Harmondsworth, England. 1951

The statistician’s job is to draw general conclusions from fragmentary data. Too often the data supplied to him for analysis are not only fragmentary but positively incoherent, so that he can do next to nothing with them. Even the most kindly statistician swears heartily under his breath whenever this happens.

*Facts from Figures*  
 What Happens When We Take a Sample (p. 120)  
 Penguin Books Ltd., Harmondsworth, England. 1951

**Sarton, George** 1884–1956

Belgian-born American scholar and writer

I like to think of the constant presence in any sound Republic of two guardian angels: the Statistician and the Historian of Science. The former keeps his finger on the pulse of Humanity...

*Sarton on the History of Science*

Quetelet (p. 241)  
 Harvard University Press. Cambridge, Massachusetts, USA. 1962

**Seaton, G. L.**

No biographical data available

...as the job of finding the truth and explaining it continues to become more complex and more difficult, management again casts a doubtful eye at the statistician, for a different reason. Management’s big question is no longer “What can the statistician do for us that we can’t do just as well ourselves?”; the question now is, “Do our statisticians have the tools and the capacity and the experience and the persistence and the breadth of vision to seek the truth and to know it when they have found it?”

The Statistician and Modern Management  
*The American Statistician, Volume 2, Number 6, December 1948* (p. 10)

**Snedecor, G. W.**

Statistician

The characteristic which distinguishes the present-day professional statistician, is his interest and skill in the measurement of the fallibility of conclusions.

On a Unique Feature of Statistics  
 Presidential Address to the American Statistical Association, December 1948  
*Journal of the American Statistical Association, Volume 44, Number 245, March 1949*

**Stamp, Josiah** 1880–1941

English economist and financier

Most of you would as soon be told that you are cross-eyed or knock-kneed as that you are destined to be a statistician...

*Some Economic Factors in Modern Life*  
 Chapter VIII (p. 253)  
 P.S. King & Son Ltd. London, England. 1929

I sometimes think that statisticians do not deserve quite all the hard things that are said about them. They are supposed to be cold, unemotional, bloodless and steely-eyed. But, as a matter of fact, we are all statisticians nowadays. We are either forming opinions on other people’s statistics, whether we like it or not, or we are providing the raw material of statistics.

*Some Economic Factors in Modern Life*  
 Chapter VIII (p. 253)  
 P.S. King & Son Ltd. London, England. 1929

**Thurber, James** 1894–1961

American writer and cartoonist

Though statisticians in our time have never kept the score, Man wants a great deal here below and Women even more.

*Further Fables of Our Times*  
 The Godfather and His Godchild  
 Simon & Schuster. New York, New York, USA. 1956

**Tukey, John W.** 1915–2000  
American statistician

Predictions, prophecies, and perhaps even guidance — those who suggested this title to me must have hoped for such — even though occasional indulgences in such actions by statisticians has undoubtedly contributed to the characterization of a statistician as a man who draws straight lines from insufficient data to foregone conclusions!

Where Do We Go From Here?

*Journal of the American Statistical Association*, Volume 55, Number 289, March 1960 (p. 80)

The most important maxim for data analysis to heed, and one which many statisticians seem to have shunned is this: “Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise.” Data analysis must progress by approximate answers, at best, since its knowledge of what the problem really is will at best be approximate.

The Future of Data Analysis

*Annals of Mathematical Statistics*, Volume 33, Number 1, March 1962 (pp. 13–14)

(The experimental statistician dare not shrink from the war cry of the analyst “Only a fool would use it, but it’s better than we used to use!”)

Unsolved Problems of Experimental Statistics

*Journal of the American Statistical Association*, Volume 49, Number 268, December 1954 (p. 718)

**Wang, Chamont** 1949–  
American statistician

Flip a coin 100 times. Assume that 99 heads are obtained. If you ask a statistician, the response is likely to be: “It is a biased coin.” But if you ask a probabilist, he may say: “Woow, what a rare event.”

*Sense and Nonsense of Statistical Inference: Controversy, Misuse, and Subtlety*

Chapter 6 (p. 154)

Marcel-Dekker, Inc. New York, New York, USA. 1993

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian and sociologist

Behind the adventurer, the speculator, comes that scavenger of adventurers, the statistician.

*The Work, Wealth and Happiness of Mankind*

Chapter Nine, Part 10 (p. 390)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

...the movement of the last hundred years is all in favor of the statistician.

*The Work, Wealth and Happiness of Mankind*

Chapter Nine, Part 10 (p. 391)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1931

**Wigner, Eugene Paul** 1902–95  
Hungarian-born American physicist

There is a story about two friends, who were classmates in high school, talking about their jobs. One of them became a statistician and was working on population trends. He showed a reprint to his former classmate. The reprint started, as usual with the Gaussian distribution and the statistician explained to his former classmate the meaning of the symbols for the actual population, for the average population, and so on. His classmate was a bit incredulous and was not quite sure whether the statistician was pulling his leg

The Unreasonable Effectiveness of Mathematics in the Natural Sciences  
*Communications on Pure and Applied Mathematics*, Volume 13, Number 1, February 1960 (p. 1)

**Yule, G. U.** 1871–1951  
Scottish statistician

Since the statistician can seldom or never make experiments for himself, he has to accept the data of daily experiences, and discuss as best he can the relations of a whole group of changes...

On the Theory of Correlation

*Journal of the Royal Statistical Society*, Volume LX, December 1897 (p. 812)

## STATISTICS

**Adams, Henry Brooks** 1838–1918  
American man of letters

History has never regarded itself as a science of statistics. It was the Science of Vital Energy in relation with time; and of late this radiating center of life has been steadily tending, — together with every form of physical and mechanical energy, — toward mathematical expression.

*A Letter to American Teachers of History*

Chapter I (p. 115)

Press of J.H. Furst Company. Washington, D.C. 1910

## Advertisement

...and you thought “impressive” statistics were 36–24–36.

*The American Statistician*, Volume 33, Number 4, November 1979 (p. 248)

**Allen, Roy George Douglas** 1906–83  
English economist and mathematician

A knowledge of statistical methods is not only essential for those who present statistical arguments it is also needed by those on the receiving end.

*Statistics for Economists*

Chapter I (p. 9)

Hutchinson’s University Library. London, England. 1951

**Angell, Roger** 1920–  
American fiction writer and essayist

Statistics are the food of love.

*Late Innings: A Baseball Companion*

Chapter 1 (p. 9)

Simon & Schuster. New York, New York, USA. 1982

**Baines, J. A.**

No biographical data available

Once again, but not I hope, too often, or for the last time, do I dip into the well of Mr. Courtney’s sagacity:—

“We may quote to one another with a chuckle the words of the Wise Statesman, lies, damned lies and statistics, still there are some easy figures which the simplest must understand but the astutest cannot wriggle out of.”

Parliamentary Representation in England Illustrated by the Elections of 1892 and 1895

*Journal of the Royal Statistical Society*, Volume 59, 1896 (p. 87)

**Balchin, Nigel** 1908–70

English novelist

Organic chemist!” said Tilley expressively. “Probably knows no statistics whatever.”

*The Small Back Room* (p. 136)

Collins. London, England. 1943

**Bailey, W. B.** 1873–?

No biographical data available

**Cummings, John**

No biographical data available

Statistical tables are essentially specific in their meaning, and they require data that are uniformly specific in the same kind and degree.

*Statistics* (p. 33)

McClurg. Chicago, Illinois, USA. 1917

**Barrett-Browning, Elizabeth** 1806–61

English poet

There’s too much abstract willing, purposing,  
In this poor world. We talk by aggregates,  
And think by systems and being used to face  
Our evils in statistics, are inclined  
To cap them with unreal remedies  
Drawn out in haste on the other side.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Eighth Book, l. 800

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Bartlett, Maurice Stevenson** 1910–2002

English statistician

[Statistics] is concerned with things we can count. In so far as things, persons, are unique or ill-defined, statistics are meaningless and statisticians silenced; in so far as things are similar and definite — so many workers over 25, so many nuts and bolts made during December — they can be counted and new statistical facts are born.

*Essays on Probability and Statistics*

Some Remarks on the Theory of Statistics (p. 11)

Methuen & Company Ltd. London, England. 1962

**Baudrillard, Jean** 1929–

French cultural theorist

Like dreams, statistics are a form of wish fulfillment.

Translated by Chris Turner

*Cool Memories*

October 1983 (p. 147)

Verso. London, England. 1990

**Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

The statistical method is social mathematics par excellence.

*The Development of Mathematics* (p. 582)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

Mankind in the mass is more despotically governed by the laws of chance than it ever was by the decrees of any tyrant. If our shambling race is ever to get anything but suicidal destruction out of science, it may be a necessary first step that half a dozen human beings in every hundred thousand understand the mass-reactions of creatures who, as individuals, occasionally show that they can stand erect and walk like men. To grasp and analyze mass-reactions, whether of atoms or of human beings, a mastery of the modern statistical method is essential.

*The Development of Mathematics* (p. 582)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1945

**Belloc, Hilaire** 1870–1953

French-born poet and historian

It has long been recognized by public men of all kinds... that statistics come under the head of lying, and that no lie is so false or inconclusive as that which is based on statistics.

*The Silence of the Sea*

On Statistics (p. 170)

Sheed & Ward. New York, New York, USA. 1940

Before the curse of statistics fell upon mankind we lived a happy, innocent life, full of merriment and go, and informed by fairly good judgment.

*The Silence of the Sea*

On Statistics (p. 171)

Sheed & Ward. New York, New York, USA. 1940

Statistics are the triumph of the quantitative method, and the quantitative method is the victory of sterility and death.

*The Silence of the Sea*

On Statistics (p. 173)

Sheed & Ward. New York, New York, USA. 1940

**Berger, J. O.**

No biographical data available

**Berry, D. A.**

No biographical data available

...to acknowledge the subjectivity inherent in the interpretation of data is to recognize the central role of statistical analysis as a formal mechanism by which new evidence can be integrated with existing knowledge. Such a view of statistics as a dynamic discipline is far from the common perception of a rather dry, automatic technology for processing data.

Statistical Analysis and the Illusion of Objectivity  
*American Scientist*, Volume 76, 1988 (p. 159)

**Bernard, Claude** 1813–78

French physiologist

Only when a phenomenon includes conditions as yet undefined, can we compile; we must learn, therefore, that we compile statistics only when we cannot possibly help it.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter II, Section IX (p. 137)  
Henry Schuman, Inc. New York, New York, USA. 1927

I do not understand how we can teach practical and exact science on the basis of statistics.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter II, Section ix (p. 138)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Billings, John Shaw** 1838–1913

American surgeon and librarian

Statistics are somewhat like old medical journals, or like revolvers in newly opened mining districts. Most men rarely use them, and find it troublesome to preserve them so as to have them easy of access; but when they do want them, they want them badly.

On Vital and Medical Statistics  
*Medical Record*, Volume 36, 1889

**Blalock, Jr., Hubert M.** 1927–91

American sociologist and statistical methods researcher

The manipulation of statistical formulas is no substitute for knowing what one is doing.

*Social Statistics*  
Chapter 19 (p. 448)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1960

**Bloch, Arthur** 1948–

American humorist

If enough data is collected, anything may be proved by statistical methods.

*Murphy's Law*  
William and Holland's Law (p. 47)  
Price/Stern/Sloan, Publishers. Los Angeles, California, USA. 1981

**Blodgett, James H.**

American statistician

In statistical work we should be able to presume upon honesty, fidelity, and diligence.

Obstacles to Accurate Statistics  
*Journal of the American Statistical Association*, New Series Number 41,  
March 1898 (p. 1)

**Boorstin, Daniel J.** 1914–2004

American historian

...statistics have tended to make facts into norms.

*The Decline of Radicalism*  
Chapter I (p. 18)  
Random House, Inc. New York, New York, USA. 1969

...statistics, which first secured prestige here by a supposedly impartial utterance of stark fact, have enlarged their dominion over the American consciousness by becoming the most powerful statement of the "ought" — displacers of moral imperatives, personal ideals, and unfulfilled objectives.

*The Decline of Radicalism*  
Chapter I (p. 19)  
Random House, Inc. New York, New York, USA. 1969

**Bowley, Arthur L.** 1869–1957

English statistician and economist

Some of the common ways of producing a false statistical argument are to quote figures without their context, omitting the cautions as to their incompleteness, or to apply them to a group of phenomena quite different to that to which they in reality relate; to take these estimates referring to only part of a group as complete; to enumerate the events favorable to an argument, omitting the other side; and to argue hastily from effect to cause, this last error being the one most often fathered on to statistics. For all these elementary mistakes in logic, statistics is held responsible.

*Elements of Statistics*  
Part I, Chapter I (pp. 12–13)  
P.S. King & Son Ltd. London, England. 1937

A statistical estimate may be good or bad, accurate or the reverse; but in almost all cases it is likely to be more accurate than a casual observer's impression, and the nature of things can only be disproved by statistical methods.

*Elements of Statistics*  
Part I, Chapter I (p. 9)  
P.S. King & Son Ltd. London, England. 1937

Great numbers are not counted correctly to a unit, they are estimated; and we might perhaps point to this as a division between arithmetic and statistics, that whereas arithmetic attains exactness, statistics deals with estimates, sometimes very accurate, and very often sufficiently so for their purpose, but never mathematically exact.

*Elements of Statistics*

Part I, Chapter I (p. 3)  
P.S. King & Son Ltd. London, England. 1937

A knowledge of statistics is like a knowledge of foreign languages or of algebra; it may prove of use at any time under any circumstances.

*Elements of Statistics*

Part I, Chapter I (p. 4)  
P.S. King & Son Ltd. London, England. 1937

**Bowman, Scotty** 1933–  
Canadian Hockey Coach

**Bowley, Arthur L.** 1869–1957  
English statistician and economist

Statistics are for losers.  
A Lot More Where They Come From  
*Sports Illustrated*, April 2, 1973

**Bowman, W. E.** 1912–1985  
English amateur hill hiker and satirist

The various estimates of the height of the true summit vary considerably, but by taking an average of these figures it is possible to say confidently that the summit of Rum Doodle is 40,000 1/2 feet above sea level.  
*The Ascent of Rum Doodle*  
Chapter 3 (pp. 32–33)  
The Vanguard Press. New York, New York, USA. 1956

**Buchner, Ludwig** 1824–99  
German physician and philosopher

The science of statistics, which has only been turned to proper account in modern times, has the great honor of having proved the existence of definite rules in a number of phenomena, which had hitherto been looked upon as merely accidental or as owing their origin to an arbitrary power.  
*Force and Matter*  
Free Will (p. 367)  
Truth Seeker. New York, New York, USA. 1950

**Burgess, Robert W.** 1887–1969  
American statistician

The fundamental gospel of statistics is to push back the domain of ignorance, prejudice, rule-of-thumb, arbitrary or premature decisions, tradition, and dogmatism and to increase the domain in which decisions are made and principles are formulated on the basis of analyzed quantitative facts.  
The Whole Duty of the Statistical Forecaster  
*Journal of the American Statistical Association*, Volume 32, Number 200, December 1937 (p. 636)

**Burnan, Tom**  
No biographical data available

No matter how much reverence is paid to anything purporting to be “statistics,” the term has no meaning unless the source, relevance, and truth are all checked.  
*The Dictionary of Misinformation*  
Statistics, Use, Misuse, and Abuse Of (p. 271)  
Ballantine Books. New York, New York, USA. 1975

...the worship of statistics has had the particularly unfortunate result of making the job of the plain, outright liar that much easier.  
*The Dictionary of Misinformation*  
Statistics, Use, Misuse, and Abuse Of (p. 274)  
Ballantine Books. New York, New York, USA. 1975

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Statistics is a science which ought to be honorable, the basis of many most important sciences; but it is not to be carried on by steam, this science, any more than others are; a wise head is requisite for carrying it on.  
*English and Other Critical Essays*  
Chartism (p. 170)  
J.M. Dent & sons Ltd. London, England. 1950

Statistics is a science which ought to be honourable, the basis of many most important sciences; but it is not to be carried on by steam, this science, any more than others are; a wise hand is requisite for carrying it on. Conclusive facts are inseparable from unconclusive except by a head that already understands and knows.  
*Critical and Miscellaneous Essays*  
Chartism, II  
D. Appleton & Company. New York, New York, USA. 1860

Statistics, one may hope, will improve gradually, and become good for something. Meanwhile, it is to be feared the crabbed satirist was partly right, as things go.  
*English and Other Critical Essays*  
Chartism, Chapter II (p. 171)  
J.M. Dent & sons Ltd. London, England. 1950

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“And on the dead level our pace is — ?” the younger suggested; for he was weak in statistics, and left all such details to his aged companion.  
*The Complete Works of Lewis Carroll*  
A Tangled Tale  
Knot I (p. 983)  
The Modern Library. New York, New York, USA. 1936

**Chatfield, Christopher**  
British statistician

Thus statistics should generally be taught more as a practical subject with analyses of real data. Of course some theory and an appropriate range of statistical tools need to be learnt, but students should be taught that Statistics is much more than a collection of standard prescriptions.

The Initial Examination of Data  
*Journal of the Royal Statistical Society*, Series A, Volume 148, 1985

**Cogswell, Theodore R.** 1918–87

American science fiction author

Statistics show that you have nothing to worry about.

In Harry Harrison

*Astounding: John W. Campbell Memorial Anthology*

Probability Zero (p. 329)

Random House, Inc. New York, New York, USA. 1973

**Cohen, Jacob** 1923–

American behavioral psychologist and statistical analyst

Since statistical significance is so earnestly sought and devoutly wished for by behavioral scientists, one would think that the a priori probability of its accomplishment would be routinely determined and well understood.

Quite surprisingly, this is not the case.

*Statistical Power Analysis for the Behavioral Sciences*

Chapter 1 (p. 1)

Lawrence Erlbaum Associates. Hillsdale, New Jersey,

USA. 1988

I have learned repeatedly, however, that the typical behavioral scientist approaches applied statistics with considerable uncertainty (if not actual nervousness), and requires a verbal-intuitive exposition, rich in redundancy and with many concrete illustrations.

*Statistical Power Analysis for the Behavioral Sciences*

Preface to the Original Edition (p. xx)

Lawrence Erlbaum Associates, Publishers. Hillsdale, New Jersey, USA.

1988

**Cox, Sir David Roxbee** 1924–

English statistician

**Hinkley, D. V.** 1924–

English statistician

Statistical methods of analysis are intended to aid the interpretation of data that are subject to appreciable hazard variability.

*Theoretical Statistics* (p. 1)

Introduction (p. 1)

Chapman & Hall. London, England. 1974

**Crichton, Michael** 1942–

American novelist

Conversation and statistics. Really boring.

*Rising Sun*

Second Day (p. 254)

Ballantine Books. New York, New York, USA. 1993

**Darwin, Charles Robert** 1809–82

English naturalist

One has, however, no business to feel so much surprise of one's ignorance, when one knows how impossible it is without statistics to conjecture the duration of life and percentage of deaths to births in mankind.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

C. Darwin to L. Jenyns, [1845?] (p. 394)

D. Appleton & Company. New York, New York, USA. 1896

**Davies, John Tasman** 1924–?

Chemist

Operational research is the application of methods of the research scientist to various rather complex practical operations.... A paucity of numerical data with which to work is a usual characteristic of the operations to which operational research is applied.

*The Scientific Approach*

Chapter 7 (p. 86)

Academic Press. London, England. 1965

**Davis, Joseph S.**

No biographical data available

Statistics are proverbially dry — forgive me if I say they are far better dry than “wet” — but to give them optimum moisture content is simply a matter of mastering fundamentals that no one should hold in contempt.

Statistics and Social Engineering

*Journal of the American Statistical Association*, Volume 32, Number

197, March 1937 (p. 6)

**Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

The essence of life is statistical improbability on a colossal scale.

*The Blind Watchmaker*

Chapter 11 (p. 317)

W.W. Norton & Company, Inc. New York, New York, USA. 1986

**de Jonnes, Moreau**

No biographical data available

Statistics are like the hieroglyphics of ancient Egypt, where the lessons of history, the precepts of wisdom, and the secrets of the future were concealed in mysterious characters.

*Elements de Statistique* (p. 5)

**de Leeuw, A. L.**

No biographical data available

The method used by the scientist to find probable exact truth is what he calls “the method of least squares.”

*Rambling Through Science*

Gambling (p. 88)

Whittlesey House. London, England. 1932

**de Madariaga, Salvador** 1886–1978

Spanish writer and statesman

Statistics only work well when they dwell on large numbers of absolutely free motions, or what has been described as “perfect disorder.” If an element of deliberate direction, of conscious “order”, meddles with their



utter “innocence”, the facts in question cease to follow statistical laws.

*Essays with a Purpose*  
Freedom and Science (p. 50)  
Hollis & Carter. London, England. 1954

**Deming, William Edwards** 1900–93  
American statistician, educator, and consultant

You need not be a mathematical statistician to do good statistical work, but you will need the guidance of a first class mathematical statistician.

Some Principles of the Shewhart Method of Quality Control  
*Mechanical Engineering*, Volume 66, March 1944

A good engineer, or a good economist, or a good chemist, already has a good start, because the statistical method is only good science brought up to date by the recognition that all laws are subject to the variations which occur in nature.

Some Principles of the Shewhart Method of Quality Control  
*Mechanical Engineering*, Volume 66, March 1944

Your study of statistical methods will not displace any other knowledge that you have; rather, it will extend your knowledge of engineering, chemistry, or economics, and make it more useful.

Some Principles of the Shewhart Method of Quality Control  
*Mechanical Engineering*, Volume 66, March 1944

Statistical research is particularly necessary in the government service because of the high level of quality and economy that the public has the right to expect in government statistics.

*Some Theory of Sampling* (p. viii)  
John Wiley & Sons, Inc. New York, New York, USA. 1950

The statistical method is more than an array of techniques. The statistical method is a Mode of Thought; it is Sharpened Thinking; it is Power.

Paper presented at meeting of the International Statistical Institute, September 1953

Unfortunately and inadvertently, intellectual gulfs have grown up between writers in statistics, least squares, and curve fitting. Each of the three groups has gone its own way, rediscovering developments long since discovered by the others, or — what is worse — not rediscovering them.

*Statistical Adjustment of Data* (p. iv)  
John Wiley & Sons, Inc. New York, New York, USA. 1938

**Devons, Ely** 1913–67  
English economist

The experience of falling in love could be adequately described in terms of statistics. A record of heart beats per minute, the stammering and hesitation in speech, the number of calories consumed per day, the heightening of poetic vision, measured by the number of lines of poetry

written to the beloved — I won’t go on; no doubt you can think of further measures.

*Essays in Economics*  
Chapter 6 (p. 105)  
Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

The two most important characteristics of the language of statistics are first, that it describes things in quantitative terms, and second, that it gives this description an air of accuracy and precision.

*Essays in Economics*  
Chapter 6 (p. 106)  
Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

How to use a language which by its very nature implies objectivity, precision and accuracy, in such a way that the subjective element of judgment, imprecision and inaccuracy are fully taken into account? It is because this task is so difficult and so rarely achieved that statistics are frequently referred to as “the hard facts”, and yet we talk of three kinds of lies — “lies, damn lies, and statistics.”

*Essays in Economics*  
Chapter 6 (p. 111)  
Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

...“statistics are only for the statistician”, and even then, I might add, only for the good statistician.

*Essays in Economics*  
Chapter 6 (p. 118)  
Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

This exaggerated influence of statistics resulting from willingness, indeed eagerness, to be impressed by the “hard facts” provided by the “figures”, may play an important role in decision-making.

*Essays in Economics*  
Chapter 7 (p. 134)  
Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

**Devons, Ely** 1913–67  
English economist

There are those who are so impressed by the notion that “quantification” is the only form of scientific knowledge, that they see no danger in the distorted, misleading, or simply ineffective picture that a statistical description of events may give. To such people the statistical picture is always to be preferred as the most meaningful and objective. It is indeed because this view is so widespread, that an argument stated in statistical terms has such a powerful influence in policy decision, and induces everyone to try to impress their case on public attention by peppering it with statistics.

*Essays in Economics*  
Chapter 6 (p. 106)  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1961

Statistical magic, like its primitive counterpart, is a mystery to the public; and like primitive magic it can never be proved wrong.... The oracle is never wrong; a mistake merely reinforces the belief in magic.

*Essays in Economics*

Chapter 7 (p. 135)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1961

**Dewey, John** 1859–1952

American philosopher and educator

Factual science may collect statistics, and make charts. But its predictions are, as has been well said, but past history reversed.

*Art as Experience*

Chapter XIV (p. 346)

Milton, Balch and Company. New York, New York, USA. 1934

**Dickens, Charles** 1812–70

English novelist

Mr. Gradgrind sat writing in the room with the deadly statistical clock, proving something no doubt — probably, in the main, that the Good Samaritan was a bad economist.

*Hard Times*

Book the Second, Chapter XII (p. 192)

J.M. Dent & Sons Ltd. London, England. 1966

**Edgeworth, Francis Ysidro** 1845–1926

Irish economist and statistician

...Statistics reigns and revels in the very heart of Physics.

On the Use of the Theory of Probabilities in Statistics Relating to Society

*Journal of the Royal Statistical Society*, January 1913 (p. 167)

**Edwards, A. W. F.** 1935–

English statistician, geneticist, and evolution biologist

There comes a time in the life of a scientist when he must convince himself either that his subject is so robust from a statistical point of view that the finer points of statistical inference he adopts are irrelevant or that the precise mode of inference he adopts is satisfactory.

*Likelihood* (p. xi)

Cambridge University Press. Cambridge, England. 1972

**Edwards, Tyron** 1809–94

American theologian

Statistics is the science of learning from experiences, especially experiences that arrive a little bit at a time.

*An Introduction to the Bootstrap*

Chapter I (p. 1)

Chapman & Hall. New York, New York, USA. 1993

**Efron, Bradley** 1938–

American statistician

**Tibshirani, Robert J.**

No biographical data available

Statistics is a subject of amazingly many users and surprisingly few effective practitioners.

*An Introduction to the Bootstrap*

Preface (p. xiv)

Chapman & Hall. New York, New York, USA. 1993

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

By applying the statistical method we cannot foretell the behavior of an individual in a crowd. We can only foretell the chance, the probability, that it will behave in some particular manner.

*The Evolution of Physics*

Probability Waves (p. 284)

Simon & Schuster. New York, New York, USA. 1961

**Eisenhart, Churchill** 1913–94

American statistician

The primary function of a statistical consultant in a research organization is to furnish advice and guidance in the collection and use of numerical data to provide quantitative foundations for decisions.

The Role of a Statistical Consultant in a Research Organization

*The American Statistician*, Volume 2, Number 2, April 1948 (p. 6)

**Ellis, Havelock** 1859–1939

English sexuality researcher

...the methods of statistics are so variable and uncertain, so apt to be influenced by circumstances, that it is never possible to be sure that one is operating with figures of equal weight.

*The Dance of Life*

Chapter VII, I (p. 286)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1923

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

One more fagot of these adamantine bandages is the new science of Statistics.

*Ralph Waldo Emerson: Essays and Lectures*

The Conduct of Life

Fate (p. 950)

The Library of America. New York, New York, USA. 1983

**Farr, William** 1807–83

English statistician

You complain that your report would be dry. The dryer the better. Statistics should be the driest of all reading.

Nightingale on Quetelet

*Journal of the Royal Statistical Society*, Series A, 1981 (p. 144)

**Ferguson, Kitty**

Science writer

Compared with the adventure of discovering them, the statistics themselves often seem terribly dry.

*Measuring the Universe: Our Historic Quest to Chart the Horizons of Space and Time*  
 Prologue (p. 3)  
 Walker & Company. New York, New York, USA. 1999

**Fienberg, Stephen E.** 1942–  
 American statistician

Although advice on how and when to draw graphs is available, we have no theory of statistical graphics...  
 Graphical Methods in Statistics  
*The American Statistician*, Volume 13, Number 4, November 1979 (p. 165)

**Fisher, Sir Ronald Aylmer** 1890–1962  
 English statistician and geneticist

This rather tumultuous overflow of statistical techniques from the quiet backwaters of theoretical methodology... into the working part of going concerns of the largest size, suggest that hidden causes have been at work...preparing men’s minds, and shaping the institutions through which they work...  
 The Expansion of Statistics  
*American Scientist Magazine*, Volume 42, Number 2, April 1954 (p. 277)

Statistical procedure and experimental design are only two different aspects of the same whole, and that whole is the logical requirements of the complete process of adding to natural knowledge by experimentation.  
*The Design of Experiments*  
 Introduction (p. 3)  
 Hafner Publishing Company. New York, New York, USA. 1971

In the original sense of the word, “statistics” was the science of Statecraft: to the political arithmetician of the eighteenth century, its function was to be the eyes and ears of the central government.  
 Presidential Address, First Indian Statistical Conference  
*Sankhya*, 1938, Volume 4, 1938 (p. 14)

**Fitzgerald, F. Scott** 1896–1940  
 American novelist and short story writer

I was counting the waves,” replied Amory gravely, “I’m going in for statistics.”  
*This Side of Paradise* (p. 213)  
 Ann Arbor Media Group, LLC. Ann Arbor, Michigan, USA. 2006

**Freeman, Linton C.**  
 No biographical data available

We are all victims of statistics.  
*Elementary Applied Statistics*  
 Section A (p. 1)  
 John Wiley & Sons, Inc. New York, New York, USA. 1965

**Gallup, George** 1901–84  
 American journalist and statistician

I could prove God statistically.  
*OMNI Magazine*, Volume 2, Issue 2, November 1979 (p. 42)

**Galton, Sir Francis** 1822–1911  
 English anthropologist, explorer, and statistician

The object of statistical science is to discover methods of condensing information concerning large groups of allied facts into brief and compendious expressions suitable for discussion. The possibility of doing this is based on the constancy and continuity with which objects of the same species are found to vary.  
*Inquiries into Human Faculty and Its Development*  
 Statistical Methods (p. 33)  
 AMS Press. New York, New York, USA. 1973

**Gann, Ernest K.** 1910–91  
 Author, sailor, fisherman, film producer, and airline captain

No, Mother dear, I do not hop into bed with every man I meet, despite your nasty little secret thoughts, but I do very much enjoy a more than occasional roll in the hay, which, if I have my statistics right, is a good deal more often than the average wife enjoys.  
*Brain 2000* (pp. 27–28)  
 Doubleday & Company, Inc. New York, New York, USA. 1980

**Gissing, George** 1857–1903  
 English novelist

...bits of jokes, bits of statistics, bits of foolery.  
*New Grub Street*  
 The Sunny Way (p. 492)  
 The Modern Library. New York, New York, USA. 1926

**Green, Celia** 1935–  
 English philosopher and psychologist

When people talk about “the sanctity of the individual” they mean “the sanctity of the statistical norm.”  
*The Decline and Fall of Science*  
 Aphorisms (p. 4)  
 Hamilton. London, England. 1976

**Greenwood, M.**  
 No biographical data available

Sometimes a David felled a Goliath of a statistical difficulty with a smooth stone. It might take a mathematician to prove how truly the stone was aimed.  
 Discussion, to the paper “Some Aspects of the Teaching of Statistics”  
*Journal of the Royal Statistical Society*, Volume 102, 1939 (p. 522)

**Gregory, John** 1724–73  
 Scottish physician and philosopher

The advancement of the sciences...requires only an attention to probabilities...a quick discernment where the greatest probability lies, and habits, of acting in consequence of this with facility and vigor.  
*Lectures on the Duties and Qualifications of a Physician* (p. 164)  
 W. Strahan. London, England. 1772

**Habera, Audrey**  
 Statistician

**Runyon, Richard P.**

Statistician

When we can't prove our point through the use of sound reasoning, we fall back upon statistical "mumbo jumbo" to confuse and demoralize our opponents.

*General Statistics*

Chapter 1 (p. 3)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1973

Statistics is the refuge of the uninformed.

*General Statistics*

Chapter 1 (p. 3)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1973

Statistics is "hocus-pocus" with numbers.

*General Statistics*

Chapter 1 (p. 3)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1973

**Hailey, Arthur** 1920–2004

English/Canadian author

Legal proceedings are like statistics. If you manipulate them, you can prove anything.

*Airport*

Part 3, Chapter 11 (p. 385)

Doubleday &amp; Company, Inc. Garden City, New York, USA. 1968

**Hancock, William Keith** 1808–?

Australian author

Oratory is dying; a calculating age has stabbed it to the heart with innumerable dagger-thrusts of statistics.

*Australia* (p. 146)

E. Benn Ltd. London, England. 1945

**Hand, D. J.**

No biographical data available

Statistics has been likened to a telescope. The latter enables one to see further and to make clear objects which were diminished or obscured by distance. The former enables one to discern structure and relationships which were distorted by other factors or obscured by random variation.

The Role of Statistics in Psychiatry

*Psychological Medicine*, Volume 15, 1985 (p. 471)**Hawkins, Francis Bisset** 1796–1894

No biographical data available

Statistics has become the key to several sciences...and there is reason to believe, that a careful cultivation of it, would materially assist the completion of a philosophy of medicine.... Medical statistics affords the most convincing proofs of the efficacy of medicine.

*Elements of Medical Statistics* (pp. 2–3)

Longman. London, England. 1829

**Hayford, F. Leslie**

No biographical data available

In the everyday use of statistics in business, complicated statistical methods rarely are necessary and always are to be avoided if possible. Simplicity of treatment and presentation is a requisite in the making of statistics useful in executive control.

Some Uses of Statistics in Executive Control

*Journal of the American Statistical Association*, Volume 31, Number 193, March 1936 (p. 36)

...neither statistics nor the statistician can ordinarily give the executive the final answer to his problems.

Some Uses of Statistics in Executive Control

*Journal of the American Statistical Association*, Volume 31, Number 193, March 1936 (p. 36)**Heinlein, Robert A.** 1907–88

American science fiction writer

Oh, the hell with! — it did not change the statistical outcome.

*Time Enough for Love*

Chapter VI (p. 208)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Hoel, P. G.**

Statistician

Statistical methods are essentially methods for dealing with data that have been obtained by repetitive operations.

*Introduction to Mathematical Statistics*

Chapter 1 (p. 1)

John Wiley &amp; Sons, Inc. New York, New York, USA. 1954

**Hogben, Lancelot** 1895–1975

English zoologist

Acceptability of a statistically significant result of an experiment on animal behavior in contradistinction to a result which the investigator can repeat before a critical audience naturally promotes a high output of publication. Hence, the argument that the techniques work has a tempting appeal to young biologists.

*Statistical Theory: The Relationship of Probability, Credibility and Error* (p. 27)

George Allen &amp; Unwin Ltd. London, England. 1957

The word statistics has at least six different meanings in current use, four in the context of statistical theory alone.

*Science in Authority*

The Present Crisis in Statistical Theory (pp. 94–95)

Unwin University Books. London, England, USA. 1963

**Holmes, Jr., Oliver Wendell** 1841–1935

American jurist

For the rational study of the law the black-letter man may be the man of the present, but the man of the future is the man of statistics and the master of economics.

Path of the Law

*The Harvard Law Review*, Volume 10, 1897

**Hooke, Robert** 1635–1703  
English physicist

Don't waste time arguing about the merits or demerits of something if you can gather some statistics that will answer the question realistically.

In J.M. Tanur

*Statistics: A Guide to the Unknown*

Statistics, Sports, and Some Other Things (p. 195)

Wadsworth & Brooks. Pacific Grove, California, USA. 1989

Do remember that your experiment is merely a hedge-podge of statistics, consisting of those cases that you happen to remember. Because these are necessarily small in number and because your memory may be biased toward one result or another, your experience may be far less dependable than a good set of statistics.

In J.M. Tanur

*Statistics: A Guide to the Unknown*

Statistics, Sports, and Some Other Things (p. 195)

Wadsworth & Brooks. Pacific Grove, California, USA. 1989

**Hopkins, Harry**

No biographical data available

Confidence in the omniscience of statistical reasoning grows by what it feeds on.

*The Numbers Game: The Bland Totalitarianism*

Chapter 6 (p. 132)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

And when, in pursuit of the black cat of definitive truth, more refined techniques of statistical analysis, factor analysis, and so forth, are developed, the researcher is more and more distanced from the subject of his pursuit, and the real human world in which it exists. He raises as by a sort of mathematical levitation, into that other, finer sphere, where black cats are clawless, mewless and abstract...

*The Numbers Game: The Bland Totalitarianism*

Chapter 7 (p. 141)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

You can't argue with statistics; generally you can't even get at them.

*The Numbers Game: The Bland Totalitarianism*

Chapter 11 (p. 232)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE  
Roman philosopher and dramatic critic

As they put it in Greek, we simply don't COUNT. We consume.

*The Satires and Epistles of Horace*

Epistle I, to Lollius Maximus

**Hotelling, Harold** 1895–1973  
American mathematical economist

Research in statistical theory and technique is necessarily mathematical, scholarly, and abstract in character, requiring some degree of leisure and detachment, and access to a good mathematical and statistical library.

*Memorandum to the Governor of India*

24 February 1940

The purely random sample is the only kind that can be examined with entire confidence by means of statistical theory, but there is one thing wrong with it. It is so difficult and expensive to obtain for many uses that sheer cost eliminates it.

*How to Lie with Statistics*

Chapter 1 (p. 21)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

**Huff, Darrell** 1913–2001

American writer

The secret language of statistics, so appealing in a fact-minded culture, is employed to sensationalize, inflate, confuse, and oversimplify.

*How to Lie with Statistics*

Introduction (p. 8)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

A well-wrapped statistic is better than Hitler's "big lie"; it misleads, yet it cannot be pinned on you.

*How to Lie with Statistics*

Introduction (p. 9)

W.W. Norton & Company, Inc. New York, New York, USA. 1954

**Jahoda, Marie** 1907–2001

Austrian social psychologist

**Deutsch, Morton** 1920–

American social psychologist

The use of available statistical records requires, first, that the social scientist be familiar with the better known sources of such data and that he display some ingenuity in discovering less obvious material.

*Research Methods in Social Relations*

Basic Process, Part I (p. 232)

Dryden Press. New York, New York, USA. 1951

**Johnson, Lyndon B.** 1908–73

36<sup>th</sup> president of the United States

The economy was never stronger in your lifetime. But statistics must not be sedatives. Economic power is important only as it is put to human use.

Speech

United Automobile Worker's Convention, Atlantic City, N.J., 23 March,

1964

**Johnson, Palmer O.** 1891–?

No biographical data available

There was a time when statistics as a tool in experimentation was almost completely ignored by the experimenter;

in fact, it was regarded [as] “introducing unnecessary confusion into otherwise plain issues.”

Modern Statistical Science and its Function in Educational and Psychological Research  
*The Scientific Monthly*, June 1951 (p. 385)

### Jones, Franklin P.

No biographical data available

[S]tatistics had to be invented...because people were so unstable and irrational, taken one at a time.

*The Non-Statistical Man* (p. 15)

Belmont Books, New York, New York, USA. 1964

In statistics, you look for the common factor in order to lump otherwise dissimilar items in a single category.

*The Non-Statistical Man* (p. 17)

Belmont Books, New York, New York, USA. 1964

Statistical laws enable the insurance company to function, and make a profit for its shareholders. But what does statistics do for the policyholder? Not one damn thing!

*The Non-Statistical Man* (p. 32)

Belmont Books, New York, New York, USA. 1964

Sarah Bascomb was well aware that she didn't live in the same world with her husband, and that made it rather nice, she thought. It would have been exceedingly boring if they both talked of nothing but expectancy tables and statistical probabilities, or the PTA and young Chuck's music lessons.

*The Non-Statistical Man* (p. 10)

Belmont Books, New York, New York, USA. 1964

### Kahn, S. J.

No biographical data available

Statistics in Israel today are like potatoes: they lie in the mud, but they're growing!

*Menorah Journal*, Volume 42, 1954 (p. 125)

### Kaplan, Abraham 1918–93

American philosopher of science, author, and educator

...statistical techniques are tools of thought, and not substitutes for thought.

*The Conduct of Inquiry: Methodology for Behavioral Science*

Chapter VI, Section 29 (p. 257)

Chandler Publishing Company. San Francisco, California, USA. 1964

### Kendall, Maurice G. 1907–83

Statistician

### Stuart, A. 1932–

American theoretical and physical chemist

Statistics is the branch of scientific method which deals with the data obtained by counting or measuring the properties of populations of natural phenomena. In this definition “natural phenomena” includes all the happenings of the external world, either human or not.

*The Advanced Theory of Statistics* (Volume 1)

Chapter 1, Section 1.4 (p. 2)

Charles Griffin & Company Ltd. London, England. 1947

### King, Willford 1880–1962

American economist and statistician

Archaeologists unearthed today in Babylon a remarkable set of clay tablets recording the minutes of the 1242 annual meeting of the Babylonical Statistical Association.

Consolidating Our Gains

*Journal of the American Statistical Association*, Volume 31, Number 193, March 1936 (p. 2)

### Koshland, Jr., Daniel E. 1920–

American biochemist

Science. I'm afraid, Dr. Noitall, you do not have any understanding of statistics.

Editorial

*Science*, Volume 263, Number 5144, 14 January 1994 (p. 155)

### Kruskal, William 1919–2005

American mathematician and statistician

It is all too easy to notice the statistical sea that supports our thoughts and actions. If that sea loses its buoyancy, it may take a long time to regain the lost support.

Coordination Today: A Disaster or a Disgrace

*The American Statistician*, Volume 37, Number 3, 1983 (p. 179)

What is there about the word “statistics” that so often provokes strained silence?

Statistics, Moliere, and Henry Adams

*American Scientist Magazine* (p. 416)

Statistics is the art of stating in precise terms that which one does not know.

Statistics, Moliere, and Henry Adams

*American Scientist Magazine* (p. 417)

...each of us has been doing statistics all his life, in the sense that each of us has been busily reaching conclusions based on empirical observations ever since birth.

Statistics, Moliere, and Henry Adams

*American Scientist Magazine* (p. 417)

### LaGuardia, Fiorello 1882–1947

American civil servant, congressman, and New York City mayor

Statistics are like alienists — they will testify for either side.

The Banking Investigation

*Liberty*, May 13, 1933

### Lang, Andrew 1844–1912

Scottish scholar and man of letters

He uses statistics as a drunken man uses lamp-posts — for support rather than illumination.

In Evan Esar

*The Dictionary of Humorous Quotations*

Doubleday & Company, Inc. Garden City, New York, USA. 1949

**Lapin, Lawrence**

No biographical data available

Statistics is a body of methods and theory applied to numerical evidence in making decisions in the face of uncertainty.

*Statistics for Modern Business Decisions*

Chapter I (p. 2)

Harcourt Brace Jovanovich, Inc. New York, New York, USA. 1973

**Leacock, Stephen** 1869–1944

Canadian humorist

“I’ve been reading some very interesting statistics,” he was saying to the other thinker.

“Ah, statistics!” said the other, “wonderful things, sir, statistics; very fond of them myself.”

*Literary Lapses*

A Force of Statistics (p. 74)

John Lane. London, England. 1911

**Lewis, Clarence Irving** 1883–1964

American philosopher

...the statistical prediction of the future from the past cannot be generally valid, because whatever is future to any given past, is in turn past for some future. That is, whoever continually revises his judgment of the probability of a statistical generalization by its successively observed verifications and failures, cannot fail to make more successful predictions than if he should disregard the past in his anticipation of the future. This might be called the “Principle of statistical accumulation.”

*Mind and the World-Order: Outline of a Theory of Knowledge*

Chapter XI (p. 386)

Charles Scribner’s Sons. New York, New York, USA. 1929

**Lippmann, Walter** 1889–1974

American journalist and author

The statistical method is of use only to those who have found it out.

*A Preface to Politics*

The Golden Rule and After (p. 92)

M. Kennerley. New York, New York, USA. 1913

Statistics then is no automatic device for measuring facts.

*A Preface to Politics*

The Golden Rule and After (p. 92)

M. Kennerley. New York, New York, USA. 1913

Even the most refined statistics are nothing but abstractions.

*A Preface to Politics*

The Golden Rule and After (pp. 93–94)

M. Kennerley. New York, New York, USA. 1913

...all statistical devices are open to abuse and require constant correction.

*A Preface to Politics*

The Golden Rule and After (p. 91)

M. Kennerley. New York, New York, USA. 1913

**Lloyd George, David, 1<sup>st</sup> Earl of Dwfors** 1863–1945

English prime minister

You can’t feed the hungry on statistics.

Advocating Tariff Reform

Speech 1904

**Longacre, William A.** 1937–

American anthropologist

...statistical techniques are not magical.

Current Thinking in American Archaeology

*Bulletin of the American Anthropological Association*, Volume 3, Number 3, Part 2, 1970 (p. 132)

**Louis, Pierre-Charles-Alexandre** 1787–1872

French physician

As to different methods of treatment, it is possible for us to assure ourselves of the superiority of one or other...by enquiring if the greater number of individuals have been cured by one means than another. Here it is necessary to count. And it is, in great part at least, because hitherto this method has not at all, or rarely been employed, that the science of therapeutics is so uncertain.

Translated by P. Martin

*Essay on Clinical Instruction* (pp. 26, 28)

S. Highley. London, England. 1834

**Ludlum, Robert** 1927–2001

American writer

“There are three major and perhaps a dozen minor rental agencies, not counting the hotels, which we’ve covered separately. These are manageable statistics, but, of course, the garages are not.”

*The Bourne Supremacy*

Chapter 18 (p. 260)

Random House, Inc. New York, New York, USA. 1986

Daniel’s a statistician. He sees numbers — fractions, equations, totals — and they spell out the odds for him. God knows he’s brilliant at it; he’s saved the lives of hundreds with those statistics.

*The Parsifal Mosaic*

Chapter 10 (p. 137)

I don’t believe you. Not because you’re a poor liar, but because it doesn’t conform with the facts. I work with statistics, Mr. Washburn, or Mr. Bourne, or whatever your name is. I respect observable data and I can spot inaccuracies; I’m trained to do that.

*The Bourne Identity*

Chapter 9 (p. 128)

Richard Marek Publishers. New York, New York, USA. 1980

Death is a statistic for the computers.

*The Bourne Identity*

Chapter 29 (p. 401)

Richard Marek Publishers. New York, New York, USA. 1980

**Marshall, Alfred** 1842–1924  
English economist

Statistics are the straw out of which I, like every other economist, have to make the bricks.

In Arthur L. Bowley  
*Elements of Statistics*  
Part I, Chapter I (p. 8)  
P.S. King & Son Ltd. London, England. 1926

**Maxwell, James Clerk** 1831–79  
Scottish physicist

...molecular science teaches us that our experiments can never give us anything more than statistical information, and that no law deduced from them can pretend to absolute precision. But when we pass from the contemplations of our experiment to that of the molecules themselves, we leave the world of chance and change, and enter a region where everything is certain and immutable.

In W.D. Niven (ed.)  
*The Scientific Papers of James Clerk Maxwell* (Volume 2)  
Molecules (p. 374)  
At The University Press. Cambridge, England. 1890

**Meitzen, August** 1822–1910  
German geographer

No statistical judgment deals with the unit, but strictly and only with the aggregate. The variable elements of persons and things otherwise typical, that are enumerated, are always counted in a specific aggregate and under certain specific circumstances. The qualities of the objects themselves, so far as they are not typical, or the subject of the investigation, are completely unknown.

History, Theory and Techniques of Statistics  
*American Academy of Political and Social Sciences*, May 1898 (p. 168)

No matter what the statistical problem may be, it must proceed according to a plan. It is always a specific question which may be answered in several more or less accurate ways. The end in view and the reasoning which can be drawn upon will indicate in which manner and within which limits the answer is to be given. According to the choice made, it may be very simple or very complicated. But under all circumstances a definite plan providing for all the detail is an absolute prerequisite.

History, Theory and Techniques of Statistics  
*American Academy of Political and Social Sciences*, May 1898 (p. 168)

**Meyers, Jr., G. J.**  
No biographical data available

Statistical methods serve as land marks which point to further improvement beyond that deemed obtainable by experienced manufacturing men. Hence, after all obvious correctives have been exhausted and all normal logic indicates no further gain is to be made, statistical methods still point toward a reasonable chance for

yet further gains; thereby giving the man who is doing trouble shooting sufficient courage of his convictions to cause him to continue to the ultimate gain, in spite of expressed opinion on all sides that no such gain exists.

American Society of Mechanical Engineers, Discussion of E.G. Olds, On Some of the Essentials of the Control Chart Analysis  
*Transactions*, Volume 64, July 1942

**Moroney, M. J.**  
American statistician

The organized charity, scrimped and iced,  
O'Reilly, John Boyle

In the name of a cautious, statistical Christ.

*In Bohemia*  
In Bohemia

A statistical analysis, properly conducted, is a delicate dissection of uncertainties, a surgery of suppositions.

*Facts from Figures*  
Statistics Undesirable (p. 3)  
Penguin Books Ltd. Harmondsworth, England. 1951

Historically, Statistics is no more than State Arithmetic, a system of computation by which differences between individuals are eliminated by the taking of an average. It has been used — indeed, still is used — to enable rulers to know just how far they may safely go in picking the pockets of their subjects.

*Facts from Figures*  
Statistics Undesirable (p. 1)  
Penguin Books Ltd. Harmondsworth, England. 1951

If you are young, then I say: Learn something about statistics as soon as you can. Don't dismiss it through ignorance or because it calls for thought... If you are older and already crowned with the laurels of success, see to it that those under your wing who look to you for advice are encouraged to look into this subject. In this way you will show that your arteries are not yet hardened, and you will be able to reap the benefits without doing overmuch work yourself. Whoever you are, if your work calls for the interpretation of data, you may be able to do without statistics, but you won't do as well.

*Facts from Figures*  
Statistics Desirable (p. 463)  
Penguin Books Ltd., Harmondsworth, England. 1951

**Mr. Gregory**  
Fictional character

Well, statistics prove that you're far safer in a modern plane than in a bathtub.

*Charlie Chan at Treasure Island*  
Film (1939)

**Neuman, James R.**  
No biographical data available

Statistics was founded by John Graunt of London, a "haberdasher of small-wares" in a tiny book called



*Natural and Political Observations Made upon the Bills of Mortality.*

*The World of Mathematics* (Volume 3)

Commentary on an Ingenious Army Captain and on a Generous and Many-sided Man (p. 1416)

Simon & Schuster. New York, New York, USA. 1956

**O. Henry (William Sydney Porter)** 1862–10

American short story writer and journalist

His mathematics carried with it a momentary qualm and a lesson. The thought had not occurred to him that the thought could possibly occur to me not to ride at his side on that red road to revenge and justice. It was the higher calculus. I was booked for the trail. I began to eat more beans.

*Tales of O. Henry*

A Technical Error (p. 1059)

Doubleday & Company, Inc. Garden City, New York, USA. 1953

“What you’ve got,” says Idaho, “is statistics, the lowest grade of information that exists. They poison your mind...”

*Tales of O. Henry*

The Handbook of Hymen (p. 113)

Doubleday & Company, Inc. Garden City, New York, USA. 1969

**Orwell, George (Eric Arthur Blair)** 1903–50

English novelist and essayist

The fabulous statistics continued to pour out of the television. As compared with last year there was more food, more clothes, more houses, more furniture, more cooking pots, more fuel, more ships, more helicopters, more books, more babies — more of everything except disease, crime, and insanity.

*Nineteen Eighty-Four*

Part One, Chapter V (p. 59)

Buccaneer Books. Cutchogue, New York, USA. 1949

Statistics were just as much a fantasy in their original version as in their rectified version. A great deal of the time you were expected to make them up out of your head. For example, the Ministry of Plenty’s forecast had estimated the output of boots for the quarter at a hundred and forty-five millions pairs. The actual output was given as sixty-two millions. Winston, however, in rewriting the forecast, marked the figure down to fifty-seven millions, so as to allow for the usual claim that the quota had been overfilled. In any case, sixty-two millions was no nearer the truth than fifty-seven millions, or a hundred and forty-five millions. Very likely no boots had been produced at all. Likelier still, nobody knew how many had been produced, much less cared.

*Nineteen Eighty-Four*

Part One, Chapter IV (pp. 41–42)

Buccaneer Books. Cutchogue, New York, USA. 1949

**Paulos, John Allen** 1945–

American mathematician

It’s been estimated that, because of the exponential growth of the world’s population, between 10 and 20 percent of all the human beings who have ever lived are alive now. If this is so, does this mean that there isn’t enough statistical evidence to conclusively reject the hypothesis of immortality?

*Innumeracy*

5 Statistics, Trade-offs, and Society (p. 99)

Hill & Wang. New York, New York, USA. 1988

**Pearson, E. S.** 1895–1980

English statistician

**Hartley, H. Q.**

No biographical data available

...it is a function of statistical method to emphasize that precise conclusions cannot be drawn from inadequate data.

*Biometrika Tables for Statisticians* (Volume 1) (p. 83)

**Pearson, Karl** 1857–1936

English mathematician

There is much value in the idea of the ultimate laws being statistical laws, though why the fluctuations should be attributed to a Lucretian “Chance”, I cannot say. It is not an exactly dignified conception of the Deity to suppose him occupied solely with first moments and neglecting second and higher moments!

*The History of Statistics in the 17<sup>th</sup> and 18<sup>th</sup> Centuries Against the Changing Background of Intellectual, Scientific, and Religious Thought* (p. 160)

[Florence Nightingale’s] statistics were more than a study, they were indeed her religion. For her Quetelet was the hero as scientist, and the presentation copy of his *Physique sociale* is annotated by her on every page. Florence Nightingale believed — and in all the actions of her life acted upon the belief — that the administrator could only be successful if he were guided by statistical knowledge. The legislator — to say nothing of the politician — too often failed for want of this knowledge.

*Life, Letters and Labours of Francis Galton* (Volume 2) (p. 57)

At The University Press. Cambridge, England. 1914–30

[Florence Nightingale]...held that the universe — including human communities — were evolving in accordance with a divine plan; that it was man’s business to endeavor to understand this plan and guide his actions in sympathy with it. But to understand God’s thoughts, she held we must study statistics, for these are the measure of His purpose. Thus, the study of statistics was for her a religious duty.

*Life, Letters and Labours of Francis Galton* (Volume 2) (p. 57)

At The University Press. Cambridge, England. 1914–30

**Perrin, Jean** 1870–1945

French physicist

It is thus that statistics reveals more and more the incon-  
stancy and the irregularity of much social phenomena,  
when in lieu of applying it to a great nation altogether,  
one descends to a province, a town, a village.

In Mary Jo Nye

*Molecular Reality: A Perspective on the Scientific Work of Jean Perrin*  
(p. 25)

MacDonald. London, England. 1972

**Playfair, William** 1759–1823

English publicist

No study is less alluring or more dry and tedious than  
statistics, unless the mind and imagination are set to, or  
that the person studying is particularly interested in, the  
subject; which last can seldom be the case with young  
men in any rank of life.

*The Statistical Breviary* (p. 16)

J. Wallis. London, England. 1801

Statistical knowledge, though in some degree searched  
after in the most early ages of the world, has not till within  
these last 50 years become a regular object of study.

*The Statistical Breviary*

J. Wallis. London, England. 1801

**Price, Derek John de Solla** 1922–83

English science historian and information scientist

His passion was to count everything and reduce it to  
statistics.

*Little Science, Big Science*

Chapter 2 (p. 33)

Columbia University Press. New York, New York, USA. 1963

**Proschan, Frank**

American statistician

Pronouncing each word with great deliberateness, Rep.  
Resent asked, “Are you now, or have you ever been, a  
member of the American Statistical Association?”

...

Looking Rep. Resent straight in the eye, Minnie defiantly  
replied, “I refuse to answer on the grounds that it might  
incriminate me.”

Investigation of Latin Squares

*Industrial Quality Control*, Volume 11, Number 1, July 1954 (p. 31)

**Puckett, Andrew**

British crime novelist

They were in monthly columns. I added them and then  
compared the two tables. Well, there was a difference, and  
a difference on the right side, more blood packs had been  
separated in the Centre than plasma packs had arrived  
in CPPL, but it wasn't as large as I would have thought.  
I stared at the figures for a moment, then I worked out  
a statistical error rate on them. The difference between

them was not significant; it could be explained by random  
error. Statistics don't lie, not in the right hands.

*Bloodstains* (p. 79)

Doubleday & Company, Inc. Garden City, New York, USA. 1987

For the first five months they were virtually identical, but  
for the past four, they showed an increasing difference!  
With shaking fingers, I worked out a Standard Deviation  
on the sets of totals. There was no doubt: the difference[s]  
between the Centre's and CPPL's totals were significant.  
Statistics don't lie...

*Bloodstains* (p. 80)

Doubleday & Company, Inc. Garden City, New York, USA. 1987

**Puzo, Mario** 1920–99

American novelist and screenwriter

“You got a ninety percent chance,” he said.

Osno said quickly, “How do you get that figure?” He  
always did that whenever somebody pulled a statistic on  
him. He hated statisticians.

*Fools Die: A Novel*

Chapter 24 (p. 270)

Putnam. New York, New York, USA. 1978

**Pynchon, Thomas** 1937–

American novelist

“I'm sorry. That's the Monte Carlo Fallacy. No matter  
how many have fallen inside a particular square, the odds  
remain the same as they always were. Each hit is inde-  
pendent of all the others. Bombs are not dogs. No link.  
No memory. No conditioning.”

*Gravity's Rainbow*

Part 1 (p. 56)

The Viking Press. New York, New York, USA. 1973

That he must always be lovable, in need of her and never,  
as now, the hovering statistical cherub who's never quite  
been to hell but speaks as if he's one of the most fallen.

*Gravity's Rainbow*

Part 1 (p. 57)

The Viking Press. New York, New York, USA. 1973

**Reynolds, H. T.**

No biographical data available

...statistics — whatever their mathematical sophistica-  
tion and elegance — cannot make bad variables into  
good ones.

*Analysis of Nominal Data*

Chapter 1 (p. 8)

Sage Publications. Beverly Hills, California, USA. 1977

**Rogers, Will** 1879–1935

American actor and humorist

Everything is figured out down to a Gnat's tooth accord-  
ing to some kind of statistics.

*The Writings of Will Rogers*

Volume 4-3 (p. 254)

Oklahoma State University Press. Stillwater, Oklahoma, USA. 1973

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

Statistics can provide a ready proof  
For doubtful facts which ought to stay aloof.  
*Encyclopedia of Thoughts*  
Couplets  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Statistics, ideally, are accurate laws about large groups;  
they differ from other laws only in being about groups,  
not about individuals.  
*The Analysis of Matter*  
Chapter XIX (p. 191)  
Harcourt, Brace & Company, Inc. New York, New York, USA. 1927

**Samuels, Ernest** 1903–96  
American biographer and lawyer

No honest historian can take part with — or against —  
the forces he has to study. To him even the extinction of  
the human race should be merely a fact to be grouped  
with other vital statistics.  
In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
Chapter XXX (p. 447)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

Taking for granted that the alternative to art was arith-  
metic, he plunged deep into statistics, fancying that  
education would find the surest bottom there; and the  
study proved the easiest he had ever approached. Even  
the Government volunteered unlimited statistics, endless  
columns of figures, bottomless averages merely for the  
asking. At the Statistical Bureau, Worthington Ford sup-  
plied any material that curiosity could imagine for filling  
the vast gaps of ignorance, and methods for applying the  
plasters of fact.  
In Ernest Samuels (ed.)  
*The Education of Henry Adams*  
Chapter XXIII (p. 351)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1974

**Schölzer, Ludwig** 1735–1809  
No biographical data available

History is statistics in a state of progression; statistics is  
history at a stand.  
Transactions of the Statistical Society of London  
Article II, Footnote on page 72  
*Westminster Review*, Volume 1, Part I, April-August 1838

History is for him continuous statistics, statistics  
stationary history.  
In August Meitzen  
*History, Theory, and Technique of Statistics* (p. 37)  
American Academy of Political Science. Philadelphia, Pennsylvania,  
USA. 1891

**Segal, Erich** 1937–  
American novelist

The emergency room was a madhouse. The stormy holi-  
day roads had yielded more than the statistical expecta-  
tion of traffic accidents.  
*Man, Woman and Child*  
Chapter 26 (p. 191)  
Harper & Row, Publishers. New York, New York, USA. 1980

“How are you, Mrs. Coleman?”  
“Not too bad. How’s yer statistics?”  
*Man, Woman and Child*  
Chapter 1 (p. 8)  
Harper & Row, Publishers. New York, New York, USA. 1980

He turned over on his side and picked up the American  
Journal of Statistics. Better than a sleeping pill. He idly  
leafed through a particularly unoriginal piece on stochastic  
processes, and thought, Christ, I’ve said this stuff a million  
times. And then he realized that he himself was the author.  
*Man, Woman and Child*  
Chapter 5 (p. 42)  
Harper & Row, Publishers. New York, New York, USA. 1980

“I mean, here you are a professor of statistics.”  
“So?”  
“So you have one lousy affair in your whole life.  
For a few lousy days. And you get a kid as evidence.  
Christ, what are the odds of that happening to any-  
body?”  
“Oh,” said Bob bitterly, “about a billion to one.”  
*Man, Woman and Child*  
Chapter 13 (p. 109)  
Harper & Row, Publishers. New York, New York, USA. 1980

“I am Professor Beckworth,” he pronounced in a kind  
of soprano-baritone. “Would you like to ask me some  
statistics, sir?”  
“Yes,” replied Bob. “What are the chances of this damn  
rain stopping today, Professor?”  
“Mmm,” said Jean-Claude, pondering earnestly, “You’ll  
have to see me tomorrow about that.”  
*Man, Woman and Child* (p. 178)  
Harper & Row, Publishers. New York, New York, USA. 1980

**Shapiro, Karl Jay** 1913–2000  
American poet

We ask for no statistics of the killed,  
For nothing political impinges on  
This single Casualty, or all those gone,  
Missing or healing, sinking or dispersed,  
Hundreds of thousands counted, millions lost.  
*Collected Poems 1940–1978*  
Elegy for a Dead Soldier  
Stanza V (p. 90)  
Random House, Inc. New York, New York, USA. 1978

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

Even trained statisticians often fail to appreciate the extent to which statistics are vitiated by the unrecorded assumptions of their interpreters.

*The Doctor's Dilemma*

Preface on Doctors

Statistical Illusions (p. lxii)

Brentano's. New York, New York, USA. 1920

**Smith, Reginald H.** 1889–1966

American lawyer and social activist

Lawyers like words and dislike statistics.

A Sequel: The Bar Is Not Overcrowded

*American Bar Association Journal*, Volume 45, September 1959 (p. 945)

**Spengler, Oswald** 1880–1936

German philosopher

Statistics belong, like chronology, to the domain of the organic, to fluctuating Life, to Destiny and Incident, and not to the world of laws and timeless causality.

*The Decline of the West*

Chapter X (p. 218)

Alfred A. Knopf. New York, New York, USA. 1962

**Stalin, Joseph** 1879–1953

Soviet Russian political leader and general secretary of Communist Party

A single death is a tragedy, a million deaths is a statistic.

Quoted by Anne Fremantle

*The New York Times Book Review*

Unwritten Pages at the End of the Diary, September 28, 1958 (p. 3)

**Stamaty, Mark Alan**

American cartoonist and children's book writer

I propose that infinitely refutable statistics be declared the official language of politics.

Washington

*Time*, September 25, 1995 (p. 21)

**Stamp, Josiah** 1880–1941

English economist and financier

You cannot escape the statistical method, so you may as well make friend with it. You think it is cold and inhuman and impersonal, but, as a matter of fact, it is fuller of red blood and human nature than half the descriptive literature in the world.

*Some Economic Factors in Modern Life*

Chapter VIII (p. 256)

P.S. King & Son Ltd. London, England. 1929

**Stekel, Wilhelm** 1868–1940

Austrian psychoanalyst

Statistics is the art of lying by means of figures.

*Marriage at the Crossroads*

Chapter II (p. 20)

W. Godwin, Inc. New York, New York, USA. 1931

**Sterne, Laurence** 1713–68

English novelist and humorist

It was demonstrated however very satisfactorily, that such a ponderous mass of heterogeneous matter could not be congested and conglomerated to the nose, whilst the infant was *in Utero*, without destroying the statistical balance of the foetus, and throwing it plump upon its head nine months before the time.

*The Life and Opinions of Tristram Shandy, Gentleman, and A Sentimental Journey Through France and Italy* (Volume 1)

Book IV (p. 228)

Macmillan & Company Ltd. London, England. 1900

**Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

Here he comes, big with statistics...

*The Complete Poems of Robert Louis Stevenson*

Troubled and sharp about fac's, LXVI

Charles Scribner's Sons. New York, New York, USA. 1923

**Stigler, Stephen M.** 1941–

American historian and statistician

...elementary statistics texts tell us that the method of least squares was first discovered about 1805. Whether it had one or two or more discoverers can be argued; still the method dates from no later than 1805. We also read that Sir Francis Galton discovered regression about 1885, in studies of heredity. Already we have a puzzle — a modern course in regression analysis is concerned almost entirely with the method of least squares and its variations. How could the core of such a course date from both 1805 and 1885? Is there more than one way a sum of squared deviations can be made small?

*The History of Statistics*

Introduction (p. 2)

Harvard University Press. Cambridge, Massachusetts, USA. 1986

**Stout, Rex** 1886–1975

American writer

There are two kinds of statistics, the kind you look up and the kind you make up.

*Death of a Doxy* (p. 90)

Bantam Book. New York, New York, USA. 1967

Statistics show that seventy-four per cent of wives open letters, with or without a teakettle.

*Death of a Doxy* (p. 120)

Bantam Book. New York, New York, USA. 1967

**Strunsky, Simeon** 1879–1948

American essayist

Statistics are the heart of democracy.

*Topics of The Times*, November 30, 1944

**Tchekhov, Anton** 1860–1904

Russian writer

Everything is quiet, peaceful and against it all is only the silent protest of statistics...

*Tchekhov's Plays and Stories*

Gooseberries

J.M. Dent & Sons Limited. London, England. 1958

### The Editors

To some people, statistics is “quartered pies, cute little battleships and tapering rows of sturdy soldiers in diversified uniforms.” To others, it is columns and columns of numerical facts. Many regard it as a branch of economics. The beginning student of the subject considers it to be largely mathematics.

Statistics, the Physical Sciences and Engineering

*The American Statistician*, Volume 11, Number 4, August 1948

### Thoreau, Henry David 1817–62

American essayist, poet, and practical philosopher

But lo! men have become the tools of their tools.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter I (p. 61)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### Thorn, John 1947–

Sports historian

While he is racing to the hole, the shortstop is figuring: Based on the speed of the runners and how hard the ball is hit, he probably has no chance of a double play; he may have a little chance of a play at second; and he almost certainly has no play at first. He throws to third because the distance from the hole to the bag is short, his calculation of the various probabilities led him to conclude that this was his “percentage play.” Now not so much as a glimmer of any number entered the shortstop’s head in this time, yet he was thinking statistically.

*The Hidden Game of Baseball: A Revolutionary Approach to Baseball and Its Statistics* (p. 5)

Doubleday & Company Inc. Garden City, New York, USA. 1984

### Thurstone, Louis Leon 1887–1955

American psychologist and psychometrician

Factor analysis is useful especially in those domains where basic and fruitful concepts are essentially lacking and where crucial experiments have been difficult to conceive. ... They enable us to make only the crudest first map of a new domain. But if we have scientific intuition and sufficient ingenuity, the rough factorial map of a new domain will enable us to proceed beyond the factorial stage to the more direct form of psychological exploration in the laboratory.

Current Issues in Factor Analysis

*Psychological Bulletin*, Volume 37, April 1940 (p. 189)

It is not wise for a statistician who knows factor analysis to attempt problems in a science which he has not himself mastered.

Current Issues in Factor Analysis

*Psychological Bulletin*, Volume 37, April 1940 (p. 235)

### Trollope, Anthony 1815–82

English novelist

We have no statistics to tell us whether there be any such disproportion in class where men do not die early from overwork.

*The Eustace Diamond* (Volume 1)

Chapter XXIV (p. 223)

Oxford University Press, Inc. London, England. 1973

As one of the legislators of the country I am prepared to state that statistics are always false.

*The Eustace Diamond* (Volume 1)

Chapter XXIV (p. 223)

Oxford University Press, Inc. London, England. 1973

### Tukey, John W. 1915–2000

American statistician

A sort of question that is inevitable is: “someone taught my students exploratory, and now (boo hoo) they want me to tell them how to assess significance or confidence for all these unusual functions of the data. (Oh, what can we do?)” To this there is an easy answer: TEACH them the JACKKNIFE.

*The American Statistician*, Volume 34, Number 1, February 1980 (p. 25)

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American author and humorist

Personally, I never care for fiction or story-books. What I like to read about are facts and statistics of any kind.

In Rudyard Kipling

*From Sea to Sea*

An Interview with Mark Twain

Macmillan & Company Ltd. London, England. 1900

Sometimes, half a dozen figures will reveal, as with a lighting-flash, the importance of a subject which ten thousand labored words with the same purpose in view, had left at last but dim and uncertain.

*Life on the Mississippi*

Chapter XXVIII (p. 241)

Harper & Row, Publishers. New York, New York, USA. 1951

July 4. Statistics show that we lose more fools on this day than in all the other days of the year put together.

*Pudd'nhead Wilson*

Chapter XVII (p. 164)

Harper & Brothers Publishers. New York, New York, USA. 1904

I was deducing from the above that I have been slowing down steadily in these thirty-six years, but I perceive that my statistics have a defect: 3,000 words in the spring of 1868, when I was working seven or eight or nine hours at a sitting, has little or no advantage over the sitting of today, covering half the time and producing

half the output. Figures often beguile me, particularly when I have the arranging of them myself; in which case the remark attributed to Disraeli would often apply with justice and force:

“There are three kinds of lies: lies, damned lies, and statistics.”

In Albert Bigelow Paine (ed.)

*Mark Twain's Autobiography* (Volume 1)

Chapters Added in Florence (p. 246)

Harper & Brothers Publishers. New York, New York, USA. 1924

**van der Post, Laurens** 1906–96

Afrikaner author

Thinking has its place...but, only when one is confronted with known facts and statistics. When you're in the unknown and the dark...you surrender your thinking in trust to the feelings that come to you out of the bush.

*A Far-Off Place*

Chapter 9 (p. 183)

The Hogarth Press. London, England. 1974

**von Mises, Richard** 1883–1953

Austrian-born American mathematician

The problems of statistical physics are of the greatest in our time, since they lead to a revolutionary change in our whole conception of the universe.

*Probability, Statistics, and Truth*

Sixth Lecture (p. 219)

Dover Publications, Inc. New York, New York, USA. 1981

**Walcott, Derek** 1930–

West Indian dramatist and poet

Statistics justify and scholars seize

The salients of colonial policy.

*Collected Poems*

A Far Cry from Africa, l. 7–8

Farrar, Straus & Giroux. New York, New York, USA. 1986

**Walker, Marshall John**

American physicist

Statistics provides a quantitative example of the scientific process usually described qualitatively by saying that scientists observe nature, study the measurements, postulate models to predict new measurements, and validate the model by the success of prediction.

*The Nature of Scientific Thought*

Chapter IV (p. 46)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

Mathematical statistics provides an exceptionally clear example of the relationship between mathematics and the external world. The external world provides the experimentally measured distribution curve; mathematics provides the equation (the mathematical model) that corresponds to the empirical curve. The statistician may be guided by a thought experiment in finding the corresponding equation.

*The Nature of Scientific Thought*

Chapter IV (p. 50)

Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

**Wang, Chamont** 1949–

American statistician

Statistics has been called a science. It is said to connect its facts by a chain of causation: if it did so, it would be a science, though even then not a distinct and separate science. But the observations of astronomy may be called the science of astronomy as properly as statistics may be denominated a science. No mere record and arrangement of facts can constitute a science.

Transactions of the Statistical Society of London, Art II

*Westminster Review*, Volume I, Part I, 1838 (p. 69)

As a matter of fact, the whole notion of “statistical inference” often is more of a plague and less of a blessing to research workers.

*Sense and Nonsense of Statistical Inference: Controversy, Misuse, and Subtlety*

Chapter 2 (p. 29)

Marcel Dekker. New York, New York, USA. 1993

But statistics is not a science, and cannot be one. Studied as the statistical council have decreed statistics shall be studied, no department of human knowledge ever could become a science — a collection of theories — because they have put their veto on theorizing. But statistics is not even a department of human knowledge; it is merely a form of knowledge — a mode of arranging and stating facts which belong to various sciences.

Transactions of the Statistical Society of London, Art II

*Westminster Review*, Volume I, Part I, 1838 (p. 70)

**Waugh, Evelyn** 1903–66

English author of satirical novels

O god thou has appointed three score years and ten as man's allotted span but O god statistics go to prove that comparatively few ever attain that age...

In Mark Amory

*The Letters of Evelyn Waugh*

Letter to Laura Herbert, dated October 1935 (p. 99)

Weidenfeld & Nicolson. London, England. 1980

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian and sociologist

Satan delights equally in statistics and in quoting scripture.

*The Undying Fire*

Chapter the First Section 3 (p. 9)

The Macmillan Company. New York, New York, USA. 1919

Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write.

In Warren Weaver

Statistics

*Scientific American*, Volume 186, Number 1, January 1952 (p. 60)

**White, William Frank** 1872–1952

No biographical data available

Just as data gathered by an incompetent observer are worthless — or by a biased observer, unless the bias can be measured and eliminated from the result — so also conclusions obtained from even the best data by one unacquainted with the principles of statistics must be of doubtful value.

*A Scrap-Book of Elementary Mathematics: Notes, Recreations, Essays*  
The Mathematical Treatment of Statistics (p. 156)  
The Open Court Publishing Company. La Salle, Illinois, USA. 1942

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

There is a curious misconception that somehow the mathematical mysteries of Statistics help Positivism to evade its proper limitation to the observed past. But statistics tell you nothing about the future unless you make the assumption of the permanence of statistical form. For example, in order to use statistics for prediction, assumptions are wanted as to the stability of the mean, the mode, the probable error, and the symmetry or skewness of the statistical expression of functional correlation.

*Adventures of Ideas*  
Chapter VIII (p. 161)  
The Macmillan Company. New York, New York, USA. 1956

**Wigner, Eugene Paul** 1902–95

Hungarian-born American physicist

With classical thermodynamics, one can calculate almost everything crudely; with kinetic theory, one can calculate fewer things, but more accurately; and with statistical mechanics, one can calculate almost nothing exactly.

In Edward B. Stuart, Benjamin Gal-Or, and Alan J. Brainard (eds.)  
*A Critical Review of Thermodynamics* (p. 205)  
Publisher undetermined

**Wilson, Edwin B.** 1879–1964

American statistician

Figures may not lie, but statistics compiled unscientifically and analyzed incompetently are almost sure to be misleading, and when this condition is unnecessarily chronic the so-called statisticians may be called liars.

*Bulletin of the American Mathematical Society*, Volume 18, 1912

**Wolfowitz, J.** 1910–

No biographical data available

Except perhaps for a few of the deepest theorems, and perhaps not even these, most of the theorems of statistics would not survive in mathematics if the subject of statistics itself were to die out. In order to survive the subject must be more responsive to the needs of application.

In R.C. Bose and others (eds.)  
*Essays In Probability and Statistics* (p. 748)  
University of North Carolina Press. Chapel Hill, North Carolina, USA. 1970

**Wonnacott, Ronald J.**

No biographical data available

“Those Platonists are a curse.” he said,  
“God’s fire upon the wan,  
A diagram hung there instead,  
More women born than men.”

*The Collected Poems of W.B. Yeats*  
Statistics  
The Macmillan Company. New York, New York, USA. 1940

**Yates, Frances** 1899–1981

English historian

It is very easy to devise different tests which, on the average, have similar properties, ...they behave satisfactorily when the null hypothesis is true and have approximately the same power of detecting departures from that hypothesis. Two such tests may, however, give very different results when applied to a given set of data. The situation leads to a good deal of contention amongst statisticians and much discredit of the science of statistics. The appalling position can easily arise in which one can get any answer one wants if only one goes around to a large enough number of statisticians.

Discussion on the Paper by Dr. Box and Dr. Andersen  
*Journal of the Royal Statistical Society*, Series B, Volume 17, 1955 (p. 31)

**STATISTICS AND MEDICINE**

**Bernard, Claude** 1813–78

French physiologist

[S]tatistics...are given a great role in medicine, and they therefore raise a medical question which we should examine here. The first requirement in using statistics is that the facts treated shall be reduced to comparable units. Now this is very often not the case in medicine. Everyone familiar with hospitals knows what errors may mark the definitions on which statistics are based. The names of diseases are very often given are haphazard, either because the diagnosis is obscure, or because the cause of death is carelessly recorded by a student who has not seen the patient, or by an employee unfamiliar with medicine. For this reason pathological statistics can be valid only when compiled from data collected by the statistician himself.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter II, Section ix (p. 136)  
Henry Schuman, Inc. New York, New York, USA. 1927

...the goal of scientific physicians...is to reduce the indeterminate. Statistics therefore apply only to cases in which the cause of the facts observed is still indeterminate.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Two, Chapter II, Section IX (p. 139)  
Henry Schuman, Inc. New York, New York, USA. 1927

When a physician is called to a patient, he should decide on the diagnosis, then the prognosis, and then the treatment. . . . Physicians must know the evolution of the disease, its duration and gravity in order to predict its course and outcome. Here statistics intervene to guide physicians, by teaching them the proportion of mortal cases; and if observation has also shown that the successful and unsuccessful cases can be recognized by certain signs, then the prognosis is more certain.

Translated by Henry Copley Greene

*An Introduction to the Study of Experimental Medicine*

Part Three, Chapter IV, Section III (p. 213)

Henry Schuman, Inc. New York, New York, USA. 1927

**Blane, Gilbert Sir** 1749–1834

Scottish physician

There is...a great difficulty attending all practical inquiries in medicine; for in order to ascertain truth, in a manner that is satisfactory to a mind habituated to chaste investigation, there must be a series of patient and attentive observations upon a great number of cases, and the different trials must be varied, weighed, and compared, in order to form a proper estimate of the real efficacy of different remedies and modes of treatment.

*Observations on the Diseases Incident to Seamen* (p. ix)

Joseph Cooper. London, England. 1785

**Fenger, Carl Emil** 1814–84

Danish physician and politician

The use of the numerical method in medicine is not essentially new. From the time of Hippocrates to our day any doctor would say that this symptom is rare in a particular disease, but that one common; that this cause is more common than that one; that this treatment cures more patients than that one. All these expressions rare, common, more, etc. are indeterminate numerical expressions and presuppose a count, be it methodical or not.

Om den numeriske metode

*Ugeskr Laeger*, Volume 1, 1839

**Salsburg, David S.**

No biographical data available

After 17 years of interacting with physicians, I have come to realize that many of them are adherents of a religion they call Statistics. Statistics refers to the seeking out and interpretation of p values. Like any good religion, it involves vague mysteries capable of contradictory and irrational interpretation. It has a priesthood and a class of mendicant friars. And it provides Salvation: Proper invocation of the religious dogmas of Statistics will result in publication in prestigious journals.

The Religion of Statistics as Practiced in Medical Journals

*The American Statistician*, Volume 39, Number 3, August 1985 (p. 220)

**STATISTICS AND SOCIETY**

**Boorstin, Daniel J.** 1914–2004

American historian

The science of statistics is the chief instrumentality through which the progress of civilization is now measured and by which its development hereafter will be largely controlled.

*The Decline of Radicalism*

Chapter I (p. 8)

Random House, Inc. New York, New York, USA. 1969

**Coats, R. H.**

Beginning softly, statistics has long been handmaid to these exact sciences, apprenticed in the scullery, but now risen housekeeper, eating with the family.

Science and Society

*Journal of the American Statistical Association*, Volume 34, Number 205, March 1939 (p. 3)

**Devons, Ely** 1913–67

English economist

What more tempting facade of rationality than the portrayal of some statistics that seem to point to policy in one direction rather than another?

*Essays in Economics*

Chapter 7 (p. 134)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

No Chancellor of the Exchequer could introduce his proposals for monetary and fiscal policy in the House of Commons by saying “I have looked at all the forecasts, some go one way, some another; so I decided to toss a coin and assume inflationary tendencies if it came down heads and deflationary if it came down tails....” And statistics, however uncertain, can apparently provide some basis.

*Essays in Economics*

Chapter 7 (p. 134)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

...there seems to be striking similarities between the role of economic statistics in our society and some of the functions which magic and divination play in primitive society.

*Essays in Economics*

Chapter 7 (p. 135)

Greenwood Press, Publishers, Westport, Connecticut, USA. 1961

**Kline, Morris** 1908–92

American mathematics professor and writer

The Mathematical Theory of Ignorance: The Statistical Approach to the Study of Man

*Mathematics in Western Culture*

Title to Chapter XXII

Oxford University Press, Inc. New York, New York, USA. 1953



**Lippmann, Walter** 1889–1974  
American journalist and author

You and I are forever at the mercy of the census-taker and the census maker. That impertinent fellow who goes from house to house is one of the real masters of the statistical situation. The other is the man who organizes the results.

*A Preface to Politics*  
The Golden Rule and After (p. 92)  
M. Kennerley. New York, New York, USA. 1913

**Ramsey, James B.**  
No biographical data available

The political practice of citing only agreeable statistics can never settle economic arguments.

*Economic Forecasting — Models or Markets?: An Introduction to the Role of Econometrics in Economic Policy* (p. 77)  
Institute of Economic Affairs. London, England. 1977

**Robinson, Lewis Newton**  
No biographical data available

In this country the statistical side of criminology is very imperfectly developed, and while the same cannot be said with equal force of other English-speaking countries, it yet remains true that the statistical terminology of this social science is characterized, so far as the English language is concerned, by great vagueness and uncertainty.

*History and Organization of Criminal Statistics in the United States*  
Chapter I (p. 1)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

**Rogers, Will** 1879–1935  
American actor and humorist

The government keeps statistics on every known thing. But there is yet to be a statistics on how many laws we are living under.

*The Writings of Will Rogers*  
Volume 4-1 (p. 167)  
Oklahoma State University Press. Stillwater, Oklahoma, USA. 1973

**Smith, Logan Pearsall** 1865–1946  
American author

For I am one of the unpraised, unrewarded millions without whom Statistics would be a bankrupt science. It is we who are born, who marry, who die, in constant ratios.

*Trivia*  
Book II, Where Do I Come In? (p. 106)  
Doubleday, Page & Company. Garden City, New York, USA. 1917

## STETHOSCOPE

**Byford, W. H.** 1817–90  
No biographical data available

The flexible stethoscope is a very handy instrument to relieve us from a fatiguing and not very delicate posture.

Advantages of the Prone Position in Examining the Foetal Circulation as a Diagnostic Sign of Pregnancy  
*Chicago Medical Journal*, Volume 15, 1858

**Laennec, René-Théophile-Hyacinthe** 1781–1826  
French physician

I had not imagined it would be necessary to give a name to such a simple device, but others thought differently. If one wants to give it a name, the most suitable would be “stethoscope.”

*Traité de l'Auscultation Médiate*  
Volume 1 (p. 11)  
J.A. Brosson & J.S. Chaude. Paris, France. 1819

**Stokes W.**  
No biographical data available

The stethoscope is an instrument, not, as some represent it, the bagatelle of a day, the brain-born fancy of some speculative enthusiast, the use of which, like the universal medicine of animal magnetism, will be soon forgotten, or remembered only to be ridiculed. It is one of those rich and splendid gifts which Science now and then bestows upon her most favored votaries, which, while they extended our views and open to us wide and fruitful fields of inquiry, confer in the meantime the richest benefits and blessings on mankind.

*An Introduction to the Use of the Stethoscope*  
Machlachlan & Stewart. Edinburgh, Scotland. 1825

## STOMACH

**Athenaeus** ca. 200  
Greek writer

Every investigation which is guided by principles of Nature fixes its ultimate aim entirely on gratifying the Stomach.

*The Deipnosophists*  
VII

## STONE

**Linnaeus, Carl (von Linné)** 1707–78  
Swedish botanist and explorer

My mind reels when, on this height, I look down on the long ages that have flowed by like waves in the sound and have left traces of the ancient world, traces so nearly obscured that they can only whisper now that everything else has been silenced.

In A.G. Nathorst  
*Annual Report of the Board of Regents of the Smithsonian Institution, 1908*  
Carl von Linné as a Geologist (p. 738)  
Government Printing Office. Washington, D.C. 1909

**Parkinson, Cornelia**  
No biographical data available

Was it a flash of divine insight, or the slower process of observation and deduction, that led human beings to perceive [an] esoteric quality in stones? They saw beauty in the sunrise; but the sun became blinding by midday. There was color in leaves and flowers, until they withered. Water sparkled, but it could not be worn for long. Of all the natural wonders of the earth, only the stones endured. They must indeed be magical; and those who possess magical things can sometimes put to work the magic in them.

*Gem Magic: The Wonder of Your Birthstone*  
Ballentine Books. New York, New York, USA. 1988

## STORM

**Conrad, Joseph** 1857–1924

Polish-born English novelist

An earthquake, a landslide, an avalanche, overtake a man incidentally, as it were — without passion. A furious gale attacks him like a personal enemy, tries to grasp his limbs, fastens upon his mind, seeks to rout his very spirit out of him.

*Typhoon*  
Chapter X (p. 77)  
Doubleday, Page & Company. Garden City, New York, USA. 1920

**Muir, John** 1838–1914

American naturalist

Even the storms are friendly and seem to regard you as a brother, their beauty and tremendous fateful earnestness charming alike.

*Our National Parks*  
Chapter IV (p. 99)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## STRATIGRAPHY

**Brown, Hugh Auchincloss** 1878–1975

Electrical engineer

Each single layer of earth  
Tells a story that's all its own;  
The sands of the ancient beaches  
Have changed into strata of stone.

*Cataclysms of the Earth*  
The Earth Is a Great Stone Book (p. 275)  
Twayne Publishers. New York, New York, USA. 1967

**Chandler, Mary**

No biographical data available

The shatter'd Rocks and Strata seem to say,  
"Nature is old, and tends to her Decay":  
Yet, lovely in Decay and green in Age,  
Her Beauty lasts to her latest Stage.

In Robert Arnold Aubin  
*Topographical Poetry in XVIII Century England*

Chapter IV (p. 164)

The Modern Language Association of America. New York, New York, USA. 1936

**Savage, D. E.**

American paleontologist

The fossil-mammal worker accepts that many mammals, marine or nonmarine, contributed fossils which are admirable tools for paleontologic stratigraphy and geochronology, and especially for age-magnitude correlations from continent to continent.

In E. Kauffman and J.E. Hazel (eds.)  
*Concepts and Methods of Biostratigraphy*  
Aspects of Vertebrate Paleontological Stratigraphy and Geochronology  
Dowden, Hutchinson & Ross. Stroudsburg, Pennsylvania, USA. 1977

**Shaw, Alan**

No biographical data available

Preoccupation with the unattainable is a stultifying approach to any problem. Practical paleontology cannot be concerned with any of the fossils we cannot find. Geologically, we can only be interested in finding the total stratigraphic range through which a species is preserved. While the life and death of millions of unrepresented individuals is of theoretical interest, we cannot gain practically useful information from them.

*Time in Stratigraphy*  
Chapter 17 (p. 103)  
McGraw-Hill Book Company. New York, New York, USA. 1964

## STREAM

**Muir, John** 1838–1914

American naturalist

...silvery branches interlacing on a thousand mountains,  
singing their way home to the sea...

*Our National Parks*  
Chapter VIII (p. 241)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...ungovernable energy, rushing down smooth inclines  
in wide foamy sheets fold over fold, springing up here  
and there in magnificent whirls, scattering crisp clashing  
spray for the sunbeams to iris, bursting with hoarse reverberating  
roar through ragged gorges and boulder dams,  
booming in falls, gliding, glancing with cool soothing,  
murmuring...

*Our National Parks*  
Chapter VIII (p. 242)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

## STREPTOMYCIN

**Waksman, Selman A.** 1888–1973

Ukrainian-born American biochemist

The highest scientific award and honor presented to me the day before yesterday gives me the opportunity to summarize briefly the discovery and utilization of streptomycin for disease control, notably in the treatment of tuberculosis, the “Great White Plague” of man.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1952

Streptomycin: Background, Isolation, Properties, and Utilization (p. 370)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## STRING THEORY

### Amati, Danielle

Italian physicist

String theory is twenty-first century physics that fell accidentally into the twentieth century.

*Attributed*

### Ferris, Timothy 1944–

American science writer

The odd thing about string theory was very odd indeed. It required that the universe have at least ten dimensions. As we live in a universe of only four dimensions, the theory postulated that the other dimensions...had collapsed into structures so tiny that we do not notice them.

*Coming of Age in the Milky Way*

Chapter 16 (p. 331)

William Morrow & Company, Inc. New York, New York, USA. 1988

## STRUCTURE

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

It is much more important for a naturalist to understand the structure of a few animals than to command the whole field of scientific nomenclature.

In Burt G. Wilder

Louis Agassiz, Teacher

*The Harvard Graduate's Magazine*, June, 1907

### Clark, R. B. 1923–

Zoologist

It is an indispensable principle that structure must be considered in relation to function; in isolation it is meaningless.

*Dynamics in Metazoan Evolution: The Origin of the Coelom and Segments*

Conclusion (p. 260)

Clarendon Press. Oxford, England. 1964

## STUDENT

### Kleiner, Israel 1948–

Ukrainian-born author

Can we not at least have a better appreciation of students' difficulties...having witnessed mathematicians of the first rank make mistakes, “prove” erroneous theorems, and often come to the right conclusions for insufficient or invalid reasons?

Thinking the Unthinkable: The Story of Complex Numbers (with a Moral)

*Mathematics Teacher*, October 1988

### Osler, Sir William 1849–1919

Canadian physician and professor of medicine

Learn to love the freedom of the student life, only too quickly to pass away; the absence of the coarser cares of after days, the joy in comradeship, the delight in new work, the happiness in knowing that you are making progress. Once only can you enjoy these pleasures.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Master-Word in Medicine (p. 362)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

## STUDY

### Agassiz, Jean Louis Rodolphe 1807–73

Swiss-born American naturalist, geologist, and teacher

Lay aside all conceit. Learn to read the book of nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search.

In David Stair Jordan

*Popular Science Monthly*, Volume 40, 1891/92

### Bacon, Sir Francis 1561–1626

English lawyer, statesman, and essayist

Studies serve for delight, for ornament, and for ability.

In C.W. Eliot (ed.)

*The Harvard Classics*, Volume 3

Of Studies

P.F. Collier & Son. New York, New York, USA. 1909–10

### Einstein, Albert 1879–1955

German-born physicist

Never regard your study as a duty, but as the enviable opportunity to learn to know the liberating influence of beauty in the realm of the spirit for your own personal joy and to the profit of the community to which your later work belongs.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives* (p. 96)

Princeton University Press. Princeton, New Jersey, USA. 1979

### Platt, John R.

No biographical data available

We praise the “lifetime of study,” but in dozens of cases, in every field, what was needed was not a lifetime but

rather a few short months or weeks of analytical inductive inference. In any new area we should try, like Roentgen, to see how fast we can pass from the general survey to analytical inductive inference. We should try, like Pasteur, to see whether we can reach strong inferences that encyclopedism could not discern.

Strong Inference

*Science*, Volume 146, Number 3641, 16 October 1964 (p. 251)

**Rowland, Henry Augustus** 1848–1901

American physicist

The whole universe is before us to study. The greatest labor of the greatest minds has only given us a few pearls; and yet the limitless ocean, with its hidden depths filled with diamonds and precious stones, is before us. The problem of the universe is yet unsolved, and the mystery involved in one single atom yet eludes us. The field of research only opens wider and wider as we advance, and our minds are lost in wonder and astonishment at the grandeur and beauty unfolded before us.

*The Physical Papers of Henry Augustus Rowland*

A Plea for Pure Science (p. 613)

Johns Hopkins Press. Baltimore, Maryland, USA. 1902

**Skinner, B. F. (Burrhus Frederick)** 1904–90

American psychologist

When you run into something interesting, drop everything else and study it.

*Cumulative Record*

A Case History in Scientific Method (p. 81)

Appleton-Century-Crofts, Inc. New York, New York, USA. 1959

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935

Russian research scientist

To place one's feet on the soil of asteroids, to lift a stone from the moon with your hand, to construct moving stations in ether space, to organize inhabited rings around Earth, moon and sun, to observe Mars at the distance of several tens of miles, to descend to its satellites or even to its own surface — what could be more insane! However, only at such a time when reactive devices are applied, will a great new era begin in astronomy: the era of more intensive study of the heavens.

In M.K. Tikhonravov (ed.)

*Works on Rocket Technology*

The Investigation of Universal Space by Means of Reactive Devices

(p. 95)

Publisher undetermined

**von Goethe, Johann Wolfgang** 1749–1832

German poet, novelist, playwright, and natural philosopher

The universe is a harmonious whole, each creature is but a note, a shade of a great harmony, which man must study in its entirety and greatness, lest each detail should remain a dead letter.

Letter to C.L. Knebel, November 17, 1784

## STUPIDITY

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

I am an Evolutionist, not a Multiplicationist. It seems rather stupid to keep doing the same thing over and over again.

*The Nature of the Physical World*

Chapter IV (p. 86)

The Macmillan Company. New York, New York, USA. 1930

**Einstein, Albert** 1879–1955

German-American physicist

Everyone has to sacrifice at the altar of stupidity from time to time, to please the Deity and the human race.

In Max Born

*The Born–Einstein Letters: Correspondence Between Albert Einstein and Max and Hedwig Born from 1916 to 1955*

Letter 219 September, 1920 (p. 35)

Walker & Company. New York, New York, USA. 1971

**Levi, Primo** 1919–87

Italian writer and chemist

To accuse another of having weak kidneys, lungs, or heart, is not a crime; on the contrary, saying he has a weak brain is a crime. To be considered stupid and to be told so is more painful than being called gluttonous, mendacious, violent, lascivious, lazy, cowardly: every weakness, every vice, has found its defenders, its rhetoric, its ennoblement and exaltation, but stupidity hasn't.

*Other People's Trades*

The Irritable Chess-Players

Summit Books. New York, New York, USA. 1989

## SUBSTANCE

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...we now know that there is, in principle, no permanence in substance; it is mere bottled energy, and possesses no more inherent permanence than bottled beer...

*Physics and Philosophy*

Chapter II (p. 41)

Dover Publications, Inc. New York, New York, USA. 1981

## SUBTERRANEAN

**Clarke, John**

No biographical data available

Beneath the earth likewise there are laws of nature, less familiar to us, but no less fixed. Be assured that there exists below everything that you see above. There, too, there are antres vast, immense recesses, and vacant spaces, with mountains overhanging on either hand.

There are yawning gulfs stretching down into the abyss, which have buried in their depths their mighty ruins. These retreats are filled with air, for nowhere is there a vacuum in nature; through their ample spaces stretch marshes over which darkness ever broods. Animals also are produced in them, but they are slow-paced and shapeless; the air that conceived them is dark and clammy, the waters are torpid through inaction.

*Physical Science in the Time of Nero, Being a Translation of the *Quaestiones Naturales* of Seneca*

Book III, Chapter XVI (pp. 128–129)

Macmillan & Company Ltd. London, England. 1910

**Cloos, Hans** 1885–1951

German geologist

A subterranean landscape is the ramified labyrinth of crevices and caves, of pores and seams, through which the trolls and earth-sprites climb up and down.

*Conversations with the Earth*

Chapter IV (p. 48)

Alfred A. Knopf. New York, New York, USA. 1953

**Deetz, James** 1930–2000

American archaeologist

Archaeology by its formal etymology, is the study of the old; and the old, more often than not, is buried. As a result, archaeologists have traditionally been concerned with the subterranean world. Like Lewis Carroll's Alice, they are confronted with the curious underground world, and attempt to understand and explain it.

In James Deetz (ed.)

*Man's Imprint from the Past: Readings in the Methods of Archaeology*

Chapter 1 (p. 4)

Little, Brown & Company. Boston, Massachusetts, USA. 1971

## SUN

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

Several billion trillion tons of super hot exploding hydrogen nuclei rose slowly above the horizon and managed to look small, cold and slightly damp.

*The Ultimate Hitchhiker's Guide to the Galaxy*

Life, the Universe, and Everything

Chapter 7 (p. 349)

Ballantine Books. New York, New York, USA. 2002

**Allen, Woody** 1935–

American film director and actor

The sun, which is made of gas, can explode at any moment, sending our entire planetary system hurtling to destruction; students are advised what the average citizen can do in such a case.

*Getting Even*

Spring Bulletin (p. 58–59)

Random House, Inc. New York, New York, USA. 1971

**Bailey, Philip James** 1816–1902

English poet

The sun, bright keystone of Heaven's world-built arch...

*Festus: A Poem*

Scene 1 (p. 32)

George Routledge & Sons, Ltd. London, England. 1893

**Bourdillon, Francis William**

The night has a thousand eyes,

And the day but one;

Yet the light of the bright world dies,

With the dying Sun.

*Among the Flowers, and Other Poems*

The Night Has a Thousand Eyes

Marcus Ward & Company. London, England. 1878

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

Since a time so remote that imagination falters in the attempt to conceive it, the sun has mothered her brood of planets.

*Autobiography of Earth*

Chapter V (p. 133)

Coward-McCann, Inc. New York, New York, USA. 1935

**Cook, J. Gordon** 1916–

No biographical data available

The darkness of night is dissolving in light that flows steadily across the sky. Over the eastern horizon a curved shoulder of fire appears; our sun has arrived, bringing with it another day of glorious light.

*We Live by the Sun*

Chapter 2 (p. 18)

The Dial Press. New York, New York, USA. 1957

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

Since the newness of the hypotheses of this work — which sets the earth in motion and puts an immovable sun at the centre of the universe — has already received a great deal of publicity, I have no doubt that certain of the savants have taken grave offense and think it wrong to raise any disturbance among liberal disciplines which have had the right set-up for a long time now.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Introduction, to the Reader Concerning the Hypothesis of this Work (p. 505)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

In the center of all rests the sun. For who would place this lamp of a very beautiful temple in another or better place than this wherefrom it can illuminate everything at the same time? As a matter of fact, not unhappily do some call it the lantern; others, the mind and still others, the

pilot of the world. Trismegistus calls it a “visible god”; Sophocles’ Electra, “that which gazes upon all things.” And so the sun, as if resting on a kingly throne, governs the family of stars which wheel around.

In *Great Books of the Western World* (Volume 16)  
*On the Revolutions of the Heavenly Spheres*  
Book One, Chapter 10 (pp. 526–528)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Crane, Stephen** 1871–1900  
American writer

The sun was pasted in the sky like a wafer.

*The Red Badge of Courage*  
IX (p. 115)  
Random House, Inc. New York, New York, USA. 1925

**Crosby, Harry** 1898–1929  
American financial heir, bon vivant, and poet

The Sun! The Sun! a fish in the aquarium of sky or golden net to snare the butterfly of soul or else the hole through which stars have disappeared...

*Sun Rhapsody*  
Six Poems 1928  
Publisher undetermined

**de Fontenelle, Bernard le Bovier** 1657–1757  
French author

Our sun enlightens the planets that belong to him; why may not every fixed star also have planets to which they give light?

*Conversations on the Plurality of Worlds*  
The Fifth Evening (p. 151)  
Printed for Peter Wilson. Dublin, Ireland. 1761

**Deutsch, Armin J.** 1918–1969  
American astronomer and science fiction writer

The face of the sun is not without expression, but it tells us precious little of what is in its heart.

The Sun  
*Scientific American*, Volume 179, Number 5, November 1948 (p. 38)

**Dryden, John** 1631–1700  
English poet, dramatist, and literary critic

The glorious lamp of heaven, the radiant sun,  
Is Nature’s eye...

*The Poetical Works of Dryden*  
The Fable of Acis, Polyphemus, and Galatea from the Thirteenth Book of Ovid’s *Metamorphoses* (p. 405)  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

And since the vernal equinox, the sun  
In Aries twelve degrees, or more, had run.

*The Poetical Works of Dryden*  
The Cock and the Fox, I. 448–449  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

Behold him setting in his western skies,  
The shadows lengthening as the vapours rise.

*The Poetical Works of Dryden*

Absalom and Achitophel  
Part I, l. 268  
The Riverside Press. Cambridge, Massachusetts, USA. 1949

**Ehrlich, Gretel** 1946–  
American travel writer, novelist, and essayist

We forget that our sun is only a star destined to someday burn out. The time scale of its transience so far exceeds our human one that our unconditional dependence on its life-giving properties feels oddly like an indiscretion we’d rather forget.

*The Solace of Open Spaces*  
To Live in Two Worlds (p. 105)  
Penguin Books. New York, New York, USA. 1986

**Eudoxus of Cnidus** ca. 400 BCE–ca. 350 BCE  
Greek astronomer, mathematician, and physician

Willingly would I burn to death like Phaeton, were this the price for reaching the sun and learning its shape, its size, and its substance.

In Carl B. Boyer  
*A History of Mathematics* (p. 91)  
John Wiley & Sons, Inc. New York, New York, USA. 1968

**Falconer, William** 1744–1824  
Poet

High in his chariot glow’d the lamp of day.

*The Shipwreck*  
Canto I, III, l. 3

**Flammarion, Camille** 1842–1925  
French astronomer and author

Dazzling source of light and heat, of motion, life, and beauty, the inimitable sun has in all ages received the earnest and grateful homage of mortals. The ignorant admire it because they feel the effects of its power and its value; the savant appreciates it because he has learned its unique importance in the system of the world; the artist salutes it because he sees in its splendor the virtual cause of all harmonies.

*Popular Astronomy: A General Description of the Heavens*  
Book III, Chapter I (p. 207)  
Chatto & Windus. London, England. 1894

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

The doctrine of the movement of the earth and the fixity of the sun is condemned on the ground that the Scriptures speak in many places of the sun moving and the earth standing still. The Scriptures not being capable of lying or erring, it followeth that the position of those is erroneous and heretical who maintain that the sun is fixed and the earth in motion.

*The Authority of Scripture in Philosophical Controversies*  
Section I  
The Defenders of Fallacy

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

The Sun, whose rays  
Are all ablaze  
With ever-living glory,

Does not deny  
His majesty —

He scorns to tell a story!

*The Complete Plays of Gilbert and Sullivan*

The Mikado

Act II (p. 322)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Heraclitus** 540 BCE–480 BCE  
Greek philosopher

The sun...is new each day.

In G.S Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 228 (p. 202)

At the University Press. Cambridge, England. 1963

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

Now, if the sun is not created a miraculous body, to shine on and give out heat forever, we must suppose it to be a body subject to the laws of matter (I do not say there may not be laws which we have not discovered) but, at all events, not violating any laws we have discovered or believe we have discovered. We should deal with the sun as we should with any large mass of molten iron, or silicon, or sodium.

*On Geological Time* (p. 18)

Address

Geological Society of Glasgoe

February 27, 1868

It seems, therefore, on the whole most probable that the sun has not illuminated the earth for 100,000,000 years, and almost certain that he has not done so for 500,000,000 years. As for the future, we may say, with equal certainty, that inhabitants of the earth can not continue to enjoy the light and heat essential to their life for many million years longer unless sources now unknown to us are prepared in the great storehouse of creation.

The Age of the Sun's Heat

*Macmillan's Magazine*, March 5, 1862 (p. 293)

**Langley, Samuel Pierpont** 1834–1906  
American astronomer and aviation pioneer

As the thought of man is widened with the process of the suns, let us hope that we shall one day know more.

The New Astronomy

*The Century Illustrated Monthly Magazine*, Volume 28, New Series

Volume 6 (p. 936)

...the fields glitter with snow-crystals in the winter noon, and the eye is dazzled with a reflection of the splendor which the sun pours so fully into every nook that by it alone we appear to see everything.

The New Astronomy

*The Century Illustrated Monthly Magazine*, Volume 28, New Series, Volume 6 (p. 922)

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Down sank the great red sun, and in golden glimmering vapours

Veiled the light of his face, like the Prophet descending from Sinai.

*The Poetical Works of Henry Wadsworth Longfellow*

Evangeline, Part I, Section 4

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Macpherson, James** 1736–1796  
Scottish poet

Whence are thy beams, O sun! thy everlasting light! Thou comest forth in thy awful beauty; the stars hide themselves in the sky; the moon, cold and pale, sinks in the western wave; but thou thyself movest alone.

*The Poems of Ossian*

Carthon (p. 233)

Printed by Dewick & Clarke. London, England. 1806

**Mann, Thomas** 1875–1955  
German-born American novelist

“He does seem rather weird,” was Hans Castorp’s view. “Some of the things he said were very queer: it sounded as if he meant to say that the sun revolves round the earth.”

*The Magic Mountain*

Chapter VI

Of City of God, and Deliverance by Evil (p. 407)

Alfred A. Knopf. New York, New York, USA. 1966

**Mayer, Robert**  
No biographical data available

The Sun...is an inexhaustible source of physical force — that continuously wound-up spring which sustains in motion the mechanism of all the activities on Earth.

In L.I. Ponomarev

*The Quantum Dice* (p. 228)

Institute of Physics Publishing. Bristol, England. 1993

**Melville, Herman** 1819–91  
American novelist

Life or death, weal or woe, the sun stays not his course. Oh: over battlefield and bower; over tower, and town, he speeds, — peers in at births, and death-beds; lights up cathedral, mosque, and pagan shrine; — laughing over all; — a very Democritus in the sky; and in one brief day sees more than any pilgrim in a century’s round.

*Typee, Omoo, Mardi*  
Mardi  
Chapter 184 (p. 1277)  
The Library of America. New York, New York, USA. 1982

**Moulton, Forest Ray** 1872–1952  
American astronomer

If the sun were created expressly to light and heat the earth, what a waste of energy!

In H.H. Newman (ed.)  
*The Nature of the World and of Man*  
Astronomy (p. 17)  
The University of Chicago Press. Chicago, Illinois, USA. 1927

**Muir, John** 1838–1914  
American naturalist

The sun, looking down on the tranquil landscape, seems conscious of the presence of every living thing on which he is pouring his blessings, while they in turn, with perhaps the exception of man, seem conscious of the presence of the sun as a benevolent father and stand hushed and waiting.

*Steep Trails*  
Chapter XVII (p. 226)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Parker, E. N.** 1927–  
No biographical data available

The riddles the sun presents are signposts to new horizons.

The Sun  
*Scientific American*, Volume 233, Number 3, September 1975 (p. 50)

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Let man then contemplate the whole of nature in her full and grand majesty, and turn his vision from the low objects which surround him. Let him gaze on that brilliant light, set like an eternal lamp to illumine the universe.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section II, 72  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Plato** 428 BCE–347 BCE  
Greek philosopher

That there might be some visible measure of their relative swiftness and slowness as they proceeded in their eight courses, God lighted a fire, which we now call the sun, in the second from the earth of these orbits...

In *Great Books of the Western World* (Volume 7)  
*Timaeus*  
Section 39 (p. 451)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Raymo, Chet** 1936–  
American physicist and science writer

For 5 billion years the sun has exhaled a faint breath as it burns, bathing the Earth in the flux of its exhalations, a wind of atoms and subatomic particles that feeds the Earth's atmosphere and ignites auroras.

*The Soul of the Night*  
Chapter 8 (p. 81)  
Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1985

**Riley, James Whitcomb** 1849–1916  
American poet

And the sun had on a crown  
Wrought of gilded thistle-down,  
And a scarf of velvet vapor  
And a raveled rainbow gown;  
And his tinsel-tangled hair  
Tossed and lost upon the air  
Was glossier and flossier  
Than any anywhere.

*The Complete Works of James Whitcomb Riley in Ten Volumes* (Volume 4)  
The South Wind and the Sun  
Harper & Brothers Publishers. New York, New York, USA. 1916

**Rutherford, Mark (William Hale White)** 1831–1913  
English writer

The sun, we say, is the cause of heat, but the heat is the sun, hence on this window-ledge.

*More Pages from a Journal*  
Notes (p. 120)  
H. Frowde. London, England. 1910

**Sagan, Carl** 1934–96  
American astronomer and science writer

**Druyan, Ann** 1949–  
American author and television producer

The immense, overpowering blackness is relieved here and there by a faint point of light — which, upon closer approach, is revealed to be a mighty sun, blazing with thermonuclear fire and warming a small surrounding volume of space.

*Shadows of Forgotten Ancestors: A Search for Who We Are*  
Prologue (p. 3)  
Random House, Inc. New York, New York, USA. 1992

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

...the glorious sun,  
Stays in his course and plays the alchemist,  
Turning with splendor of his precious eye  
The meagre cloddy earth to glittering gold.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
The Twelfth Night  
Act V, Scene i, l. 77–80  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952



**Smart, Christopher** 1722–71  
English poet

Glorious the sun in mid-career;  
Glorious th' assembled fires appear.

*Collected Poems*

A Song to David, LXXXIV

Routledge & Kegan Paul. London, England. 1949

**Starr, Victor P.**

No biographical data available

**Gilman, Peter A.**

No biographical data available

It has always been easier to record and describe solar events than to provide theoretical explanations for them.

The Circulation of the Sun's Atmosphere

*Scientific American*, Volume 218, Number 1, January 1968 (p. 100)

**Stoppard, Tom** 1937–

Czech-born English playwright

Meeting a friend in a corridor, Wittgenstein said: "Tell me, why do people always say it was natural for men to assume that the sun went round the earth, rather than that the earth was rotating?" His friend said, "Well, obviously, because it looks as if the sun is going round the earth." To which the philosopher replied, "Well, what would it have looked like if it had looked as if the earth was rotating?"

*Jumpers*

Act Two (p. 65)

Grove Press, Inc. New York, New York, USA. 1972

**Swift, Jonathan** 1667–1745

Irish-born English writer

These people [Laputians] are under continual disquietudes, never enjoying a minute's peace of mind; and their disturbances proceed from causes which very little affect the rest of mortals. Their apprehension arises from several changes they dread in the celestial bodies. For instance...that the sun, daily spending its rays without any nutriment to supply them, will at last be wholly consumed and annihilated; which must be attended with the destruction of this earth, and all the planets that receive their light from it.

In *Great Books of the Western World* (Volume 36)

*Gulliver's Travels*

Part III, Chapter II (p. 98)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Tennyson, Alfred (Lord)** 1809–92

English poet

There sinks the nebulous star we call the sun.

*Alfred Tennyson's Poetical Works*

The Princess, Part IV, l. 19

Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

It is true, I never assisted the sun materially in his rising; but doubt not, it was of the last importance only to be present at it.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter I (p. 30)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Updike, John** 1932–

American novelist, short story writer, and poet

The zeros stared back, every one a wound leaking the word "poison." "That's the weight of the Sun," Caldwell said.

*The Centaur*

Chapter I (p. 37)

Alfred A. Knopf. New York, New York, USA. 1995

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

...the sun, red and very large, halted motionless upon the horizon, a vast dome glowing with a dull heat, and now and then suffering a momentary extinction...[it] grew larger and duller in the westward sky, and the life of the old earth ebbed away. At last, more than thirty million years hence, the huge red-hot dome of the sun had come to obscure nearly a tenth part of the darkling heavens.

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today*, 1971

The Time Machine, Chapter 11

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Give me a splendid silent sun, with all his beams full-dazzling.

*Complete Poetry and Collected Prose*

Give Me a Splendid Sun

The Library of America. New York, New York, USA. 1982

**Xenophanes** ca. 575 BCE–ca. 478 BCE

Greek philosopher

The sun comes into being each day from little pieces of fire that are collected...

In G.S Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 178 (p. 172)

At the University Press. Cambridge, England. 1963

## SUNSPOT

**Birrell, Augustine** 1850–1933

English author and politician

The sun is not all spots.

*Obiter Dicta*

Second Series

John Milton

Elliot Stock. London, England. 1884

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

Neither the satellites of Jupiter nor any other stars are spots or shadows, nor are the sunspots stars. It is indeed true that I am quibbling over names, while I know that anyone may impose them to suit himself. So long as a man does not think that by names he can confer inherent and essential properties on things, it would make little difference whether he calls these “stars.”

Translated by Stillman Drake

*Discoveries and Opinions of Galileo*

Letters on Sunspots, Third Letter on Sunspots, From Galileo Galilei to Mark Welsler (p. 139)

Doubleday & Company, Inc. New York, New York, USA. 1957

**Harris, John** 1667?–1719  
No biographical data available

Spots! Said she, What, are there Spots in the Sun, which sometimes appear there, and sometimes not; for God’s sake what are those Spots?

*Astronomical Dialogues Between a Gentleman and a Lady* (p. 74)

Printed by T. Wood for Benj. Cowse. London, England. 1719

**Zirin, Harold**  
Astrophysicist

Just like the green fields and virgin forests, the granules, the sunspots, the elegant prominences reflect the pure beauty of nature. They offer aesthetic pleasure, as well as scientific challenge, to those who study them.

*Astrophysics of the Sun*

Preface (p. ix)

Cambridge University Press. Cambridge, England. 1988

## SUPERNOVA

**Crowley, Abraham** 1618–67  
English poet

So when by various Turns of the Celestial Dance,  
In many thousand years,

A Star, so long unknown, appears,

Though Heaven it self more beauteous by it grow,

It troubles and alarms the World below,

Does to the Wise a Star, to Fools a Meteor show.

In Thomas Sprat

*The History of the Royal-Society of London for Improving of Natural Knowledge*

To the Royal Society

Printed for A. Millar. London, England. 1756–1757

**Schaaf, Fred**  
No biographical data available

...a star gone to seed — a star spectacularly sowing space with heavy elements and the promise of new stars, worlds, life, and eyes.

*The Starry Room: Naked Eye Astronomy in the Intimate Universe*

Chapter 11 (p. 194)

John Wiley & Sons, Inc. New York, New York, USA. 1988

**Woosley, Stan**  
No biographical data available

**Weaver, Tom**

No biographical data available

The collapse and explosion of a massive star is one of nature’s grandest spectacles. For sheer power nothing can match it. During the supernova’s first 10 seconds...it radiates as much energy from a central region 20 miles across as all the other stars and galaxies in the rest of the visible universe combined.... It is a feat that stretches even the well-stretched minds of astronomers.

The Great Supernova of 1987

*Scientific American*, Volume 261, Number 2, August 1989 (p. 32)

## SUPERSTITION

**Gell-Mann, Murray** 1929–  
American physicist

Unscientific approaches to the construction of models of the world around us have characterized much of human thinking since the time immemorial, and they are still widespread. Take, for example, the version of sympathetic magic based on the idea that similar things must be connected. It seems natural to many people around the world that, when in need of rain, they should perform a ceremony in which water is procured and poured on the ground.

*The Quark and the Jaguar: Adventures In the Simple and the Complex* (p. 89)

W.H. Freeman & Company. New York, New York, USA. 1994

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

...the beauty of the universe and the order of celestial things force us to recognize some superior nature which ought to be remarked and admired by the human race. But as far as it is proper to propagate religion, which is joined to the knowledge of nature, so far it is necessary to work toward the extirpation of superstition, for it torments one, importunes one, and pursues one continually and in all places.

*A Philosophical Essays on Probabilities*

Chapter XVI (p. 174)

Dover Publications, Inc. New York, New York, USA. 1951

**Van Sloan, Edward** 1882–1964  
American actor

Superstition? Who can define the boundary line between the superstition of yesterday and the scientific fact of tomorrow?

*Dracula’s Daughter*

Film (1936)

## SUPERSTRING

**Dyson, Freeman J.** 1923–  
American physicist and educator

Superstrings and butterflies are examples illustrating two different aspects of the universe and two different notions of beauty. Superstrings come at the beginning and butterflies at the end because they are extreme examples. Butterflies are at the extreme of concreteness, superstrings at the extreme of abstraction. They mark the extreme limits of the territory over which science claims jurisdiction. Both are, in their different ways, beautiful. Both are, from a scientific point of view, poorly understood. Scientifically speaking, a butterfly is at least as mysterious as a superstring....

*Infinite in All Directions*

Part One, Chapter Two (p. 14)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

## SUPPOSITION

**Stoney, George Johnstone** 1826–1911  
Irish physicist

A theory is a supposition which we hope to be true, a hypothesis is a supposition which we expect to be useful; fictions belong to the realm of art; if made to intrude elsewhere, they become either makebelieves or mistakes.

In Sir William Ramsay

*Essays Biographical and Chemical*

Chemical Essays

Radium and Its Products (p. 179)

Archibald Constable & Company Ltd. London, England. 1908

## SURFACE TENSION

**Roth, V. Louise**  
American zoologist

You may have inner tranquility, but you can't escape surface tension.

In Steven Vogel

*Life's Devices: The Physical World of Animal and Plants*

Chapter 5 (p. 82)

Princeton University Press. Princeton, New Jersey, USA. 1988

## SURGEON

### Author undetermined

A good surgeon must have an eagle's eye, a lion's heart, and a lady's hand.

In John Timbs

*Doctors and Patients, or, Anecdotes of the Medical World and*

*Curiosities of Medicine* (Volume 2) (p. 155)

Richard Bentley & Son. London, England. 1873

**Aylett, Robert** 1583–1655?  
Religious poet

For Mercy doth like skilfull Surgeon deal,  
That hath for ev'ry sore a remedy:

If gentle drawing plaisters cannot heal  
The wound, because it festreth inwardly,  
He sharper corrasives must then apply,  
And as he oft cuts off some member dead,  
Or rotten, lest the rest should putrifie,  
So Mercy wicked Members off doth shred,  
Lest they should noysome prove to body and the head.

*Peace with Her Four Gardners*

The Brides Ornaments, Meditation III, l. 307–315

### Caldwell, George W.

No biographical data available

Who is the man in sterile white  
Delving deep at the point of light,  
With nurses, trained, at left and right?

*Poet Physician: An Anthology of Medical Poetry Written by Physicians*  
The Surgeon (p. 136)

C.C. Thomas. Springfield, Illinois, USA. 1945

**Carnochan, John Murray** 1817–87  
American surgeon

While respect for life will dictate to the surgeon the greatest prudence — will counsel him to attempt no operation which he would not be willing to perform on his own child — it will also teach him, that if the extremes of boldness are to be shunned, pusillanimity is not the necessary alternative.

*Contributions to Operative Surgery and Surgical Pathology*

Preface

Lindsay & Blakiston. Philadelphia, Pennsylvania, USA. 1857

**Celsus, Aulus Cornelius** fl. 14 AD  
Roman medical writer

A surgeon ought to be young, or at any rate, not very old; his hand should be firm and steady, and never shake; he should be able to use his left hand with as much dexterity as his right; his eye-sight should be acute and clear; his mind intrepid, and so far subject to pity as to make him desirous of the recovery of his patient, but not so far as to suffer himself to be moved by his cries; he should neither hurry the operation more than the case requires, nor cut less than is necessary, but do everything just as if the other's screams made no impression upon him.

In Samuel Evans Massengill

*A Sketch of Medicine and Pharmacy and a View of Its Progress by the*  
*Massengill Family from the Fifteenth to the Twentieth Century* (p. 30)

The S.E. Massengill Company. Bristol, Tennessee, USA. 1943

**Crichton-Browne, Sir James** 1840–1938  
English physician

“Oh, sir, we made a terrible mistake in the case of that man yesterday! We amputated the wrong leg!”

“Ah well,” the surgeon replied, complacently, “it’s of no consequence, for I have just been looking at the other leg, and it’s going to get better.”

*The Doctor’s After Thoughts* (p. 15)

E. Benn Ltd. London, England. 1932

Every great surgeon, it used to be said, shakes, swears or sweats when he operates.

*The Doctor Remembers*

Bret Harte (p. 170)

Duckworth & Company. London, England. 1938

**Croll, Oswald** 1560–1609

German chemist and physician

...it is necessary that every Surgeon should be a Physician, and every Physician a Chyrurgion, that there may be a sound Bridegroom for a sound Bride...

*Philosophy Reformed and Improved in Four Profound Tractates* (p. 151)

Printed by M.S. for Lodowick Lloyd. London, England. 1657

**Cvikota, Raymond J.**

Surgeon: Fee lancer.

*Quote, the Weekly Digest*, June 9, 1968 (p. 457)

**da Costa, J. Chalmers** 1863–1933

American physician

A vain surgeon is like a milking stool; of no use except when sat upon.

*The Trials and Triumphs of the Surgeon* (p. 17)

Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

A surgeon is like a postage stamp. He is useless when stuck on himself.

*The Trials and Triumphs of the Surgeon* (p. 17)

Dorrance & Company. Philadelphia, Pennsylvania, USA. 1944

**Davies, Robertson** 1913–95

Canadian novelist

A man mentioned casually to me this afternoon that his brother was in a hospital, having his appendix removed. This operation is now undertaken without qualm; surgeons regard it as a pastime, something to keep the hands busy, like knitting or eating salted nuts.

*The Table Talk of Samuel Marchbanks* (p. 176)

Clarke, Irwin. Toronto, Ontario, Canada. 1949

**de Chauliac, Guy**

No biographical data available

The surgeon should be learned, skilled, ingenious, and of good morals. Be bold in things that are sure, cautious in dangers; avoid evil cures and practices; be gracious to the sick, obliging to his colleagues, wise in his predictions. Be chaste, sober, pitiful, and merciful; not covetous nor extortionate of money, but let the recompense be moderate, according to the work, the means of the sick, the character of the issue or event, and its dignity.

In Samuel Evans Massengill

*A Sketch of Medicine and Pharmacy and a View of Its Progress by the Massengill Family from the Fifteenth to the Twentieth Century* (p. 262)

The S. E. Massengill Company. Bristol, Tennessee, USA. 1943

**de Mondeville, Henri** 1260–1320

French pioneer surgeon

The surgeon should be fairly audacious [yet] he should operate with prudence and sagacity; he should never commence perilous operations unless he has provided everything in order to avoid danger; ...he should not sing his own praises; he should not cover his colleagues with blame; he should not cause envy among them; he should work always with the idea of acquiring a reputation of probity; he should be reassuring to his patients by kind words and acquiesce to their requests when nothing harmful will result from them as to their cure.

In C.G. Cumston

Henry de Mondeville, the Man and His Writings, with Translations of Several Chapters of His Works

*Buffalo Medical Journal*, Volume 42, 1903

A Surgeon ought to be fairly bold. He ought not to quarrel before the laity, and although he should operate wisely and prudently, he should never undertake any dangerous operation unless he is sure that it is the only way to avoid a greater danger. His limbs, and especially his hands, should be well shaped with long, delicate and supple fingers which must not be tremulous.

In John Arderne

*Treatise of Fistula in Ano* (pp. xx)

**Dickens, Charles** 1812–70

English novelist

What! don’t you know what a Sawbones is, Sir? inquired Mr. Weller. I thought everybody know’d as a Sawbones was a Surgeon.

*The Posthumous Papers of the Pickwick Club*

Chapter XXX (p. 348)

Dodd, Mead & Company. New York, New York, USA. 1944

**Dickinson, Emily** 1830–86

American lyric poet

Surgeons must be very careful

When they take the knife!

Underneath their fine incisions

Stirs the Culprit, — Life!

*The Complete Poems of Emily Dickinson*

No. 108 (p. 52)

Little, Brown & Company. Boston, Massachusetts, USA. 1960

**Dimmick, Edgar L.**

No biographical data available

The public views his *status regas*,  
In the profession he’s “The Eagle.”

With super-supple fingers slim

(Pus, blood, and guts don’t bother him),

Up to his elbows, filled with glee,  
 With snick and slice sadistically,  
 Into a jar, up on a shelf  
 He puts a fragment of yourself.  
 For him no diagnostic doubt —  
 He'll operate, and so find out.

The In-Side of Two

*Journal of the American Medical Association*, Volume 199, Number 6,  
 1967 (p. 274)

**Dunlop, William** 1766–1839

American dramatist and theatrical manager

There is hardly on the face of the earth a less enviable  
 situation than that of an Army Surgeon after a battle...

*Recollection of the American War, 1812–1814*

Chapter III (p. 54)

Historical Publishing Company. Toronto, Ontario, Canada. 1906

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

The wounded surgeon plies the steel  
 That questions the distempered part;  
 Beneath the bleeding hands we feel  
 The sharp compassion of the healer's art  
 Resolving the enigma of the fever chart.

*The Collected Poems and Plays 1909–1950*

East Coker, Part IV (p. 127)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Findley, Thomas**

Physician

The surgeon...is a man of action. He lives in an exhilarating world of knives, blood, and groans. His tempo is of necessity rapid. He is inclined to look at his less kinetic colleague with an air of puzzled condescension but may, in a relaxed moment, admit that the medical man is occasionally able to assist uncomfortable dowagers in the selection of a cathartic.

The Obligations of an Internist to a General Surgeon

*Surgery*, Volume 16, 1944 (p. 557)

**Gilbertus, Anglicus**

No biographical data available

Why in God's name is there such a great difference  
 between a physician and a surgeon?

Surgery

*Time*, May 3, 1963 (p. 44)

**Gogarty, Oliver St. John** 1878–1957

Irish author

Let Surgeon MacCardle confirm you in Hope.  
 A jockey fell off and his neck it was broke.  
 He lifted him up like a fine, honest man;  
 And he said "He is dead; but I'll do all I can."

*The Collected Poems of Oliver St. John Gogarty*

The Three (p. 109)

Constable. London, England. 1951

**Gross, S. D.** 1805–84

American emeritus professor of surgery

It is impossible for any man to be a great surgeon if he is destitute...of the finer feelings of our nature... I do not think that it is possible for a criminal to feel much worse the night before his execution than a surgeon when he knows that upon his skill and attention must depend the fate of a valuable citizen, husband, father, mother or child. Surgery under such circumstances is a terrible task master, feeding like a vulture upon a man's vitals.

*Autobiography of Samuel D. Gross, MD.* (p. 172)

George Barrie. Philadelphia, Pennsylvania, USA. 1887

**Hazlitt, William Carew** 1834–1913

English bibliographer

An ignorant drunken Surgeon that kil'd all men that came under his hands, boasted himself a better man than the Parson; for, said he, your Cure maintains but yourself, but my Cures maintaine all the Sextons in the Towne.

*Shakespeare Jest Books* (Volume 3)

Conceit, Clichés, Flashes and Whimzies, Number 163

Willis & Sotheran. London, England. 1864

**Helmuth, William Tod** 1833–1902

American physician

...doctors are the Devil's progeny,

While surgeons come directly down from God!

*Scratches of a Surgeon*

Surgery vs. Medicine (p. 66)

W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Jones J.**

No biographical data available

It might...be of singular advantage to young surgeons, particularly before they begin an operation to go through every part of it attentively in their own minds to consider every possible accident which may happen and to have the proper remedies at hand in case they should; and in all operations of delicacy and difficulty to act with deliberation...

*Plain, concise, practical remarks on treatment of wounds and fractures; to which is added, a short appendix on camp and military hospitals; principally designed for the use of young military surgeons in North America* (pp. 39–40)

John Holt. New York, New York, USA. 1775

**Kafka, Franz** 1883–1924

German-language novelist

That is what people are like in my district. Always expecting the impossible from the doctor. They have lost their ancient beliefs; the parson sits at home and unravels his vestments, one for another; but the doctor is supposed to be omnipotent with his merciful surgeon's hands. Well, as it pleases them; I have not thrust my services on them...

*The Complete Stories*

A Country Doctor (p. 224)  
Schocken Books. New York, New York, USA. 1971

**Massinger, Philip** 1583–1640  
English dramatic poet

WELL.: Thou wert my surgeon; you must tell no tales;  
Those days are done.

I will pay you in private.

*A New Way to Pay Old Debts*  
Act IV, Scene II (p. 123)

**Ogilvie, Sir Heneage** 1887–1971  
English physician

A surgeon conducting a difficult case is like the skipper of an ocean-going racing yacht. He knows the port he must make, but he cannot foresee the course of the journey.

*A Surgeon's Life*  
*The Lancet*, Volume 255, July 3, 1948 (p. 1)

**Paretsky, Sara** 1947–  
American author

Heart surgeons do not have the world's smallest egos: when you ask them to name the world's three leading practitioners, they never can remember the names of the other two.

In Marilyn Wallace (ed.)  
*Sisters in Crime* (Volume 1)  
The Case of the Pietro Andromache II (p. 116)  
Berkley Books. New York, New York, USA. 1989

**Selzer, Richard** 1928–  
American physician and essayist

In the operating room the patient must be anaesthetized in order that he or she feel no pain. The surgeon too must be anaesthetized, insulated against the emotional heat of the event so that he can perform this act of laying open the body of a fellow human being, which, take away the purpose for which it is being done, is no more than an act of assault and battery. A barbaric act. So the surgeon dons a carapace which keeps him from feeling. It is what gives many surgeons the appearance of insensitivity.

Speech  
Humanities Symposium, Dalhousie University, 1991

**Shadwell, Thomas** 1642?–92  
English dramatist and poet

Oh this Surgeon! this damn'd Surgeon, will this Villainous Quack never come to me? Oh this Plaster on my Neck! It gnaws more than Aqua-Fortis: this abominable Rascle has mistaken sure, and given me the same Caustick he appli'd to my Shins, when they were open'd last.

*The Complete Works of Thomas Shadwell* (Volume 1)

The Humorists, The First Act (p. 193)  
The Fortune Press. London, England. 1927

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

It is a gratification to me to know that I am ignorant of art, and ignorant also of surgery. Because people who understand art find nothing in pictures but blemishes, and surgeons and anatomists see no beautiful women in all their lives, but only a ghastly stack of bones with Latin names to them, and a network of nerves and muscles and tissues.

*Mark Twain's Travels with Mr. Brown*  
Academy of Design (p. 238)  
Alfred A. Knopf. New York, New York, USA. 1946

## SURGERY

**Clendening, Logan** 1884–1945  
No biographical data available

Surgery does the ideal thing — it separates the patient from his disease.

*Modern Methods of Treatment*  
Part I, Chapter I (p. 17)  
The C.V. Mosby Company. St. Louis, Missouri, USA. 1924

**Dennis, F. S.**  
No biographical data available

There is no science that calls for greater fearlessness, courage, and nerve than that of surgery, none that demands more of self-reliance, principle, independence and the determination in the man. These were the characteristics which were chiefly conspicuous in the early settlers of this country. And it is these old-time Puritan qualities, which descending to them in succeeding generations, have passed into surgeons of America, giving them boldness in their art, and enabling them to win that success in surgery, which now commands the admiration of the civilized world.

Address  
The History and Development of Surgery during the Past Century,  
International Congress of Arts and Sciences  
St. Louis, Missouri, September 1904

**Fenger, Carl Emil** 1814–84  
Danish physician and politician

We must naturally ask ourselves: Does suffering humanity gain anything by this operation? or, in other words, Does the operation enable us to save, or only to prolong life, and is it worth while for patients having uterine cancer to undergo this severe operation?

*The Total Extirpation of the Uterus Through the Vagina*  
*American Journal of Medical Science*, Volume 83, January 1883 (p. 45)

**Giles, Roscoe C.**

No biographical data available

It cannot be too often emphasized, however, that the post-operative treatment is as essential as the operation, and the surgeon is as much responsible for the post-operative treatment as for the operation.

Rickets, the Surgical Treatment of the Chronic Deformities of, with Emphasis on Bow-Legs and Knock-Knees  
*Journal of the National Medical Association*, Volume 14, 1922

**Helmuth, William Tod** 1833–1902

American physician

There is not one man in a hundred outside of the medical profession, and scarcely one man in ten in it, who understands and appreciates the marvels of modern surgery.

*Scratches of a Surgeon*  
Some of the Wonders of Modern Surgery (p. 42)  
W.A. Chatterton & Company. Chicago, Illinois, USA. 1879

**Hippocrates** 460 BCE–377 BCE

Greek physician

The prime object of the physician in the whole art of medicine should be to cure that which is diseased; and if this can be accomplished in various ways, the least troublesome should be selected; for this is more becoming a good man, and one well skilled in the art, who does not covet popular coin of base alloy.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
On the Articulations, 78 (p. 119)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The things relating to surgery, are — the patient; the operator; the assistants; the instruments; the light, where and how; how many things, and how; where the body, and the instruments; the time; the manner; the place.

In *Great Books of the Western World* (Volume 10)  
*Hippocratic Writings*  
On the Surgery, 2 (p. 70)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hubbard, Elbert** 1856–1915

American editor, publisher, and author

**SURGERY:** An adjunct, more or less valuable to the diagnostician.

*The Roycroft Dictionary Concocted by Ali Baba and the Bunch on Rainy Days* (p. 143)  
The Roycrofters. East Aurora, New York, USA. 1914

**Johnson, Ernest**

No biographical data available

[Back fusions are] like killing a fly on a windowpane with a sledgehammer. The fly is dead, but you've also broken the glass.

That Aching Back  
*Time*, 14 July 1980 (p. 34)

**Jones J.**

No biographical data available

The exterior of this science, has nothing pleasing or attractive in it, but is rather disgusting to nice, timid, and delicate persons; Its objects too, except in time of war, lying chiefly among the poor and lower classes of mankind, do not excite the industry of the ambitious or avaricious, who find their best account among the rich and great.

*Plain, concise, practical remarks on treatment of wounds and fractures; to which Is added, a short appendix on camp and military hospitals; principally designed for the use of young military surgeons in North America* (pp. ii–iii)  
John Holt. New York, New York, USA. 1775

**Kirklin, John** 1917–2004

American cardiovascular surgeon

Surgery...is always second best. If you can do something else, it's better. Surgery is limited. It is operating on someone who has no place else to go.

Surgery  
*Time*, May 3, 1963 (p. 60)

**Mayo, William J.** 1861–1939

American physician

Surgery is more a matter of mental grasp than it is of handicraftsmanship.

Master Surgeons of America; Frederic S. Dennis  
*Surgery, Gynecology and Obstetrics*, Volume 67, October 1938

**Ogilvie, Sir Heneage** 1887–1971

English physician

Surgery thus attracts the man whose interest in medicine is humanitarian rather than scientific, who loves his fellow men, who wishes to help them and to see that his help is effective. It appeals to the craftsman who enjoys the use of his hands, to the artist whose mind works on visual images, to the romantic who enjoys the drama of life, particularly when it affords him the opportunity to play a decisive role, to the extrovert.

A Surgeon's Life  
*The Lancet*, Volume 255, July 3, 1948 (p. 1)

**O'Malley, Austin** 1858–1932

American physician and humorist

**Surgery:** by far the worst snob among the handicrafts.

In Herbert V. Prochnow and Herbert V. Prochnow, Jr.  
*A Treasury of Humorous Quotations: For Speakers, Writers, and Home Reference*  
#5724 (p. 322)  
Harper & Row, Publishers. New York, New York, USA. 1969

**Ovid** 43 BCE–17 AD

Roman poet

But that which is incurable must be cut away with the knife, lest the untainted part also draw infection.

Translated by Frank Justus Miller

*Metamorphoses* (Volume 1)  
Book I, l. 190–191 (p. 15)  
William Heinemann. London, England. 1916

**Selzer, Richard** 1928–  
American physician and essayist

One enters the body in surgery, as in love, as though  
one were an exile returning at last to his hearth, daring  
uncharted darkness in order to reach home.

*Mortal Lessons*  
The Surgeon as Priest (p. 25)  
Simon & Schuster. New York, New York, USA. 1976

...surgery is the red flower that blooms among the leaves  
and thorns that are the rest of Medicine.

*Letters to a Young Doctor*  
Letter II (p. 510)  
Simon & Schuster, Inc. New York, New York, USA. 1982

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

We do not go to the operating table as we go to the theatre,  
to the picture gallery, to the concert room, to be entertained  
and delighted; we go to be tormented and maimed, lest a worse  
thing should befall us.... The experts on whose assurance we  
face this horror and suffer this mutilation should have no interests  
but our own to think of; should judge our cases scientifically; and  
should feel about them kindly.

*The Doctor's Dilemma*  
Preface on Doctors  
Psychology of Self Respect in Surgeons (p. xxii)  
Brentano's. New York, New York, USA. 1920

The notion that therapeutics or hygiene or surgery is any more  
or less scientific than making or cleaning boots is entertained  
only by people to whom a man of science is still a magician who  
can cure diseases, transmute metals, and enable us to live forever.

*The Doctor's Dilemma*  
Preface on Doctors  
The Technical Problem (p. lxxxii)  
Brentano's. New York, New York, USA. 1920

**Sigerist, Henry E.** 1891–1957  
German-born medical historian

Ignorance is more immediately fatal in surgery than in medicine,  
or rather, mistakes are more easily apparent to the layman.

*A History of Medicine* (Volume 2)  
Chapter III, Section 1 (p. 203)  
Oxford University Press, Inc. New York, New York, USA. 1961

**Yeo, R.**  
No biographical data available

The work was in a moment done.  
If possible, without a groan:  
So swift thy hand, I could not feel

The progress of the cutting steel....  
For quicker e'en than sense, or thought,  
The latent ill view was brought;  
And I beheld with ravish'd eyes,  
The cause of all my agonies.  
And above all the race of men,  
I'll bless my GOD for Cheselden.  
The Grateful Patient  
*Gentlemen's Magazine*, Volume 2, 1732 (p. 769)

## SURPRISE

**Faraday, Michael** 1791–1867  
English physicist and chemist

Let us now consider, for a little while, how wonderfully we stand upon this world. Here it is we are born, bred, and live, and yet we view these things with an almost entire absence of wonder to ourselves respecting the way in which all this happens. So small, indeed, is our wonder, that we are never taken by surprise.

*On the Various Forces of Nature and Their Relations to Each Other: A Course of Lectures Delivered Before a Juvenile Audience at the Royal Institution*  
Lecture I (p. 14)  
George Routledge & Sons. New York, USA. 1874

**Planck, Max** 1858–1947  
German physicist

...compared with immeasurably rich, ever young Nature, advanced as man may be in scientific knowledge and insight, he must forever remain the wondering child and must constantly be prepared for new surprises.

*Scientific Autobiography and Other Papers*  
The Meaning and Limits of Exact Science, Part IV (p. 117)  
Philosophical Library. New York, New York, USA. 1949

**Thomas, Lewis** 1913–93  
American physician and biologist

The safest and most prudent of bets to lay money on is surprise. There is a very high probability that whatever astonishes us in biology today will turn out to be useable, and useful, tomorrow.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
Medical Lessons from History (p. 172)  
The Viking Press. New York, New York, USA. 1979

**Watson, Sir William** 1858–1935  
English author of lyrical and political verse

Strange the world about me lies,  
Never yet familiar grown — Still disturbs me with surprise,  
Haunts me like a face half known.

*The Poems of William Watson*  
World Stangeness  
The Macmillan Company. New York, New York, USA. 1939



## SURVEY

### Deming, William Edwards 1900–93

American statistician, educator, and consultant

A perfect survey is a myth.

*Some Theory of Sampling* (p. 24)

John Wiley & Sons, Inc. New York, New York, USA. 1950

A questionnaire is never perfect: some are simply better than others.

*Some Theory of Sampling* (p. 31)

John Wiley & Sons, Inc. New York, New York, USA. 1950

The only excuse for taking a survey is to enable a rational decision to be made on some problem that has arisen and on which decision, right or wrong, will be made.

*Some Theory of Sampling* (p. 545)

John Wiley & Sons, Inc. New York, New York, USA. 1950

### Deutscher, I.

No biographical data available

...neither the interviewer nor the instrument should act in any way upon the situation. The question, ideally, should be so put and so worded as to be unaffected by contextual contaminations. The interviewer must be an inert agent who exerts no influence or response by tone, expression, stance, or statement. The question must be unloaded in that it does not hint in any way that one response is more desirable or more correct than any other response. It must be placed in the sequence of the instrument in such a way that the subject's response is not affected by previous queries or by his own previous responses.

In S.Z. Nagi and R.G. Corwin

*The Social Contexts of Research*

Public and Private Opinions: Social Situations and Multiple Realities (p. 325)

John Wiley & Sons, Inc. New York, New York, USA. 1972

### Fisher, Sir Ronald Aylmer 1890–1962

English statistician and geneticist

No aphorism is more frequently repeated with field trial, than that we must ask Nature few questions or, ideally, one question at a time. The writer is convinced that this view is wholly mistaken. Nature, he suggests, will best respond to a logical and carefully thought out questionnaire; indeed, if we ask her a single question, she will often refuse to answer until some other topic has been discussed.

*Journal of the Ministry of Agriculture of Great Britain*, Volume 33 (p. 511)

### Heinlein, Robert A. 1907–88

American science fiction writer

But what is the purpose of your survey? he asked.

“Does it need a purpose? I tell you, I just made it up.”

“But your numbers are too few to be significant. You can't fair a curve with so little data. Besides, your conditions are uncontrolled. Your results don't mean anything.”

*Beyond this Horizon*

Chapter One (p. 2)

Gregg Press. Boston, Massachusetts, USA. 1981

### Norton, John K.

No biographical data available

The time of busy people is sometimes wasted by time-consuming questionnaires dealing with inconsequential topics, worded so as to lead to worthless replies, and circulated by untrained and inexperienced individuals, lacking in facilities for summarizing and disseminating any worthwhile information which they may obtain.

In Douglas R. Berdie and John F. Anderson

*Questionnaires: Design and Use* (p. ix)

The Scarecrow Press, Inc. Metuchen, New Jersey, USA. 1974

### Oppenheim, Abraham Naftali 1924–

No biographical data available

A questionnaire is not just a list of questions or a form to be filled out. It is essentially a scientific instrument for measurement and for collection of particular kinds of data. Like all such instruments, it has to be specifically designed according to particular specifications and with specific aims in mind, and the data it yields are subject to error. We cannot judge a questionnaire as good or bad, efficient or inefficient, unless we know what job it was meant to do. This means that we have to think not merely about the wording of particular questions, but first and foremost, about the design of the investigation as a whole.

*Questionnaire Design and Attitude Measurement*

Chapter 1 (pp. 2–3)

Basic Books, Inc. New York, New York, USA. 1966

### Perelman, Sidney Joseph 1904–79

American comic writer

There is nothing like a good, painstaking survey full of decimal points and guarded generalizations to put a glaze like a Sung vase on your eyeballs.

*Keep it Crisp*

Sleepy-Time Extra (p. 173)

Random House, Inc. New York, New York, USA. 1946

### Strong, Lydia

No biographical data available

Your sales last year just paralleled the sales of rum cokes in Rio de Janeiro, as modified by the sum of the last digits of all new telephone numbers in Toronto. So, why bother with surveys of your own market? Just send away for the data from Canada and Brazil.

Sales Forecasting: Problems and Prospects

*Management Review*, September 1956 (p. 803)

## SURVIVAL

**Arnold, Sir Edwin** 1832–1904  
English poet

How lizard fed on ant, and snake on him,  
And kite on both; and how the fish-hawk robbed  
The fish-tiger of that which it had seized;  
The shrike chasing the bulbul, which did chase  
The jeweled butterflies; till everywhere  
Each slew a slayer and in turn was slain,  
Life living upon death.

*Edwin Arnold's Poetical Works* (Volume 1)  
The Light of Asia, Book the First (p. 21)  
Roberts Brothers. Boston, Massachusetts, USA. 1889

**Darwin, Charles Robert** 1809–82  
English naturalist

What a trifling difference must often determine which  
shall survive, and which shall perish.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 1)  
Darwin to Asa Gray, September 5, 1857 (p. 480)  
D. Appleton & Company. New York, New York, USA. 1896

I should premise that I use this term [Struggle for Existence] in a large and metaphorical sense including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny. . . .

In *Great Books of the Western World* (Volume 49)  
*The Origin of Species by Means of Natural Selection*  
Chapter III (p. 33)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Sagan, Carl** 1934–96  
American astronomer and science writer

If we have a profound respect for other human beings as co-equal recipients of this precious patrimony of 4.5 billion years of evolution, why should the identification not apply also to all the other organisms on Earth which are equally the product of 4.5 billion years of evolution? We care for a small fraction of the organisms on Earth — dogs, cats, and cows, for example — because they are useful or because they flatter us. But spiders and salamanders, salmon and sunflowers are equally our brothers and sisters.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 1 (p. 7)  
Dell Publishing, Inc. New York, New York, USA. 1975

**Thomson, J. Arthur** 1861–1933  
Scottish biologist

The shore is almost noisy with the conjugation of the verb to eat in its many tenses.

*The Outline of Science* (Volume 1)  
Chapter III (p. 117)  
G.P. Putnam's Sons. New York, New York, USA. 1937

**Walker, Marshall**  
American physicist

The survival technique of the tyrannosaurus was ferocity; it is extinct. The survival technique of the dodo was passive resistance; it is extinct. The survival technique of man is science. . . .

*The Nature of Scientific Thought*  
Chapter XV (p. 179)  
Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA. 1963

## SYMBIOTICISM

**Wallin, Ivan E.** 1883–1969  
American anatomist

Their universal presence in the cell, coupled with the known properties of bacteria, appear to indicate that mitochondria represent the end adjustment of a fundamental biologic process. The establishment of intimate microsymbiotic complexes has been designated “symbioticism” by the author. . . .

*Symbioticism and the Origin of Species*  
Chapter I (p. 8)  
Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

Symbioticism, then is proposed as the fundamental factor or the cardinal principle involved in the origin of species.

*Symbioticism and the Origin of Species*  
Chapter I (p. 8)  
Williams & Wilkins Company. Baltimore, Maryland, USA. 1927

## SYMBIOSIS

**de Bary, Anton** 1831–88  
German scientist and physician

Parasitism, mutualism, lichenism, etc., are each special cases of that one general association for which the term symbiosis is proposed as the collective name.

*Vortrag auf der Versammlung der Naturforscher und Ärzte zu Cassel*  
Die Erscheinung der Symbiose (p. 21)  
Publisher undetermined

**Merezhkovskii, Konstantine** 1855–1921  
Russian biologist

Above all, a plant, an oak for example, is an animal. An enormous animal in which live parasites or rather symbionts, an infinite multitude of small microscopic green organisms, of the species of unicellular “algae,” cyanophyceae.

In Jan Sapp  
*Evolution by Association: A History of Symbiosis*  
Chapter 4 (p. 47)  
Oxford University Press, Inc. New York, New York, USA. 1994

**Pound, Roscoe** 1870–1964  
American jurist

Ethically, there is nothing in the phenomena of symbiosis to justify the sentimentalism they have excited in certain writings. Practically, in some instances, symbiosis seems to result in mutual advantage. In all cases it results advantageously to one of the parties, and we can never be sure that the other would not have been nearly as well off, if left to itself.

Symbiosis and Mutualism

*The American Naturalist*, Volume 27, Number 318, June 1893 (p. 520)

### Sapp, Jan

No biographical data available

We have located studies of symbiosis peering through the cracks and creeping across the boundaries which separated ecology from evolution, plants from animals, health from disease, nurture from nature, and the individual from the community. In doing so, we have uncovered layers of oppositions, doctrines and disciplines, and diverse phenomena that have led to disparate interpretations of symbiosis, its scope and significance. In summarizing them here, we see that this history is not a matter of peeling off obstacles to come closer to some hidden core of naked truth. Symbiosis is as much like an onion today as it was a century ago.

*Evolution by Association: A History of Symbiosis*

Concluding Remarks (p. 205)

Oxford University Press, Inc. New York, New York, USA. 1994

## SYMBIOTE

### Portier, Paul 1866–1922

French biologist

All Living beings, all animals from Amoeba to Man, all plants from Cryptogams to Dicotyledons are constituted by an association, the “*emboîtement*” of two different beings.

Each living cell contains in its protoplasm formations which histologists designate by the name of “mitochondria.” These organelles are, for me, nothing other than symbiotic bacteria, which I call “symbiotes.”

*Les Symbiotes* (p. vii)

Masson. Paris, France. 1918

## SYMBOL

### Brodie, Sir Benjamin Collins 1817–80

English chemist

A symbol, however, should be something more than a convenient and compendious expression of facts. It is, in the strictest sense, an instrument for the discovery of facts, and is of value mainly with reference to this end, by its adaptation to which it is to be judged.

The Calculus of Chemical Observations

*Philosophical Transactions of the Royal Society of London*, Volume 156, 1866 (p. 857)

### Buchanan, Scott 1895–1968

American educator and philosopher

Symbols, formulae and proofs have another hypnotic effect. Because they are not immediately understood, they, like certain jokes, are suspected of holding in some sort of magic embrace the secret of the universe, or at least some of its more hidden parts.

*Poetry and Mathematics*

Chapter 1 (p. 37)

The University of Chicago Press. Chicago, Illinois, USA. 1975

Each symbol used in mathematics, whether it be a diagram, a numeral, a letter, a sign, or a conventional hieroglyph, may be understood as a vehicle which someone has used on a journey of discovery.

*Poetry and Mathematics*

Chapter 2 (p. 47)

The University of Chicago Press. Chicago, Illinois, USA. 1975

### Butler, James Newton

No biographical data available

### Bobrow, Daniel Gureasko

No biographical data available

“When I use a symbol, it means just what I choose it to mean — neither more nor less.”

“The question is, whether you can make symbols mean so many different things?”

“The question is, which is to be master — that’s all.”

*The Calculus of Chemistry*

Chapter 2 (p. 7)

W.A. Benjamin, Inc. New York, New York, USA. 1965

### Eddington, Sir Arthur Stanley 1882–1944

English astronomer, physicist, and mathematician

The symbol A is not the counterpart of anything in familiar life. To the child the letter A would seem horribly abstract; so we give him a familiar conception along with it.

*The Nature of the Physical World*

Introduction (p. xiv)

The Macmillan Company. New York, New York, USA. 1930

### Goldstein, Herbert 1922–2005

American Physicist and author

It has been remarked in a jocular vein that if H stands for the Hamiltonian, K must stand for the Kamiltonian!

*Classical Mechanics* (2<sup>nd</sup> edition)

Classical Transformations (p. 380)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1980

### Hilbert, David 1862–1943

German mathematician

Arithmetical symbols are written diagrams and geometrical figures are graphic formulas.

*Bulletin of the American Mathematical Society*

Mathematical Problems, Volume 8, July 1902 (p. 443)

In the beginning there was the symbol.

In Walter R. Fuchs

*Mathematics for the Modern Mind*

Chapter 7, Section 7.1 (p. 164)

The Macmillan Company. New York, New York, USA. 1967

**Huxley, Aldous** 1894–1963

English writer and critic

...some of the greatest advances in mathematics have been due to the invention of symbols, which it afterwards became necessary to explain; from the minus sign proceeded the whole theory of negative quantities.

*Jesting Pilate*

India and Burma (p. 108)

Chatto & Windus. London, England. 1926

**Jung, Carl G.** 1875–1961

Swiss psychiatrist and founder of analytical psychology

Thus a word or an image is symbolic when it implies something more than its obvious and immediate meaning. It has a wider “unconscious” aspect that is never precisely defined or fully explained.... As the mind explores the symbols it is led to ideas that lie beyond the grasp of reason.

*Man and His Symbols*

Part I. The Importance of Dreams (p. 20)

Doubleday & Company, Inc. Garden City, New York, USA. 1964

The Sign is always less than the concept it represents, while a symbol always stands for something more than its obvious and immediate meaning. Symbols, moreover, are natural and spontaneous products.

*Man and His Symbols*

Part I. The Analysis of Dreams (p. 50)

Doubleday & Company, Inc. Garden City, New York, USA. 1964

**Nicholas of Cusa** 1401–64

German philosopher, mathematician, and physician

If we approach the Divine through symbols, then it is most suitable that we use mathematical symbols, these have an indestructible certainty.

In Stanley Gudder

*A Mathematical Journey* (p. 349)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

**Tillyard, E. M. W.** 1889–1962

English classical scholar

**Lewis, C. S. (Clive Staples)** 1898–1963

English author

Two kinds of symbol must surely be distinguished. The algebraic symbol comes naked into the world of mathematics and is clothed with value by its masters. A poetic symbol — like the Rose, for Love, in Guillaume de Lorris — comes trailing clouds of glory from the real world, clouds whose shape and colour largely determine and explain its poetic use. In an equation,  $x$  and  $y$  will do as well as  $a$  and  $b$ ; but the Romance of the Rose could not,

without loss, be re-written as the Romance of the Onion, and if a man did not see why, we could only send him back to the real world to study roses, onions, and love, all of them still untouched by poetry, still raw.

*The Personal Heresy: A Controversy*

Chapter V (p. 97)

Oxford University Press, Inc. London, England. 1939

**Truesdell, Clifford** 1919–2000

American mathematician, mathematics historian, and natural philosopher

There is nothing that can be said by mathematical symbols and relations which cannot also be said by words. The converse, however, is false. Much that can be and is said by words cannot successfully be put into equations, because it is nonsense.

*Six Lectures on Modern Natural Philosophy*

III, Thermodynamics of Visco-Elasticity (p. 35)

Springer-Verlag. Berlin, West Germany. 1966

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

There is an old epigram which assigns the empire of the sea to the English, of the land to the French, and of the clouds to the Germans. Surely it was from the clouds that the Germans fetched + and –; the ideas which these symbols have generated are much too important to the welfare of humanity to have come from the sea or from the land.

*An Introduction to Mathematics*

Chapter 6 (p. 60)

Oxford University Press, Inc. New York, New York, USA. 1958

Mathematics is often considered a difficult and mysterious science, because of the numerous symbols which it employs. Of course, nothing is more incomprehensible than a symbolism which we do not understand. Also a symbolism, which we only partially understand and are unaccustomed to use is difficult to follow. In exactly the same way the technical terms of any profession or trade are incomprehensible to those who have never been trained to use them. But this is not because they are difficult in themselves. On the contrary they have invariably been introduced to make things easy.

*An Introduction to Mathematics*

Chapter 5 (p. 40)

Oxford University Press, Inc. New York, New York, USA. 1958

...in mathematics, granted that we are giving any serious attention to mathematical ideas, the symbolism is invariably an immense simplification.

*An Introduction to Mathematics*

Chapter 5 (p. 40)

Oxford University Press, Inc. New York, New York, USA. 1958

## SYMBOLIC LOGIC

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Symbolic Logic has been disowned by many logicians on the plea that its interest is mathematical, and by many mathematicians on the plea that its interest is logical.

*Universal Algebra*

Preface (p. 6)

Cambridge University Press. Cambridge, England. 1898

## SYMMETRY

**Aristotle** 384 BCE–322 BCE

Greek philosopher

A rose which varies from the ideal of straightness to a hook or snub may still be of good shape and agreeable to the eye.

*Politics*

Book V, Chapter 9, 1309b [20]

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Blake, William** 1757–1827

English poet, painter, and engraver

Tyger, Tyger, burning bright

In the forest of the night,

What immortal hand or eye

Could frame thy fearful symmetry?

*The Complete Poetry and Prose of William Blake*

The Tyger

University of California Press. Berkeley, California, USA. 1982

**Borges, Jorge Luis** 1899–1986

Argentine writer

...reality favors symmetry.

In Richard Burgin

*Conversations with Jorge Luis Borges*

Chapter VI (p. 109)

Holt, Rinehart & Winston. New York, New York, USA. 1969

**Bulwer, John** 1606–56

English physician and writer

True and native beauty consists in the just composure and symmetry of the parts of the body.

*Anthropometamorphosis*

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

You boil it in saw dust: you salt it in glue:

You condense it with locust and tape:

Still keeping one principle object in view —

To preserve its symmetrical shape.

*The Complete Works of Lewis Carroll*

The Hunting of the Snark

Fit the Fifth (p. 772)

The Modern Library. New York, New York, USA. 1936

Perhaps Looking-glass milk isn't good to drink...

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter I (p. 147)

The Modern Library. New York, New York, USA. 1936

**Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

Suppose some mathematical creature from the moon were to reckon up the human body; he would at once see that the essential thing about it was that it was duplicate. A man is two men, he on the right exactly resembling him on the left. Having noted that there was an arm on the right and one on the left, a leg on the right and one on the left, he might go further and still find on each side the same number of fingers, the same number of toes, twin eyes, twin ears, twin nostrils, and even twin lobes of the brain. At last he would take it as a law; and then, where he found a heart on one side, would deduce that there was another heart on the other. And just then, where he most felt he was right, he would be wrong.

*Orthodoxy*

Chapter VI (p. 149)

John Lane Company. New York, New York, USA. 1918

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

Anyone who, upon looking down at his bare feet, doesn't laugh, has either no sense of symmetry or no sense of humor.

In Abdus Salam

The Role of Chirality in the Origin of Life

*Journal of Molecular Evolution*, Volume 33, Number 2, August 1991 (p. 105)

**Ferris, Timothy** 1944–

American science writer

...let us pause to slake our thirst one last time at symmetry's bubbling spring.

*Coming of Age in the Milky Way*

Chapter 20 (p. 385)

William Morrow & Company, Inc. New York, New York, USA. 1988

**Frankland, A.**

No biographical data available

When the formulae of inorganic compounds are considered even a superficial observer is struck with the general symmetry of their construction; the compounds of nitrogen, phosphorous, antimony and arsenic especially exhibit the tendency of these elements to form compounds containing three or five equivalents of other elements, and it is in these proportions that their affinities are best satisfied.

*Philosophical Transactions of the Royal Society of London*, Volume 67, 1852 (p. 417)

**Herbert, George** 1593–1633

English clergyman and metaphysical poet

My body is all symmetry,

Full of proportions, one limb to another,

And all to all the world besides:

Each part may call the farthest, brother:  
For head with foot hath private smity,  
And both with moon and tides.

*The Works of George Herbert*

The Temple, Man

Thomas Y. Crowell & Company. Birmingham, England. No date

**Joyce, James** 1882–1941

Irish expatriate writer and poet

ZOE: Come and I'll peel off.

BLOOM: (Feeling his occiput dubiously with the unparalleled embarrassment of a harassed peddler gauging the symmetry of her peeled pears.) Somebody would be dreadfully jealous if she knew.

*Ulysses* (p. 490)

Random House, Inc. New York, New York, USA. 1946

**Kaku, Michio** 1947–

Japanese-American theoretical physicist

**Thompson, Jennifer Trainer**

American author

...nature, at the fundamental level, does not just prefer symmetry in a physical theory; nature demands it.

*Beyond Einstein: The Cosmic Quest for the Theory of the Universe*

Chapter 6 (p. 108)

Bantam Books. Toronto, Ontario, Canada. 1987

**Mackay, Charles** 1814–89

English poet and journalist

Truth...and if mine eyes

Can bear its blaze, and trace its symmetries,

Measure its distance, and its advent wait,

I am no prophet — I but calculate.

*The Poetical Works of Charles Mackay*

The Prospects of the Future

G. Routledge & Sons. London, England. 1857

**Mao Zedong** 1893–1976

Chinese political and military leader and Communist Party chairman

Tell me why should symmetry be of importance?

In T.D. Lee

*Symmetries, Asymmetries, and the World of Particles*

30 May, 1974 (p. xi)

Washington University Press. Seattle, Washington, USA, and London, England. 1988

**Newman, James Roy** 1907–66

Mathematician and mathematical historian

Symmetry establishes a ridiculous and wonderful cousinship between objects, phenomena, and theories outwardly unrelated: terrestrial magnetism, women's veils, polarized light, natural selection, the theory of groups, invariants and transformations, the work habits of bees in the hive, the structure of space, vase designs, quantum physics, scarabs, flower petals, X-ray interference

patterns, cell division in sea urchins, equilibrium positions in crystals, Romanesque cathedrals, snowflakes, music, the theory of relativity.

*The World of Mathematics* (Volume 1)

Commentary On Symmetry (p. 670)

Simon & Schuster. New York, New York, USA. 1956

**Pascal, Blaise** 1623–62

French mathematician and physicist

Those who make antitheses by forcing words are like those who make false windows for symmetry.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 27

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Symmetry is what we see at a glance...

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section I, 28

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Valéry, Paul** 1871–1945

French poet and critic

The universe is built on a plan the profound symmetry of which is somehow present in the inner structure of our intellect.

In Jefferson Hane Weaver

*The World of Physics* (Volume 2)

O.2 (p. 521)

Simon & Schuster. New York, New York, USA. 1987

**Warner, Sylvia Townsend** 1893–1978

English novelist and poet

An umbrella, Lueli, when in use resembles the — the shell that would be formed by rotating an arc of curve about its axis of symmetry, attached to a cylinder of small radius whose axis is the same as the axis of symmetry of the generating curve of the shell. When not in use it is properly an elongated cone, but it is more usually helicoidal in form.

Lueli made no answer. He lay down again, this time face downward.

*Mr. Fortune's Maggot*

Mr. Fortune's Maggot (p. 115)

New York Review of Books. New York, New York, USA. 1927

**Weyl, Hermann** 1885–1955

German mathematician

Symmetry, as wide or as narrow as you may define its meaning, is one idea by which man through the ages has tried to comprehend and create order, beauty, and perfection.

*Symmetry*

Bilateral Symmetry (p. 5)

Princeton University Press. Princeton, New Jersey, USA. 1960

As far as I can see, all a priori statements in physics have their origin in symmetry.

*Symmetry*

Crystals. The General Mathematical Idea of Symmetry (p. 126)  
Princeton University Press. Princeton, New Jersey, USA. 1952

Symmetry is a vast subject, significant in art and nature. Mathematics lies at its root, and it would be hard to find a better one on which to demonstrate the working of the mathematical intellect.

*Symmetry*

Crystals: The General Mathematical Idea of Symmetry (p. 145)  
Princeton University Press. Princeton, New Jersey, USA. 1960

### Wickham, Anna (Edith Alice Mary

**Harper)** 1884–1947

English poet

God, Thou great symmetry,  
Who put a biting lust in me  
From whence my sorrows spring  
For all the frittered days  
That I have spent in shapeless ways  
Give me one perfect thing.

*The Contemplative Quarry, and The Man with a Hammer*

Envoi

Harcourt Brace. New York, USA. 1921

### Yang, Chen Ning 1922–

Chinese-born American theoretical physicist

Nature seems to take advantage of the simple mathematical representations of the symmetry laws. When one pauses to consider the elegance and the beautiful perfection of the mathematical reasoning involved and contrast it with the complex and far-reaching physical consequences, a deep sense of respect for the power of the symmetry laws never fails to develop.

*Nobel Lectures, Physics 1942–1962*

Nobel lecture for award received in 1957

The Law of Parity Conservation and Other Symmetry Laws of Physics (p. 394)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

### Zee, Anthony

Chinese-American physicist and author

Pick your favorite group: write down the Yang-Mills theory with your groups as its local symmetry group; assign quark fields, lepton fields, and Higgs fields to suitable representations; let the symmetry be broken spontaneously. Now watch to see what the symmetry breaks down to. ...that, essentially, is all there is to it. Anyone can play. To win, one merely has to hit on the choice used by the Greatest Player of all time. The prize? Fame and glory, plus a trip to Stockholm.

*Fearful Symmetry*

Chapter 14 (pp. 253–254)

Macmillan Publishing Company. New York, New York, USA. 1986

## SYMPTOM

### Hare, Hobart Amory 1862–1931

American physician

A clear understanding by the physician of the value of the symptoms of disease which he sees and of those described by the patient is of vital importance for the purpose of diagnosis and treatment, and one of the advantages of older physicians over their younger brethren is the ability which they have gained through long training to grasp the essential details of a case almost at their first glance at the patient.

*Practical Diagnosis*

Introduction (p. 17)

Lea Brothers & Company. Philadelphia, Pennsylvania, USA. 1902

### Latham, Peter Mere 1789–1875

English physician

It is by symptoms, and by symptoms only, that we can learn the existence, and seat, and nature, of diseases in the living body, or can direct and methodize their treatment.

In William B. Bean

*Aphorisms from Latham* (p. 59)

Prairie Press. Iowa City, Iowa, USA. 1962

## SYNTHESIS

### Berthelot, Marcellin 1827–1907

French chemist

The domain in which chemical synthesis exercises its creative power is vaster than that of nature herself.

In Philip Ball

*Designing the Molecular World: Chemistry at the Frontier* (p. 13)

Princeton University Press. Princeton, New Jersey, USA. 1994

### Dalton, John 1766–1844

English chemist and physicist

Chemical analysis and synthesis go no farther than the separation of particles one from another, and their reunion. No new creation or destruction of matter is within the reach of chemical agency. We might as well attempt to introduce a new planet into the solar system, or to annihilate one already in existence, as to create or destroy a particle of hydrogen.

*A New System of Chemical Philosophy* (Volume 1)

Part I, Chapter III (p. 212)

R. Bickerstaff. London, England. 1810

### Mayr, Ernst 1904–2005

German-born American biologist

What is still lacking is a critical analysis of the writings of the architects of the synthesis.

*The Growth of Biological Thought: Diversity, Evolution, Inheritance*

Chapter 12 (p. 568)

Harvard University Press. Cambridge, Massachusetts, USA. 1982

We didn't sit down together and forge a synthesis. We all knew each other's writings; all spoke with each other. We all had the same goal, which was simply to understand fully the evolutionary process. ... By combining our knowledge, we managed to straighten out all the conflicts and disagreements so that finally a united picture of evolution emerged.

In Pamela Weintraub (ed.)

*The Omni Interviews*

Darwin Flights (p. 47)

Ticknor & Fields. New York, New York, USA. 1984

The term "evolutionary synthesis" was introduced by Julian Huxley in *Evolution: The Modern Synthesis* to designate the general acceptance of two conclusions: gradual evolution can be explained in terms of small genetic changes ("mutations") and recombination, and the ordering of this variation by natural selection; and the observed evolutionary phenomena, particularly macro-evolutionary processes and speciation, can be explained in a manner that is consistent with the known genetic mechanisms.

*The Evolutionary Synthesis*

Prologue: Some Thoughts on the History of Evolutionary Synthesis (p. 1)

Harvard University Press. Cambridge, Massachusetts, USA. 1980

### Seebach, D.

No biographical data available

No matter what the narrow goal of any particular project, whether the work involved is groundbreaking or of a more routine nature, synthesis and analysis are crucial to every chemist's activities.

Organic Synthesis — Where Now?

*Angewandete Chemie International Edition in English*, Volume 29, 1990 (p. 1321)

### Vivilov, N. I.

No biographical data available

We are now entering an epoch of differential ecological, physiological and genetic classification. It is an immense work. The ocean of knowledge is practically untouched by biologists. It requires the joint labors of many different specialists — physiologists, cytologists, geneticists, systematists, and biochemists. It requires international spirit, the cooperative work of investigators throughout the whole world...it will bring us logically to the next step: integration and synthesis.

In Julian Huxley

*The New Systematics*

The New Systematics of Cultivated Plants (p. 565)

University Press. Oxford, England. 1940

### von Goethe, Johann Wolfgang 1749–1832

German poet, novelist, playwright, and natural philosopher

"Affinities begin really to interest only when they bring about separations."

"What...is that miserable word, which unhappily we hear so often now-a-days — in the world; is that to be found in nature's lessons too?"

"Most certainly," answered Edward; "the title with which chemists were supposed to be most honorably distinguished was, artists of separation."

"It is not so any more," replied Charlotte; "and it is well that it is not. It is a higher art, and it is a higher merit, to unite. An artist of union is what we should welcome in every province of the universe."

*Elective Affinities*

Chapter IV (p. 38)

Frederick Unger Publishing Company. New York, New York, USA.

1962

### Woodward, Robert Burns 1917–79

American chemist

The structure known, but not yet accessible by synthesis, is to the chemist what the unclimbed mountain, the uncharted sea, the untilled field, the unreachd planet, are to other men.... The unique challenge which chemical synthesis provides for the creative imagination and the skilled hands ensures that it will endure as long as men write books, paint pictures, and fashion things which are beautiful, or practical, or both.

In William H. Brock

*The Norton History of Chemistry*

Chapter 16 (p. 633)

W.W. Norton & Company, Inc. New York, New York, USA. 1993

[S]ynthetic objectives are seldom if ever taken by chance, nor will the most painstaking, or inspired, purely observational activities suffice. Synthesis must always be carried out by plan, and the synthetic frontier can be defined only in terms of the degree to which realistic planning is possible, utilizing all of the intellectual and physical tools available. It can scarcely be gainsaid that the successful outcome of a synthesis of more than thirty stages provides a test of unparalleled rigor of the predictive capacity of the science, and of the degree of its understanding of its portion of the environment.

In A.R. Todd (ed.)

*Perspectives in Organic Chemistry*

Synthesis (p. 155)

Interscience, Inc. New York, New York, USA. 1956

## SYSTEM

### Coates, Robert M.

No biographical data available

He has so clearly laid open and set before our eyes the most beautiful frame of the System of the World, that if King Alphonse were now alive he would not complain for want of the graces of simplicity or of harmony in it.

In Robert H. March

*Physics for Poets*



Preface to the Principia (p. 35)  
McGraw-Hill, Inc. New York, New York, USA. 1996

**Lavoisier, Antoine Laurent** 1743–94  
French chemist

Systems in physical science...are no more than appropriate instruments to aid the weakness of our organs: they are, properly speaking, approximate methods which put us on the path to the solution of the problem; these are the hypotheses which, successively modified, corrected, and changed in proportion as they are found false, should lead us infallibly one day, by a process of exclusion, to the knowledge of the true laws of nature.

*Mémoires de l'Académie Royale des Sciences 1777*  
Memoir on Combustion in General (p. 592)

Facts, observations, experiments — these are the materials of a great edifice, but in assembling them we must combine them into classes, distinguish which belongs to which order and to which part of the whole each pertains.

*Mémoires de l'Académie Royale des Sciences 1777*  
Memoir on Combustion in General (p. 592)

As dangerous as is the desire to systematize in the physical sciences, it is, nevertheless, to be feared that in storing without order a great multiplicity of experiments we obscure the science rather than clarify it, render it difficult of access to those desirous of entering upon it, and finally, obtain at the price of long and tiresome work only disorder and confusion.

*Mémoires de l'Académie Royale des Sciences 1777*  
Memoir on Combustion in General (p. 592)

**Peacock, Thomas Love** 1785–1866  
English writer

All philosophers who find  
Some favorite system to their mind,  
In every point to make it fit  
Will force all nature to submit.

*Headlong Hall* (p. 44)  
J.M. Dent & Company London, England. No date

**Thomas, Lewis** 1913–93  
American physician and biologist

You cannot meddle with one part of a complex system from the outside without the almost certain risk of setting off disastrous events that you hadn't counted on in other, remote parts.

*The Medusa and the Snail: More Notes of a Biology Watcher*  
On Meddling (p. 110)  
The Viking Press. New York, New York, USA. 1979

**Thompson, W. R.** 1887–?  
Canadian entomologist

The good systematist develops what the medieval philosophers called a habitus, which is more than a habit and

is better designated by its other name of *secunda natura*. Perhaps, like a tennis player or a musician, he works best when he does not get too introspective about what he is doing.

The Philosophical Foundation of Systematics  
*Canadian Entomology*, Volume 84, 1952 (p. 5)

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Natural system — a contradiction in terms. Nature has no system; she has, she is life and its progress from an unknown center toward an unknowable goal. Scientific research is therefore endless, whether one proceed analytically into minutiae or follow the trail as a whole, in all its breadth and height.

*Goethe's Botanical Writings*  
Problems (p. 116)  
University of Hawaii Press. Honolulu, Hawaii, USA. 1952

## SYSTEMATICS

**Darwin, Charles Robert** 1809–82  
English naturalist

Systematize and study affinities.

*The Autobiography of Charles Darwin, 1809–1882: With Original Omissions Restored*  
Appendix, Quotations (p. 160)  
Harcourt, Brace. New York, New York, USA. 1959

**de Queiroz, K.**

Phylogeneticist

**Donoghue, M. J.**

Phylogeneticist

If the goal of systematics is to depict relationships accurately, then any tradition that interferes with this goal should be abandoned.

Phylogenetic Systematics of Nelson's Version of Cladistics  
*Cladistics*, Volume 4, Number 4, December 1988 (p. 332)

**Elton, Charles S.** 1900–91  
English biologist

The extent to which progress in ecology depends upon accurate identification and upon the existence of sound systematic groundwork for all groups of animals, cannot be too much impressed upon the beginner in ecology. This is the essential basis of the whole thing; without it the ecologist is helpless, and the whole of his work may be rendered useless.

*Animal Ecology*  
Chapter XI (p. 165)  
Sidgwick & Jackson, Ltd. London, England. 1927

**Hennig, W.**

No biographical data available

In order to be able to judge correctly the position of systematics in the field of biology and the role that it is called upon to play in the solution of the basic problems of this science, one must first make clear that there is a systematics not only in biology, but that it is rather an integrating part of any science whatever. It is surprising and peculiar to see to what degree the original significance of this concept has been forgotten in biology in the course of the fundamentally inadmissible but now general limitation of the concept of systematics to a particular subdivision of the science as a whole.

In George Gaylord Simpson  
*Principles of Animal Taxonomy*  
Systematics, Taxonomy, Classification, Nomenclature (p. 6)  
Columbia University Press. New York, New York, USA. 1961

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

...the system of this earth has either been intentionally made imperfect, or has not been the work of infinite power and wisdom.

*The Theory of the Earth* (Volume 1)  
Part I, Chapter I, Section I (p. 17)  
Messrs Cadwell, Junior, and Davies. London, England. 1795

**Mayr, Ernst** 1904–2005  
German-born American biologist

The amount of diversity in the living world is staggering. About 1 million species of animals and half a million species of plants have already been described, and esti-

mates on the number of still undescribed species range from 3 to 10 million.... It would therefore be impossible to deal with this enormous diversity if it were not ordered and classified. Systematic zoology endeavors to order the rich diversity of the animal world and to develop methods and principles to make this task possible.

*Principles of Systematic Zoology*  
Chapter 1 (p. 1)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

The systematist who studies the factors of evolution wants to find out how species originate, how they are related, and what this relationship means. He studies species not only as they are, but also their origin and changes. He tries to find his answers by observing the variability of natural populations under different external conditions and he attempts to find out which factors promote and which inhibit evolution. He is helped in this endeavor by his knowledge of the habits and the ecology of the studied species.

*Systematics and the Origin of Species*  
Chapter I (p. 11)  
Harvard University Press. Cambridge, Massachusetts, USA. 1942

**Simpson, George Gaylord** 1902–84  
American paleontologist

Systematics is the scientific study of the kinds and diversity of organisms and of any and all relationships among them.

*Principles of Animal Taxonomy*  
Systematics, Taxonomy, Classification, Nomenclature (p. 7)  
Columbia University Press. New York, New York, USA. 1961

## T

### TABLE

#### **Carlyle, Thomas** 1795–1881

English historian and essayist

Tables are like cobwebs, like the sieve of the Danaides; beautifully reticulated, orderly to look upon, but which will hold no conclusion. Tables are abstractions.... There are innumerable circumstances; and one circumstance left out may be the vital one on which all turned.... Conclusive facts are inseparable from inconclusive except by a head that already understands and knows.

*English and Other Critical Essays*

Chartism, Chapter II (p. 170)

J.M. Dent & Sons Ltd. London, England. 1950

#### **Devons, Ely** 1913–67

English economist

The way statistics are presented, their arrangement in a particular way in tables, the juxtaposition of sets of figures, in itself reflects the judgment of the author about what is significant and what is trivial in the situation which the statistics portray.

*Essays in Economics*

Chapter 6 (p. 109)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1961

#### **Fisher, Sir Ronald Aylmer** 1890–1962

English statistician and geneticist

[Referring to] ...witty comments made by A.L. Bowley] (a) The terms used in the headings and margins of the table are all employed in a technical sense, known only to the officers who compiled it, and which they are unable for official reasons to divulge. (b) The sub-divisions of the table and the region to which it refers have been changed since the last return was published. (c) Before tabulation the data have been subjected to numerous adjustments, allowances and other corrections, of a kind to vitiate any tests of significance which the reader may be tempted to apply to them.

Presidential Address, First Indian Statistical Conference, 1938

*Sankhya*, Volume 4, 1938 (p. 15)

#### **Playfair, William** 1759–1823

English publicist

Information that is imperfectly acquired, is generally as imperfectly retained; and a man who has carefully investigated a printed table, finds, when done, that he has only a very faint and partial idea of what he has read; and that like a figure imprinted on sand, is soon totally erased and defaced.

*The Commercial and Political Atlas* (p. 3)

Printed for J. Debrett. London, England. 1786

### TACHYON

#### **Herbert, Nick**

American physicist

Although most physicists today place the probability of the existence of tachyons only slightly higher than the existence of unicorns, research into the properties of these hypothetical FTL [faster than light] particles has not been entirely fruitless.

*Faster Than Light: Superluminal Loopholes in Physics*

Chapter 7 (p. 137)

New American Library. New York, New York, USA. 1988

#### **Nahin, Paul J.**

American electrical engineering professor and author

...if tachyons are one day discovered...the day before the momentous occasion a notice from the discoverers should appear in newspapers announcing "tachyons have been discovered tomorrow."

*Time Machines: Time Travel in Physics, Metaphysics, and Science Fiction*

Notes and References, Note 36 (p. 408)

Springer-Verlag. New York, New York, USA. 1993

### TAXONOMIST

#### **Moss, W. W.**

No biographical data available

Taxonomists have always had the reputation of being difficult. Intransigence may be rooted in the necessity of defending prolonged self-immersion in a taxon that others find a total bore; it is frustrating to have one's work greeted with a yawn.

In J. Felsenstein (ed.)

*Numerical Taxonomy*

Taxa, Taxonomists, and Taxonomy (p. 73)

Springer-Verlag. New York, New York, USA. 1983

Numerical taxonomists have proved to be just as prickly as conventional taxonomists, possibly more so because some of the brightest people in systematics are involved in the current taxonomic battles. The political maneuvering and character assassination that characterize certain taxonomists today may not be atypical for science; they certainly provide a fine example of its seamier side. If Feyerabend is correct, it may even be a requirement of human nature that scientific progress occur in this manner.

In J. Felsenstein (ed.)

*Numerical Taxonomy*

Taxa, Taxonomists, and Taxonomy (p. 73)

Springer-Verlag. New York, New York, USA. 1983

## TAXONOMY

**Abbott, Donald Putnam** 1920–86  
American marine biologist and professor

You'll be tempted to grouse about the instability of taxonomy: but stability occurs only where people stop thinking and stop working.

In Galen Howard Hilgard (ed.)

*Observing Marine Invertebrates: Drawings from the Laboratory*

Author's Preface (p. xvi)

Stanford University Press. Stanford, California, USA. 1987

**Blackwelder, R. E.**

No biographical data available

Much has been written in recent decades about subspecies and their use in taxonomy. There are strong feelings that they are usable, useful and desirable. There are also strong feelings that they are not really relevant to taxonomy and are an unnecessary encumbrance to classification and nomenclature.

*Taxonomy: A Text and Reference Book* (p. 171)

John Wiley & Sons, Inc. New York, New York, USA. 1967

**Brew, John O.** 1906–88

American archaeologist

...classificatory systems are merely tools, tools of analysis, manufactured and employed by students, just as shovels, trowels and whisk brooms are tools of excavation.

Papers of the Peabody Museum of American Archaeology and Ethnology

*The Archaeology of Alkali Ridge, Southeastern Utah*

The Use and Abuse of Taxonomy, Volume 21 (p. 46)

Peabody Museum. Cambridge, Massachusetts, USA. 1946

**Burt, B. L.**

No biographical data available

Numerical taxonomy uses statistical methods to form groups whereas traditional taxonomy only uses them to discriminate more precisely between groups already perceived. If it becomes increasingly apparent that there is a fundamental divergence here, let us remember Whitehead's dictum, that a clash of doctrines is not a disaster — it is an opportunity.

Andanson and Modern Taxonomy

*Edinburgh Royal Botanic Gardens, Notes*, Volume 26, 1966

**Cain, A. J.**

Taxonomist

It is not extraordinary that young taxonomists are trained like performing monkeys, almost wholly by imitation, and that in only the rarest cases are they given any instruction in taxonomic theory.

In George Gaylord Simpson

*Principles of Animal Taxonomy*

Preface (p. vii)

Columbia University Press. New York, New York, USA. 1961

**Constance, L.**

No biographical data available

Plant taxonomy has not outlived its usefulness: it is just getting under way on an attractively infinite task.

Plant Taxonomy in an Age of Experiment

*American Journal of Botany*, Volume 44, Number 1, January 1957

(p. 92)

**Gould, Stephen Jay** 1941–2002

American paleontologist and evolutionary biologist

Parochial taxonomies are a curse of intellectual life.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 3)

Harvard University Press. Cambridge, Massachusetts, USA. 1987

Taxonomy (the science of classification) is often undervalued as a glorified form of filing — with each species in its folder, like a stamp in its prescribed place in an album; but taxonomy is a fundamental and dynamic science, dedicated to exploring the causes of relationships and similarities among organisms. Classifications are theories about the basis of natural order, not dull catalogues compiled only to avoid chaos.

*Wonderful Life: The Burgess Shale and the Nature of History*

Chapter III (p. 98)

W.W. Norton & Company, Inc. New York, New York, USA. 1989

**Heywood, V. H.** 1947–

No biographical data available

In these days when Molecular Biology is beginning to be seen as a restricted science, narrowing our vision by concentrating on the basic uniformity of organisms at the macromolecular level, the need for taxonomists to draw attention to the enormous diversity and variation of this earth's biota becomes more and more pressing.

In Tod. F. Stuessy

*Plant Taxonomy: The Systematic Evaluation of Comparative Data*

Plant Taxonomy (p. xvii)

Columbia University Press. New York, New York, USA. 1990

**Jeffrey, C.** 1866–1952

Canadian-American botanist

The bringing to light of overlooked names in the old literature is perhaps nearing completion...it is hoped that this will lead to name-changes for nomenclature reasons becoming ever fewer and fewer until eventually they cease to trouble us. Unfortunately, the same cannot be said of name-changes that become necessary for taxonomic reasons. These arise from taxonomic research itself and are inevitable accompaniments of our systems of classifications.

*Biological Nomenclature* (3<sup>rd</sup> edition) (p. 31)

Edward Arnold. London, England. 1989

**Kevan, D. Keith McE.** 1920–1991  
British ethnoentomologist

Bad taxonomy, of which there has been plenty, persists. Unlike bad chemistry or bad physiology, of which there has probably been equally as much, it cannot be ignored; it must be undone and redone. Poor taxonomy is not only an ill unto itself; it is contagious, often with a very long incubation period.... One assumes that when [experimental biologists] state that they used 5 ml ethanol, they were not using 6 ml of methanol; and yet, if the experimental animal is wrongly identified, what are the grounds for such an assumption?

The Place of Classical Taxonomy in Modern Systematic Entomology  
*Canadian Entomology*, Volume 105, 1973 (p. 1212)

**Rollins, R. C.** 1911–1998  
No biographical data available

In other words, the field of taxonomy in a way epitomizes the work of all other branches of biology centered on the organism itself, and brings the varied factual information from them to bear on the problems of interrelationship, classification and evolution. Thus taxonomy, as has been aptly remarked, is at once the alpha and omega of biology.

Taxonomy of the Higher Plants  
*American Journal of Botany*, Volume 44, Number 1, January 1957 (p. 188)

**Simpson, George Gaylord** 1902–84  
American paleontologist

Taxonomy is a science, but its application to classification involves a great deal of human contrivance and ingenuity, in short, of art. In this art there is leeway for personal taste, even foibles, but there are also canons that help to make some classifications better, more meaningful, more useful than others.

*Principles of Animal Taxonomy*  
From Taxonomy to Classification (p. 107)  
Columbia University Press. New York, New York, USA. 1961

**Stace, C.** 1938–  
English botanist and author

The species is the lowest rank which it is essential to recognize for general taxonomic purposes. It is not, however, the lowest rank which it is desirable and useful to recognize.

*Plant Taxonomy and Biosystematics* (2<sup>nd</sup> edition) (p. 192)  
Edward Arnold Publishers Ltd. London, England. 1989

**Stuessy, Tod F.** 1943–  
No biographical data available

We as taxonomists celebrate diversity. We celebrate the wildness of the planet. We celebrate the numerous human attempts to understand this wilderness, and we mourn its loss through human miscalculation. We sense

the aesthetic of life and much of our efforts are aimed at reflecting this composition. Above all we celebrate the challenges of being alive and dealing with the living world. There is no greater responsibility, privilege, nor satisfaction.

*Plant Taxonomy: The Systematic evaluation of Comparative Data Epilogue* (p. 406)  
Columbia University Press. New York, New York, USA. 1990

The rise beyond the generic level in classification is to enter a world of much greater uncertainty.... Taxa at higher levels will be well-defined or ill-defined depending on the group in question.

*Plant Taxonomy: The Systematic Evaluation of Comparative Data* (p. 207)  
Columbia University Press. New York, New York, USA. 1990

**Wald, George** 1906–97  
American biologist and biochemist

The most important thing about a name, after all, is that it remain attached to the thing it designates. One wishes that once a name had come into common use for an organism, it could be stabilized for the use of busy persons who want nothing but that each animal have a name.

In E.S. Guzman Barron (ed.)  
*Modern Trends in Physiology and Biochemistry*  
Biochemical Evolution (fn p. 339)  
Academic Press, Inc. New York, New York, USA. 1952

## TEACHER

**Alexander, Burton F.**  
American mathematics teacher

The responsibility of developing and improving the general and technical vocabularies that are associated with elementary mathematics lies in the hand of the subject teacher.

Language Development in Mathematics Through Vocabularies  
*The Mathematics Teacher*, Volume 40, Number 8, December 1947 (p. 389)

**Nunn, T. F.**  
No biographical data available

It is not sufficient that the teacher should have a competent knowledge of the subject which he professes...he must (in addition) have considered his science from the point of view at which it appears as a human acquisition.

In Lloyd William Taylor  
*Physics: The Pioneer Science* (Volume 1)  
Chapter 8 (p. 111)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

## TEACHING

**Acton, F. S.**  
No biographical data available

When an engineer apologetically approaches a statistician, graph in hand, and asks how he should fit a straight line to these points, the situation is not unlike the moment when one's daughter inquires where babies come from. There is a need for tact, there is a need for delicacy, but here is opportunity for enlightenment and it must not be discarded casually — or destroyed with the glib answer.

*National Bureau of Standards Report 12-10-51* (p. 1)  
U.S. Government Printing Office, Washington, D.C. 1951

### Author undetermined

It is not needful in the present day to discourage thinkers, they are not too numerous.

Exclusion of Opinion  
*Westminster Review*, Volume 29, 1838 (p. 49)

### Barzun, Jacques 1907–

French-born American educator, historian, and author

To begin with, no school subject should be treated like a bitter pill that will go down only if sugar-coated. The merest hint of this confirms the pupil's belief that he faces something dreadful and is a victim.

*Begin Here: The Forgotten Conditions of Teaching and Learning* (p. 81)  
University of Chicago Press, Chicago, Illinois, USA. 1992

### Berrill, Norman John 1903–96

English-born American biologist

A great teacher is not simply one who imparts knowledge to his students but is one who awakens their interest in the subject and makes them eager to pursue it for themselves. An outstanding teacher is a spark plug, not a fuel line.

In B.W. Rossiter  
*Journal of Chemical Education*, Volume 49, 1972 (p. 388)

### Blake, William 1757–1827

English poet, painter, and engraver

To teach doubt and Experiment  
Certainly was not what Christ meant.

*The Complete Writings of William Blake*  
The Everlasting Gospel, d, l. 49  
Houghton Mifflin Company, Boston, Massachusetts, USA. 1904–1917

### Boerhaave, Herman 1668–1738

Dutch Chemist, physician, and botanist

As you have put your selves under my care, to instruct you in the knowledge of Chemistry, I shall think it my duty to endeavor as much as possible to answer your expectations.

*Elements of Chemistry* (Volume 1)  
The Design (p. 1)  
Printed for J. & J. Pemberton. London, England. 1735

### Bruner, Jerome Seymour 1915–

American psychologist

The teaching of probabilistic reasoning, so very common and important a feature of modern science, is hardly developed in our educational system before college.

*The Process of Education*  
Chapter 3 (p. 45)  
Harvard University Press, Cambridge, Massachusetts, USA. 1961

### Darwin, Charles Robert 1809–82

English naturalist

I am inclined to give up the attempt as hopeless. Those who do not understand, it seems cannot be made to understand.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
Darwin to Hooker, June 5<sup>th</sup>, 1860 (p. 110)  
D. Appleton & Company, New York, New York, USA. 1896

### Ehrensvärd, Gosta Carl Henrik 1910–1980

Swedish biochemist

...consciousness will always be one dimension above comprehensibility.

Translated by Lennart Rodén  
*Man on Another World*  
Chapter X (p. 151)  
The University of Chicago Press, Chicago, Illinois, USA. 1961

### Eldridge, Paul 1888–1982

American educator

What difference does it make how often we lower and raise the bucket into the well if the bucket has no bottom?

*Maxims for a Modern Man*  
484  
T. Yoseloff, New York, New York, USA. 1965

### Faraday, Michael 1791–1867

English physicist and chemist

The most prominent requisite to a lecturer, though perhaps not really the most important, is a good delivery; for though to all true philosophers science and nature will have charms innumerable in every dress, yet I am sorry to say that the generality of mankind cannot accompany us one short hour unless the path is strewn with flowers.

In J.M. Thomas  
*Michael Faraday — and the Royal Institution*  
Chapter 5 (p. 97)  
Adam Hilger, Bristol, England. 1991

...a truly popular lecture cannot teach, and a lecture that truly teaches cannot be popular.

In J.M. Thomas  
*Michael Faraday — and the Royal Institution*  
Chapter 8 (p. 192)  
Adam Hilger, Bristol, England. 1991

A lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him and his mind

clear for the contemplation and description of his subject. His action should be slow, easy and natural consisting principally in changes of posture of the body, in order to avoid the air of stiffness or sameness that would otherwise be unavoidable.

In J.M. Thomas

*Michael Faraday — and the Royal Institution*

Chapter 3 (p. 18)

Adam Hilger. Bristol, England. 1991

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

A good teacher will not just make people accept a form of life, he will also provide them with means of seeing it in perspective and perhaps of even rejecting it.

In Gerard Radnitzky and Gunnar Andersson

*The Structure and Development of Science*

Dialogue on Method (p. 86)

D. Ridel Publishing Company. Dordrecht, Germany. 1979

**Feynman, Richard P.** 1918–88

American theoretical physicist

What I am going to tell you about is what we teach our physics students in the third or fourth year of graduate school.... It is my task to convince you not to turn away because you don't understand it. You see my physics students don't understand it.... That is because I don't understand it. Nobody does.

*QED: The Strange Theory of Light and Matter*

Chapter 1 (p. 9)

Princeton University Press. Princeton, New Jersey, USA. 1985

**Gauss, Johann Carl Friedrich** 1777–1855

German mathematician, physicist, and astronomer

I am giving this winter two courses of lectures to three students, of which one is only moderately prepared, the other less than moderately, and the third lacks both preparation and ability. Such are the onera of a mathematical profession.

*Briefwechsel zwischen Gauss und Bessel*

Letter 4, Letter to Bessel, January 7, 1810 (p. 107)

**Heiss, E. D.** 1899–?

No biographical data available

**Osborn, E. S.** 1897–?

No biographical data available

Science teaching has long concerned itself chiefly with the mastery of laws, facts, and principles to the neglect of certain of the less tangible, but non the less desirable outcomes, such as attitude of mind.

*Modern Methods and Materials for Teaching Science*

Chapter 2 (p. 15)

The Macmillan Company. New York, New York, USA. 1940

**Herbert, George** 1593–1633

English metaphysical poet

Teach me, my God and King,  
In all things thee to see,  
And what I do in any thing,  
To do it as for thee...

*The Elixir*

**Hutchison, Sir Robert Grieve** 1871–1960

English radiologist

Those of us who have the duty of training the raising generation of doctors...must not inseminate the virgin minds of the young with the tares of our own fads. It is for this reason that it is easily possible for teaching to be top "up to date." It is always well, before handing the cup of knowledge to the young, to wait until the froth has settled.

*British Medical Journal*, Volume 1, 1925 (p. 995)

**Huxley, Aldous** 1894–1963

English writer and critic

Ram it in, ram it in!  
Children's heads are hollow.  
Ram it in, ram it in!  
Still there's more to follow.

*Proper Studies*

Education (p. 111)

Chatto & Windus. London, England. 1957

**Huxley, Thomas Henry** 1825–95

English biologist

Therefore, the great business of the scientific teacher is, to imprint the fundamental, irrefragable facts of his science, not only by words upon the mind, but by sensible impressions upon the eye, and ear, and touch of the student, in so complete a manner, that every term used, or law enunciated, should afterwards call up vivid images of the particular structural, or other, facts which furnished the demonstration of the law, or the illustration of the term.

*Lay Sermons, Addresses and Reviews*

On the Study of Zoology (p. 112)

New York, New York, USA. 1872

**Jaffe, Bernard** 1896–1968

Freelance science writer

An effective way to teach the methods of science is to show how our great scientists reached their goals and how their minds worked in the process.

*Journal of Chemical Education*, Volume 15, 1938 (p. 383)

**Milne, A. A. (Alan Alexander)** 1882–1956

English poet, children's writer, and playwright

He learns.

He becomes educated.... He instigates knowledge.

*The Complete Tales and Poems of Winnie-the-Pooh*

The House at Pooh Corner (p. 254)

Dutton Children's Books. New York, New York, USA. 2001

**Moroney, M. J.**

American statistician

Statistics is not the easiest subject to teach, and there are those to whom anything savoring of mathematics is regarded as for ever anathema.

*Facts from Figures*

Statistics Desirable (p. 458)

Penguin Books Ltd., Harmondsworth, England. 1951

**Noble, D. F.**

No biographical data available

You will please keep in mind that this is a college and not a technical school. The students who come here are not to be trained as chemists, or geologists or physicists. They are to be taught the great fundamental truths of all sciences. The object aimed at is culture, not practical knowledge.

In George E. Peterson

*The New England College in the Age of the University* (pp. 4–7)

Amherst College Press. Amherst, Massachusetts, USA. 1964

**Olds, Edwin G.**

No biographical data available

It is hard to understand why he failed to appreciate the pedagogical value of designing an experiment to illustrate a point of theory, predicting the result, running the experiment, and then taking the consequences if it turned out wrong.

Teaching Statistical Quality Control for Town and Gown

*Journal of the American Statistical Association*, Volume 44, 1949

(pp. 223–224)

**Regnault, Noël** 1702–62

Jesuit mathematician

Will you discover to me...those Secrets which Nature has imparted to you?

*Philosophical Conversations* (Volume 1)

Conversation XII (p. 154)

Printed for W. Innyes, C. Davis, and N. Prevost. London, England. 1731

**Rohrlich, Fritz**

No biographical data available

Come, join me on an adventure of the mind. The going will be a little demanding at times but there will be rich rewards. The new vistas are spectacular. Come with me, I am an experienced guide!

*From Paradox to Reality: Our Basic Concepts of the Physical World*

Preface (p. vii)

Cambridge University Press. Cambridge, England. 1987

**Romanoff, Alexis Lawrence** 1892–1980

Russian soldier and scientist

True teaching is a grave profession — Demands most thoughtful, wise discretion.

*Encyclopedia of Thoughts*

Couplets

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Schuffe, J. A.**

No biographical data available

The teaching of chemistry has for too long been a process in which facts are transmitted from the notebook of the professor into the notebook of the student without going through the heads of either.

The Use of Case Histories in the Teaching of History of Science

*The Texas Journal of Science*, Volume 21, Number 1, October 1969

(p. 101)

**Stoppard, Tom** 1937–

Czech-born English playwright

THOMASINA: If you do not teach me the true meaning of things, who will?

SEPTIMUS: Ah. Yes, I am ashamed. Carnal embrace is sexual congress, with the insertion of the male genital organ into the female genital organ for purposes of procreation and pleasure. Fermat's last theorem, by contrast, asserts that when  $x$ ,  $y$ , and  $z$  are whole numbers each raised to power of  $n$ , the sum of the first two can never equal the third when  $n$  is greater than 2. (Pause.)

THOMASINA: Eurghhhh!

SEPTIMUS: Nevertheless, that is the theorem.

THOMASINA: It is disgusting and incomprehensible. Now when I am grown to practice it myself I shall never do so without thinking of you.

*Arcadia*

Act I, Scene One (p. 3)

Faber & Faber Ltd. London, England. 1993

**Sylvester, James Joseph** 1814–97

English mathematician

May the time never come when the two offices of teaching and researching shall be sundered in this University [Johns Hopkins]! So long as man remains a gregarious and sociable being, he cannot cut himself off from the gratification of the instinct of imparting what he is learning, of propagating through others the ideas and impressions seething in his own brain, without stunting and atrophying his moral nature and drying up the surest sources of his future intellectual replenishment.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 3)

Proof of the Fundamental Theorem of Invariants (1878) (p. 77)

University Press. Cambridge, England. 1904–1912

...the two functions of teaching and working in science should never be divorced.

*The Collected Mathematical Papers of James Joseph Sylvester*

(Volume 3)

An Inquiry into Newton's Rule for the Discovery of Imaginary Roots

(p. 75)

University Press. Cambridge, England. 1904–1912

**Truesdell, Clifford** 1919–2000

American mathematician, natural philosopher, historian of mathematics



Formerly, the beginner was taught to crawl through the underbrush, never lifting his eyes to the trees; today he is often made to focus on the curvature of the universe, missing even the earth.

*Six Lectures on Modern Natural Philosophy*

Lecture I (p. 22)

Springer-Verlag. New York, New York, USA. 1966

**Tukey, John W.** 1915–2000

American statistician

Teaching data analysis is not easy, and the time allowed is always far from sufficient.

The Future of Data Analysis

*Annals of Mathematical Statistics*, Volume 33, Number 1, March 1962

(p. 11)

**Weinberg, Alvin Martin** 1915–

American physicist

Very typically a field that was once fashionable eventually ceases to command the interest of the scientists in that field and becomes the concerns of scientists in another field. Nuclear chemistry is a good example of this trend: it began as nuclear physics, was taken over by the chemists, and now, insofar as nuclear properties of radionuclide are important for technology, parts of nuclear chemistry are being taken over by engineers. This tendency for fashions in science to come and go greatly complicates the teaching of science. For, as science proliferates, the discrepancy tends to widen between the older, consolidated body of scientific knowledge and the parts of science that excite the active researcher.

*Reflections on Big Science*

Chapter II (p. 46)

The MIT Press. Cambridge, Massachusetts, USA. 1967

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

No man can be a good teacher when his subject becomes inexplicable.

*Experiment in Autobiography*

Chapter 5, Section 2 (p. 176)

The Macmillan Company. New York, New York, USA. 1934

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Education is an admirable thing, but it is well to remember from time to time that nothing that is worth knowing can be taught.

*Epigrams: Phrases and Philosophies for the Use of the Young*

Sebastian Melmoth

A.R. Keller. London, England. 1907

**Wright, Charles R. A.**

No biographical data available

...in teaching the science of chemistry it is preferable, first, to enumerate the facts in language independent

of any hypothesis, and then to enunciate the various hypotheses that have been and are held, showing how far each is in accordance or contradiction with the observed facts; rather than to mix up from the outset one particular hypothesis with the facts, so as finally to impress on the mind the manifestly erroneous conclusion that the facts have no evidence apart from the hypothesis that more or less clearly explains them.

Atoms

*The Athenaeum*, Number 2398, 11 October 1873 (p. 468)

## TECHNOLOGY

**Abbey, Edward** 1927–89

American environmentalist and nature writer

High technology has done us one great service: It has retaught us the delight of performing simple and primordial tasks — chopping wood, building a fire, drawing water from a spring...

*A Voice Crying in the Wilderness: Notes from a Secret Journal*

Chapter 10 (p. 92)

St. Martin's Press. New York, New York, USA. 1989

**Adler, Alfred** 1870–1937

Austrian psychiatrist

The confusion of science with technology is understandable. Certainly the two often appear to be aspects of a single larger process, as when science proposes new laws of physics, which inspire the development of a technology for their exploration, which in turn exposes inaccuracies in the laws and forces science to seek a more profound level of theory. But in fact their divergence is great. It is in the divergence of engagement from fulfillment, of means from ends...

*Atlantic Monthly*, Volume 279, Number 2, February 1997 (p. 16)

If truth is a path, then science explores it, and the brief stops along the way are where technologies begin (they build towns and pave a highway). Technology is results, science is process; though the two fuse and separate and then fuse once more, as ends and means must, their opposition is profound.

*Atlantic Monthly*, Volume 279, Number 2, February 1997 (p. 16)

**Allen, Charles M.**

American academic

If the human race wants to go to hell in a basket, technology can help it get there by jet. It won't change the desire or the direction, but it can greatly speed the passage.

Speech

Wake Forest University, Winston-Salem, North Carolina, April 25, 1967

**Ashby, Sir Eric** 1904–82

British botanist and educator

The habit of apprehending a technology in its completeness: this is the essence of technological humanism, and this is what we should expect education in the higher technology to achieve. I believe it could be achieved by making specialists' studies the core around which are grouped liberal studies which are relevant to these specialist studies. But they must be relevant; the path to culture should be through a man's specialism, not by-passing it.

*Technology and the Academics: An Essay on Universities and the Scientific Revolution*

Chapter 4 (p. 84)

St. Martin's Press. New York, New York, USA. 1959

A student who can weave his technology into the fabric of society can claim to have a liberal education; a student who cannot weave his technology into the fabric of society cannot claim even to be a good technologist.

*Technology and the Academics: An Essay on Universities and the Scientific Revolution*

Chapter 4 (p. 85)

St. Martin's Press. New York, New York, USA. 1959

### Association of American Colleges

...we have become a people unable to comprehend the technology we invent...

*Integrity in the College Curriculum*, February 1985 (p. 2)

### Ballard, James Graham 1930–

English writer

Science and technology multiply around us. To an increasing extent they dictate the languages in which we speak and think. Either we use those languages, or we remain mute.

*Crash*

Introduction (p. 7)

Flamingo. London, England. 1993

### Barzun, Jacques 1907–

French-born American educator, historian, and author

...something pervasive that makes the difference, not between civilized man and the savage, not between man and the animals, but between man and the robot, grows numb, ossifies and falls away like black mortified flesh when techné assails the senses and science dominates the mind.

In Theodosius Dobzhansky

*The Biology of Ultimate Concern*

Chapter 5 (p. 103)

The New American Library, Inc. New York, New York, USA. 1967

### Beer, Stafford 1926–2002

English theorist academic and consultant

If it works, it's out of date.

*Brain of the Firm: A Development in Management Cybernetics*

Dedication (p. v)

Herder & Herder. New York, New York, USA. 1972

### Bronowski, Jacob 1908–74

Polish-born British mathematician and polymath

Every civilization has been grounded on technology: what makes ours unique is that for the first time we believe that every man is entitled to all its benefits.

Technology and Culture in Evolution

*The American Scholar*, Volume 41, Number 2, Spring 1972 (p. 207)

### Bunge, Mario 1919–

Argentine philosopher and physicist

...whereas science elicits changes in order to know, technology knows in order to elicit changes.

In G. Bugliarello and D. B. Doner (eds.)

*The History and Philosophy of Technology*

Chapter 15 (p. 264)

University of Illinois Press. Urbana, Illinois, USA. 1979

### Byrom, Gletcher L.

No biographical data available

Technology is like having a spouse who helps you with the problems that you wouldn't have had if you hadn't gotten married in the first place.

Technology Is...and Where It's Taking Us

*Science Digest*, Volume 83, Number 2, February 1978 (p. 25)

### Clarke, Arthur C. 1917–

English science and science fiction writer

Any sufficiently advanced technology is indistinguishable from magic.

*The Lost Worlds of 2001*

Chapter 34 (p. 189)

New American Library. New York, New York, USA. 1972

...we know now that comet and asteroid impacts have changed history, and soon we will have the technology to avert that disaster. ...[T]he dinosaurs became extinct because they didn't have a space program.

Interview, *Discover Magazine*, July 1999

### Commoner, Barry 1917–

American biologist, ecologist, and educator

Despite the dazzling successes of modern technology and the unprecedented power of modern military systems, they suffer from a common and catastrophic fault. While providing us with a bountiful supply of food, with great industrial plants, with high-speed transportation, and with military weapons of unprecedented power, they threaten our very survival.

*Science and Survival*

Chapter 7 (p. 126)

The Viking Press. New York, New York, USA. 1966

### de Bono, Edward 1933–

Maltese psychologist and writer

Those who assert that technology has done more harm than good are thinking of a romantic dream world in which a select elite lived a short life of ease and intellectual sophistication surrounded by a population living an even shorter life of poverty, starvation and disease.

*Technology Today*, 1971

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

...the machine does not isolate man from the great problems of nature but plunges him more deeply into them.

*Wind, Sand, and Stars*

Chapter 3 (p. 67)

Reynal & Hitchcock. New York, New York, USA. 1939

**DeSimone, Daniel V.**

No biographical data available

**Cross, Hardy** 1885–1959

American engineer

Technological invention and innovation are the business of engineering. They are embodied in engineering change.

*Education for Innovation*

Introduction (p. 4)

Pergamon Press. New York, New York, USA. 1968

**Drexler, K. Eric** 1955–

American nanotechnology engineer and researcher, and futurist

The promise of technology lures us onward, and the pressure of competition makes stopping virtually impossible. As the technology race quickens, new developments sweep toward us faster, and a fatal mistake grows more likely. We need to strike a better balance between our foresight and our rate of advance. We cannot do much to slow the growth of our technology, but we can speed growth of foresight. And with better foresight, we will have a better chance to steer the technology race in safe directions.

*Engines of Creation*

Finding the Facts (p. 203)

Anchor Press/Doubleday. Garden City, New York, USA. 1986

**Dubos, René Jules** 1901–82

French-born American microbiologist and environmentalist

The idealistic and the demonic forces in nationalism are as powerful today as they were in the past but their expressions are changing, because human history is moving from its hallowed parochial traditions to the era of global technology.... The one credo of technology which has been accepted practically all over the world is that nature is to be regarded as a source of raw materials to be exploited for human ends rather than as an entity to be appreciated for its own value.

*A God Within*

Chapter 10 A Demon Within (p. 204)

Charles Scribner's Sons. New York, New York, USA. 1972

**Dyson, Freeman J.** 1923–

American physicist and educator

If we had a reliable way to label our toys good and bad, it would be easy to regulate technology wisely. But we can rarely see far enough ahead to know which road leads to damnation. Whoever concerns himself with big technology, either to push it forward or to stop it, is gambling in human lives.

*Disturbing the Universe*

Chapter 1 (p. 7)

Basic Books, Inc. New York, New York, USA. 1979

**Editorial**

Technology, when misused, poisons air, soil, water and lives. But a world without technology would be prey to something worse: the impersonal ruthlessness of the natural order, in which the health of a species depends on relentless sacrifice of the weak.

*New York Times*

29 August 1986

**Embree, Alice** 1945–

American peace and women's rights activist

America's technology has turned in upon itself; its corporate form makes it the servant of profits, not the servant of human needs.

In Robin Morgan

*Sisterhood Is Powerful: An Anthology of Writings from the Women's Liberation Movement*

Media Images 1 (p. 211)

Random House, Inc. New York, New York, USA. 1970

**Feynman, Richard P.** 1918–88

American theoretical physicist

For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled.

*What Do You Care What Other People Think?*

Appendix F (p. 237)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

**Frisch, Max** 1911–

Novelist, playwright and diarist

We live technologically, with man as the master of nature, man as the engineer, and let anyone who raises his voice against it stop using bridges not built by nature.... No electric light bulbs, no engines, no atomic energy, no calculating machines, no anesthetics — back to the jungle.

Translated by Michael Bullock

*Homo Faber: A Report* (p. 103)

Harcourt Brace Jovanovich. San Diego, California, USA. 1959

Technology is the knack of so arranging the world that we don't have to experience it.

In Rollo May

*The Cry for Myth*

Chapter Three (p. 57)  
W.W. Norton & Company, Inc. New York, New York, USA. 1991

**Gäbor, Dennis** 1900–79  
Hungarian-English physicist

The most important and urgent problems of the technology of today are no longer the satisfactions of the primary needs or of archetypal wishes, but the reparation of the evils and damages by technology of yesterday.

*Innovations: Scientific, Technological and Social*  
Introduction (p. 9)  
Oxford University Press, Inc. Oxford, England. 1970

**Galbraith, John Kenneth** 1908–2006  
Canadian-American economist

The imperatives of technology and organization, not the images of ideology, are what determine the shape of economics.

*The New Industrial State*  
Chapter I, Section 3 (p. 7)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

It is a commonplace of modern technology that there is a high measure of certainty that problems have solutions before there is knowledge of how they are to be solved.

*The New Industrial State*  
Chapter II, Section 4 (p. 19)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1967

**Gore, Al** 1948–  
45<sup>th</sup> vice-president of the United States and environmentalist

Mistakes in our dealings with Mother Nature can now have much larger unintended consequences, because many of our new technologies confer upon us new power without automatically giving us new wisdom.

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (p. 247)  
Rodale. New York, New York, USA. 2006

**Hanham, H. J.**  
No biographical data available

Great technological advances are always around the corner.  
Clio's Weapons  
*Daedalus*, Spring 1971 (p. 509)

**Heidegger, Martin** 1889–1976  
German philosopher

...the essence of technology...is nothing technological.

*Basic Writings*  
The Question Concerning Technology (p. 285)  
Harper & Row. New York, New York, USA. 1977

**Hoffer, Eric** 1902–83  
American longshoreman and philosopher

Where there is the necessary technical skill to move mountains, there is no need for the faith that moves mountains.

*The Passionate State of Mind, and Other Aphorisms*  
No. 12  
Harper & Brothers. New York, New York, USA. 1955

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

Science is unique to human activities in that it possesses vast areas of certain knowledge. The collective opinion of scientists in these areas about any problem covered by them will almost always be correct. It is unlikely that much in these areas will be changed in the future, even in a thousand years. And because technology rests almost exclusively on these areas the products of technology work as they are intended to do.

*The Origin of the Universe and the Origin of Religion* (p. 17)  
Moyer Bell. Wakefield, Rhode Island, USA. 1993

**Huxley, Aldous** 1894–1963  
English writer and critic

Advances in technology do not abolish the institution of war; they merely modify its manifestations.

*Science, Liberty and Peace*  
Chapter II (p. 47)  
William Morrow & Company, Inc. New York, New York, USA. 1967

**Jones, Barry**  
No biographical data available

The reality is that many of the changes in science and technology are complex because of the complexity of them.

Sayings of the Week  
*Sydney Morning Herald*, 12 July 1986

**Kaysen, Carl** 1920–  
American economist

...the advance of technology, like the growth of population and industry, has also been proceeding exponentially.

Limits to Growth  
*Foreign Affairs*, Volume 50, Number 4, July 1972 (p. 664)

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

Technology made large populations possible; large populations now make technology indispensable.

*Human Nature and the Human Condition*  
Chapter VIII (p. 145)  
Random House, Inc. New York, New York, USA. 1959

**Lerner, Max** 1902–92  
American educator and author

...a world technology means either a world government or world suicide.

*Actions and Passions: Notes on the Multiple Revolution of Our Time*  
The Imagination of H.G. Wells (p. 17)  
Simon & Schuster. New York, New York, USA. 1949

**Lilienthal, David E.** 1899–1981  
American businessman and Tennessee Valley Authority administrator

The machine that frees man's back of drudgery does not thereby make his spirit free. Technology has made us more productive, but it does not necessarily enrich our lives. Engineers can build us great dams, but only great people make a valley great. There is no technology of goodness. Men must make themselves spiritually free.

*TVA: Democracy on the March* (p. 218)  
Harper & Brothers. New York, New York, USA. 1944

**Lovins, Amory B.** 1947–  
American physicist and industry consultant

Any demanding high technology tends to develop influential and dedicated constituencies of those who link its commercial success with both the public welfare and their own. Such sincerely held beliefs, peer pressures, and the harsh demands that the work itself places on time and energy all tend to discourage such people from acquiring a similarly thorough knowledge of alternative policies and the need to discuss them.

*Energy Strategy*  
*Foreign Affairs*, Volume 55, Number 1, October 1976 (p. 93)

**Meadows, Donella H.** 1941–2001  
American scientist, sustainability advocate, and writer

**Meadows, Dennis L.**

American professor of systems science

Technology can relieve the symptoms of a problem without affecting the underlying causes. Faith in technology as the ultimate solution to all problems can thus divert our attention from the most fundamental problem — the problem of growth in a finite system — and prevent us from taking effective action to solve it.

*The Limits to Growth: The 30 Year Update*  
Chapter IV (p. 154)  
Chelsea Green Publishing. White River Junction, Vermont, USA. 2004

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

The open society, the unrestricted access to knowledge, the unplanned and uninhibited association of men for its furtherance — these are what may make a vast, complex, ever growing, ever changing, ever more specialized and expert technological world, nevertheless a world of human community.

*Science and the Common Understanding*  
Chapter 6 (p. 95)  
Simon & Schuster. New York, New York, USA. 1953

In fact, most people — when they speak of Science as a good thing — have in mind such Technology as has altered the condition of their life.

*The Sacred Beetle and Other Great Essays in Science*

*Physics in the Contemporary World* (p. 194)  
Prometheus Books. Buffalo, New York, USA. 1984

## Organisation for Economic Co-Operation and Development

Science and technology...have a number of distinguishing characteristics [that] cause special problems or complications. One...is ubiquity: they are everywhere. They are at the forefront of social change. They not only serve as agents of change, but provide the tools for analysing social change. They pose, therefore, special challenges to any society seeking to shape its own future and not just to react to change or to the sometimes undesired effects of change.

*Technology on Trial: Public Participation in Decision-Making Related to Science and Technology*  
Chapter I, Section B (p. 16)  
Organization for Economic Co-operation and Development. Paris, France. 1979

**Pirsig, Robert M.** 1928–  
American writer

The way to solve the conflict between human values and technological needs is not to run away from technology, that's impossible. The way to resolve the conflict is to break down the barriers of dualistic thought that prevent a real understanding of what technology is — not an exploitation of nature, but the fusion of nature and the human spirit into a new kind of creation that transcends both.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part III, Chapter 25 (p. 291)  
William Morrow & Company, Inc. New York, New York, USA. 1974

**Pope Pius XII** 1876–1958  
Bishop of Rome

The Church welcomes technological progress and receives it with love, for it is an indubitable fact that technological progress comes from God and, therefore, can and must lead to Him.

Christmas message, 1953

**Reich, Charles A.**  
No biographical data available

Technology and production can be great benefactors of man, but they are mindless instruments, and if undirected they careen along with a momentum of their own. In our country, they pulverize everything in their path: the landscape, the natural environment, history and tradition, the amenities and civilities, the privacy and spaciousness of life, beauty, and the fragile, slow-growing social structures which bind us together.

*The Greening of America*  
Chapter 1 (pp. 5–6)  
Bantam Books. New York, New York, USA. 1971

**Rickover, Hyman G.** 1900–86

American naval nuclear engineer

...technology can have no legitimacy unless it inflicts no harm.

A Humanistic Technology

*Mechanical Engineering*, November 1982 (p. 45)

**Sagan, Carl** 1934–96

American astronomer and science writer

Many visionary leaders have imagined a time when the allegiance of an individual human being is not to his particular nation-state, religion, race, or economic group, but to mankind as a whole; when the benefit to a human being of another sex, race, religion, or political persuasion ten thousand miles away is as precious to us as to our neighbor or our brother. The trend is in this direction, but is agonizingly slow. There is a serious question whether such a global self-identification of mankind can be achieved before we destroy ourselves with the technological forces our intelligence has unleashed.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 1 (p. 6)

Dell Publishing, Inc. New York, New York, USA. 1975

The so-called generation gap is a consequence of the rate of social and technological change.

Even within a human lifetime, the change is so great that many people are alienated from their own society. Margaret Mead had described older people as involuntary immigrants from the past to the present.

*The Cosmic Connection: An Extraterrestrial Perspective*  
Chapter 5 (p. 36)

Dell Publishing, Inc. New York, New York, USA. 1975

**Schumacher, Ernst Friedrich** 1911–77

German-born British economist

...the system of nature, of which man is a part, tends to be self-balancing, self-adjusting, self-cleansing. Not so with technology. ... The technology of mass production is inherently violent, ecologically damaging, self-defeating in terms of non-renewable resources, and stultifying for the human person.

*Small Is Beautiful*

Part II, Chapter V (p. 145)

Harper & Row, Publishers. New York, New York, USA. 1973

**Snow, Charles Percy** 1905–80

English novelist and scientist

Technology...is a queer thing. It brings you great gifts with one hand, and it stabs you in the back with the other.

*New York Times*, 15 March 1971

**Sophocles** 496 BCE–406 BCE

Greek playwright

Wonders are many, and none is more wonderful than man; the power that crosses the white sea, driven by the stormy south-wind, making a path under surges that threaten to engulf him...turning the soil with the offspring of horses, as the ploughs go to and fro from year to year. ... And speech, and windswift thought, and all the moods that mould a state, hath he taught himself; and how to flee the arrows of the frost, when 'tis hard lodging under the clear sky, and the arrows of the rushing rain; yea, he hath resource for all....

In *Great Books of the Western World* (Volume 5)

*The Plays of Sophocles*

Antigone, l. 333–340, 349–354

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Soulé, Michael E.**

American conservation biologist

Since we have no choice but to be swept along by this vast technological surge, we might as well learn to surf.

In David Western and Mary C. Pearl

*Conservation for the Twenty-First Century*

Conservation Biology in the Twenty-First Century: Summary and Outlook (p. 303)

Oxford University Press. New York, New York, USA. 1989

**Stevenson, Adlai E.** 1900–65

American political leader and diplomat

Technology, while adding daily to our physical ease, throws daily another loop of fine wire around our souls. It contributes hugely to our mobility, which we must not confuse with freedom. The extensions of our senses, which we find so fascinating, are not adding to the discrimination of our minds, since we need increasingly to take the reading of a needle on a dial to discover whether we think something is good or bad, or right or wrong.

My Faith in Democratic Capitalism

*Fortune Magazine*, October, 1955 (p. 156)

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Our inventions are wont to be pretty toys, which distract our attention from serious things. They are but improved means to an unimproved end.

*The Writings of Henry David Thoreau* (Volume 2)

Walden

Chapter I (p. 84)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Toffler, Alvin** 1928–

American writer and futurist

...[a] great, growling engine of change — technology.

*Future Shock*

Chapter 2 (p. 25)

Random House, Inc. New York, New York, USA. 1979

...technology feeds on itself. Technology makes more technology possible...

*Future Shock*

Chapter 2 (p. 27)

Random House, Inc. New York, New York, USA. 1979

If technology...is to be regarded as a great engine, a mighty accelerator, then knowledge must be regarded as its fuel. And we thus come to the crux of the accelerative process in society, for the engine is being fed a richer and richer fuel every day.

*Future Shock*

Chapter 2 (pp. 29–30)

Random House, Inc. New York, New York, USA. 1979

**Wilkins, Maurice** 1916–2004

New Zealand-born English molecular biologist

Science, with technology, is the only way we have to avoid starvation, disease, and premature death. The misapplication of science and technology is due to the fact that the politics are wrong. Now my own view is that the politics are indeed wrong; but politics and science are so closely interrelated that they can hardly be separated.

In Horace Freeland Judson

*The Eighth Day of Creation: Makers of the Revolution in Biology*

DNA, You Know, Is Midas' Gold (p. 97)

Simon & Schuster. New York, New York, USA. 1979

## TEETH

**Alison, Richard** fl. 1606

English poet

Those cherries fairly do enclose  
Of orient pearl a double row,  
Which, when her lovely laughter shows,  
They look like rosebuds fill'd with snow.

*An Howre's Recreation in Musike*

**Berry, James H.**

No biographical data available

Brush them and floss them and take them to the dentist,  
Care for them and they will stay with you. Ignore them,  
and they'll go away.

Special Advertising Section

*Time*, February 11, 1985 (p. 21)

**Christie, Agatha** 1890–1976

English author

Beastly things, teeth.... Give us trouble from the cradle  
to the grave.

*At Bertram's Hotel*

Chapter X (p. 93)

Dodd, Mead & Company. New York, New York, USA. 1966

**de la Salle, St. Jean Baptiste** 1651–1719

French educational reformer and priest

It is necessary to clean the teeth frequently, more especially after meals, but not on any account with a pin,

or the point of a penknife, and it must never be done at table.

*The Rules of Christian Manners and Civility*

Chapter I

## Editor of the Louisville Journal

Probably the reason why women's teeth decay sooner than men's is not the perpetual friction of their tongues upon the pearl, but rather the intense sweetness of their lips.

In George Denison Prentice

*Prenticeana* (p. 35)

Derby & Jackson. New York, New York, USA. 1859

**Franklin, Benjamin** 1706–90

American printer, scientist, and diplomat

Hot things, sharp things, sweet things, old things, all rot the teeth.

*Poor Richard's Almanac*

1734

**Herrick, Robert** 1591–1674

English poet

Some ask'd how pearls did grow, and where,

Then spoke I to my girle,

To part her lips, and showed them there

The quarelets of pearl.

*The Works of Robert Herrick*

The Rock of Rubies and the Quarry of Pearls

Reprinted for W. & C. Tait. Edinburgh, Scotland. 1823

**Hood, Thomas** 1582–98

English poet and editor

The best of friends fall out, and so

His teeth had done some years ago.

*The Complete Poetical Works of Thomas Hood*

A True Story, Stanza 2

Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**Lamb, Charles** 1775–1834

English essayist and critic

The fine lady, or fine gentleman, who show me their teeth, show me bones.

*The Complete Works and Letters of Charles Lamb*

The Praise of Chimney-Sweeps (p. 99)

Modern Library. New York, New York, USA. 1935

**Martial (Marcus Valerius Martialis)** ca. 40–ca.103

Latin poet and epigrammatist

Thais has black, Laecania snowy teeth. What is the reason? One has those she purchased, the other her own.

Translated by Walter C.A. Ker

*Epigrams* (Volume 1)

Book V, Epigram XLIII (p. 327)

William Heinemann. London, England. 1930

**O'Donoghue, Michael** 1940–94

American writer and performer

Tough teeth make tough soldiers.

*National Lampoon Tenth Anniversary Anthology*

Frontline Dentists (p. 111)

National Lampoon. New York, New York, USA. 1979

**Perelman, Sidney Joseph** 1904–79

American comic writer

I'll dispose of my teeth as I see fit, and after they've gone,  
I'll get along. I started off living on gruel, and by God, I  
can always go back to it again.

*Crazy Like a Fox*

Nothing But the Tooth (p. 72)

Random House, Inc. New York, New York, USA. 1944

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Last scene of all,

That ends this strange eventful history,

Is second childishness and mere oblivion,

Sans teeth, sans eyes, sans taste, sans everything.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

As You Like It

Act II, Scene vii, l. 163–166

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Bid them wash their faces,

And keep their teeth clean.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Coriolanus

Act II, Scene iii, l. 65–66

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Swift, Jonathan** 1667–1745

Irish-born English writer

...sweet Things are bad for the Teeth.

*The Prose Works of Jonathan Swift* (Volume the Fourth)

Polite Conversation, Dialogue II (p. 181)

Printed at the Shakespeare Head Press. Oxford, England. 1939–1968

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

Adam and Eve had many advantages, but the principal  
one was that they escaped teething.

*The Tragedy of Pudd'nhead Wilson*

Chapter IV (p. 39)

New American Library. New York, New York, USA. 1980

**Wheeler, Hugh** 1912–87

English-born playwright

To lose a lover or even a husband or two during the  
course of one's life can be vexing. But to lose one's teeth  
is a catastrophe.

*Four by Sondheim*

A Little Night Music

Act II, Scene I (p. 269)

Applause. New York, New York, USA. 2000

## TEKTITES

**Faul, Henry** 1920–81

Czech-American geochronologist

To anyone who has worked with them, tektites are  
probably the most frustrating stones ever found on  
Earth.

Tektites are Terrestrial

*Science*, Volume 152, Number 3727, 3 June 1966 (p. 1341)

## TELEOLOGY

**Ayala, Francisco J.** 1934–

Spanish-American biologist and philosopher

Biological evolution can however be explained with-  
out recourse to a Creator or a planning agent external  
to the organisms themselves. The evidence of the fos-  
sil record is against any directing force, external or  
immanent, leading the evolutionary process toward  
specified goals. Teleology in the stated sense is, then,  
appropriately rejected in biology as a category of  
explanation.

Biology as an Autonomous Science

*American Scientist*, Volume 56, Number 3, Autumn 1968 (p. 213)

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

Of all the questions now engaging the attention of those  
whose destiny has commanded them to take more or less  
exercise of mind, I know of none more interesting than  
that which deals with what is called teleology — that is to  
say, with design or purpose, as evidenced by the different  
parts of animals and plants.

*Evolution, Old and New*

Chapter I (p. 1)

Hardwicke & Bogue. London, England. 1879

**Reichenbach, Hans** 1891–1953

German philosopher of science

Teleology is analogism, is pseudo explanation; it belongs  
in speculative philosophy, but has no place in scientific  
philosophy.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 195)

University of California Press. Berkeley, California, USA. 1951

**von Brücke, Ernst** 1819–92

German-born physicist and physiologist

Teleology is a lady without whom no biologist can  
live. Yet he is ashamed to show himself with her in  
public.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Five (p. 61)

W.W. Norton & Company, Inc. New York, New York, USA. 1957



**TELESCOPE**

**Bierce, Ambrose** 1842–1914  
American newspaperman, wit, and satirist

Telescope (n): A device having a relation to the eye similar to that of a telephone to the ear, enabling distant objects to plague us with a multitude of needless details.

*The Devil's Dictionary*

Doubleday & Company, Inc. Garden City, New York, USA. 1967

**Brecht, Bertolt** 1898–1956  
German writer

LUDOVICO: ...look at that queer tube thing they're selling in Amsterdam. I gave it a good looking-over. A green leather casing and a couple of lenses, one this way [he indicates a concave lens]. ... One of them's supposed to magnify and the other reduces. Anyone in his right mind would expect them to cancel out. They don't. The thing makes everything appear five times the size. That's science for you.

Translated by John Willett

*Life of Galileo*

Scene 1 (pp. 12–13)

Arcade Publishing. New York, New York, USA. 1994

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

And now the lofty telescope, the scale  
By which they venture Heav'n itself t' assail,  
Was raised, and planted full against the Moon...

*The Poetical Works of Samuel Butler* (Volume 2)

Elephant in the Moon

Bell & Daldy. London, England. 1835

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

All this time the Guard was looking at her, first through a telescope, then through a microscope, and then through an opera-glass.

*The Complete Works of Lewis Carroll*

Through the Looking-Glass

Chapter III (pp. 169–170)

The Modern Library. New York, New York, USA. 1936

**Cedering, Siv** 1939–  
Swedish-American poet, painter, and sculptor

I have helped him polish the mirrors and lenses of our new telescope. It is the largest in existence. Can you imagine the thrill of turning it to some new corner of the heavens to see something never before seen from the earth?

*Science 84*

Letter from Caroline Herschel (1750–1840)

**Copeland, Leland S.** 1886–?  
American poet and writer

Then outward turn an optic tube

From some high, lonely hill,  
That we may glance at cosmic nooks  
And marvels rich, until  
The morning glow conceals those realms  
Where precious things distill,  
Far-forth beyond the utmost reach  
Of human hope and will.

*All Night with the Stars*

*Sky & Telescope*, November 1949

Many of us find that to leave bright room and cozy chair for the dark world outside is contrary to nature, like a moth flying from the light. As a bather plunges into cold water, so the sky hunter must immerse himself in darkness before he will find it comfortable in the night.... So rich is this nocturnal wonderland that even for smallest telescopes numerous objects await observation. A larger lens or mirror is not an assured benefit. Devotion and patience are as important as light grasp.

*All Night with the Stars*

*Sky & Telescope*, November 1949

**de Grasse Tyson, Neil** 1958–  
American astrophysicist and writer

The most famous telescope in modern times is, of course, the Hubble, known to the public primarily through the beautiful, full-color, high-resolution images it has produced of objects in the universe. The problem here is that after viewing such exhibits, you wax poetic about the beauty of the universe yet are no closer than before to understanding how it all works. ...

*Over the Rainbow*

*Natural History*, Volume 110, Number 7, September 2001 (p. 34)

While much good science has come from the Hubble telescope (including the most reliable measure to date for the expansion rate of the universe), you would never know from media accounts that the foundation of our cosmic knowledge continues to flow primarily from the analysis of spectra and not from looking at pretty pictures.

*Over the Rainbow*

*Natural History*, Volume 110, Number 7, September 2001 (p. 34)

**Dressler, Alan**  
American astronomer

To look into space is to look back into time, and telescopes are time machines we can ride nearly all the way back to creation itself.

*Observing Galaxies Through Time*

*Sky and Telescope*, Volume 82, Number 2, August 1991 (p. 126)

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

The sight of a planet through a telescope is worth all the course on astronomy...

*Ralph Waldo Emerson: Essays and Lectures*

Essays: Second Series  
New England Reformers (p. 594)  
The Library of America. New York, New York, USA. 1983

**Everett, Edward** 1794–1865  
American statesman, educator, and orator

The telescope may be likened to a wondrous cyclopean eye, endued with superhuman power, by which the astronomer extends the reach of his vision to the further heavens, and surveys galaxies and universes compared with which the solar system is but an atom floating in the air.

An Oration  
The Uses of Astronomy, Versility of Genius, Albany, New York, 28 July 1856 (p. 22)  
Ross & Tousey. New York, New York, USA. 1856

**Ferris, Timothy** 1944–  
American science writer

Telescopes are like musical instruments, in that you get out of them what you put into them.

*Seeing in the Dark*  
Appendix A (p. 299)  
Simon & Schuster. New York, New York, USA. 2002

**Frost, Robert** 1874–1963  
American poet

Man acts more like the poor bear in a cage  
That all day fights a nervous inward rage...  
The toenail click at the shuffle of his feet,  
The telescope at one end of his beat,  
And at the other end the microscope,  
Two instruments of nearly equal hope...

*Complete Poems of Robert Frost*  
The Bear  
Henry Holt & Company. New York, New York, USA. 1949

He burned his house down for the fire insurance  
And spent the proceeds on a telescope  
To satisfy a lifelong curiosity  
About our place among the infinities.

*Complete Poems of Robert Frost*  
The Star Splitter  
Henry Holt & Company. New York, New York, USA. 1949

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

O telescope, instrument of much knowledge, more precious than any scepter! Is not he who holds thee in his hand made king and lord of the works of God?

In William H. Jefferys and R. Robert Robbins  
*Discovering Astronomy* (p. 174)  
John Wiley & Sons, Inc. New York, New York, USA. 1995

**Gamow, George** 1904–68  
Russian-born American physicist

My telescope  
Has dashed your hope;

Your tenets are refuted.

Let me be terse:

Our universe

Grows daily more diluted!

*Mr. Tompkins in Paperback*  
Chapter 6 (p. 63)  
At The University Press. Cambridge, England. 1965

**Hankins, Arthur Preston** 1880–1932  
No biographical data available

Midnight — with Cole of Spyglass Mountain seated high up on his ladder, his far-seeing blue-gray eye glued to the powerful five-hundred-diameter eye-piece of his telescope. Unnoticeably the refractor followed the planet in its endless flight. The driving clock purred softly, the only sound on Spyglass Mountain — cold and still and fraught with uncanny tensity.

*Cole of Spyglass Mountain* (p. 302)  
Dodd, Mead & Company. New York, New York, USA. 1923

**Hastings, C. S.**  
No biographical data available

Let us therefore congratulate the possessors of this noble instrument, wish them God speed in their search after knowledge, while we remind them that although no astronomer can ever make another discovery that will rival that made by the insignificant tube first directed toward the heavens by the Paduan philosopher, yet no mind can weigh the importance of any truth, however trivial in appearance, which may be added to that store which we call “science.”

*Annual Report of the Board of Regents of the Smithsonian Institution, 1893*  
The History of the Telescope (p. 109)  
Government Printing Office. Washington, D.C. 1894

**Herschel, Friedrich Wilhelm** 1738–1822  
English astronomer

In the old Telescope’s tube we sit,

And the shades of the past around us flit...

*Herschel at the Cape*  
Introduction (p. xix)  
University of Texas Press. Austin, Texas, USA. 1969

I will make such telescopes and see such things!

In Grant Allen  
*Biographies of Working Men*  
Chapter IV

**Holmes, Oliver Wendell** 1809–94  
American physician, poet, and humorist

I was riding on the outside of a stage-coach from London to Windsor, when all at once a picture familiar to me from my New England village childhood came upon me like a reminiscence rather than a revelation. It was a mighty bewilderment of slanted masts and spars and ladders and

ropes, from the midst of which a vast tube, looking as if it might be a piece of ordnance such as the revolted angels battered the walls of Heaven with, according to Milton, lifted its muzzle defiantly towards the sky.

*The Poet at the Breakfast-Table*

Chapter VIII (p. 219)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1895

I love all sights of earth and skies,  
From flowers that grow to stars that shine;  
The comet and the penny show,  
All curious things above, below...  
But most I love the tube that spies  
The orbs celestial in their march;  
That shows the comet as it whisks  
Its tail across the planet's disk,  
Or wheels so close against the sun  
We tremble at the thought of risks  
Our little spinning ball may run.

*The Complete Poetical Works of Oliver Wendell Holmes*

The Flaneur

Houghton Mifflin Company. Boston, Massachusetts, USA. 1899

### **Hubble, Edwin Powell** 1889–1953

American astronomer

The exploration of space is an achievement of great telescopes.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1938*

The Nature of the Nebulae (p. 137)

Government Printing Office. Washington, D.C. 1939

### **Kepler, Johannes** 1571–1630

German astronomer

What now, dear reader, shall we make out of our telescope? Shall we make a Mercury's magic-wand to cross the liquid ether with, and like Lucian lead a colony to the uninhabited evening star, allured by the sweetness of the place? Or shall we make it a Cupid's arrow which, entering by our eyes, has pierced our inmost mind, and fired us with love of Venus?...

*Dioptrice*

Preface (p. 86)

O telescope, instrument of much knowledge, more precious than any scepter! Is not he who holds thee in his hand made king and lord of the works of God?

*Dioptrice*

Preface (p. 103)

### **Kitchiner, William** 1775–1827

English doctor/optician and telescope inventor

Immense telescopes are only about as useful as the enormous spectacles which are suspended over the doors of opticians!

In William Sheehan

*Planets and Perception: Telescopic Views and Interpretations, 1609–1909*

Chapter 9 (p. 113)

The University of Arizona Press. Tucson, Arizona, USA. 1988

### **Longair, Malcolm** 1941–

Scottish astronomer

Twas brillig and the slithy toves  
Brought plans of telescopes fair to see.  
The Jabberwock, he clapped his hands  
And said, "That's just for me."

*Alice and the Space Telescope*

Chapter 2 (p. 7)

The John Hopkins University Press, Baltimore, Maryland, USA. 1989

### **Lovell, Sir Alfred Charles Bernard** 1913–

English astrophysicist

Astronomy has marched forward with the growth in size of its telescopes.

Radio Stars

*Scientific American*, Volume 188, Number 1, January 1953 (p. 21)

### **Maunder, Edward Walter** 1851–1928

English astronomer

We have no right to assume, and yet we do habitually assume, that our telescopes reveal to us the ultimate structure of the planet.

The Canals of Mars

*Knowledge*, Number 1, 1894 (p. 251)

### **Milton, John** 1608–74

English poet

...a spot like which perhaps  
Astronomer in the Sun's lucent Orbe  
Through his glaz'd Optic Tube yet never saw.

In *Great Books of the Western World* (Volume 32)

*Paradise Lost*

Book III, l. 588–590

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Mitchell, Maria** 1818–89

American astronomer and educator

The tube of Newton's first telescope...was made from the cover of an old book—a little glass at one end of the tube and a large brain at the other...

In Helen Wright

*Sweeper in the Sky*

Chapter 9 (p. 168)

Macmillan & Company. New York, New York, USA. 1949

### **Moulton, Forest Ray** 1872–1952

American astronomer

The eye of the fabled Cyclops was not even prophetic of the great telescope at Mt. Wilson, the pupil of whose eye, so to speak, is 100 inches in diameter.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 1)

The University of Chicago Press. Chicago, Illinois, USA. 1927

**Mullaney, James**

American astronomy writer, lecturer, and consultant

The telescope in particular need to be regarded as not just another gadget or material possession but a wonderful, magical gift to humankind — a window on creation, a time machine, a spaceship of the mind that enables us to roam the universe in a way that is surely the next best thing to being out there.

Focal Point

*Sky & Telescope*, March 1990 (p. 244)

**Newton, Sir Isaac** 1642–1727

English physicist and mathematician

If the theory of making telescopes could at length be fully brought into practice, yet there would be certain bounds beyond which telescopes could not perform. For the air through which we look upon the stars is in a perpetual tremor; as may be seen by the tremulous motion of shadows cast from high towers, and by the twinkling of the fixed stars.... The only remedy is a most serene and quiet air, such as may perhaps be found on the tops of the highest mountains above the gossamer clouds.

In *Great Books of the Western World* (Volume 34)

*Optics*

Book 1, Part 1, Proposition viii, problem 2 (p. 423)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Noyes, Alfred** 1880–1958

English poet

My periwig's askew, my ruffle stained

With grease from my new telescope!

*The Torch Bearers: Watchers of the Sky*

William Herschel Conducts (p. 231)

Frederick A. Stokes Company. New York, New York, USA. 1922

**Panek, Richard**

No biographical data available

The relationship between the telescope and our understanding of the dimensions of the universe is in many ways the story of modernity. It's the story of how the development of one piece of technology has changed the way we see ourselves and of how the way we see ourselves has changed this piece of technology, each set of changes reinforcing the other over the course of centuries until, in time, we've been able to look back and say with some certainty that the pivotal division between the world we inhabit today and the world of our ancestors was the invention of this instrument.

*Seeing and Believing: How the Telescope Opened Our Eyes and Minds to the Heavens*

Prologue (p. 4)

The Viking Press. New York, New York, USA. 1998

**Peltier, Leslie C.** 1900–80

American comet hunter

Old telescopes never die, they are just laid away.

*Starlight Nights*

Chapter 28 (p. 232)

Harper & Row, Publishers. New York, New York, USA. 1965

**Rowan-Robinson, Michael** 1942–

English astronomer, astrophysicist, and professor

Once it was the navigators crossing the oceans to find new continents and new creatures, the globe opening up before their eyes, and at the same time the unknown areas, white on the map, shrinking.

Now it is the astronomers' telescopes penetrating the void to find new worlds, voyages of discoveries made with giant metal eyes, seeing light we cannot see.

*Our Universe: An Armchair Guide*

Cosmic Landscape

After Preface

W.H. Freeman & Company. New York, New York, USA. 1990

**Ryder-Smith, Roland**

No biographical data available

All night he watches roving worlds go by

Through tempered glass, his window on the sky

Feels in his own beat

Of some far mightier heart, and hears

The mystic concert of the spheres.

Astronomer

*The Scientific Monthly*, Volume 67, Number 4, October 1948 (p. 253)

**Toogood, Hector B.**

No biographical data available

The telescope, an instrument which, if held the right way up, enables us to examine the stars and constellations at close quarters. If held the wrong way up, however, the telescope is of little or no use.

*The Outline of Everything with a Critical Survey of the World's Knowledge*

Chapter VIII (p. 96)

Little, Brown & Company. Boston, Massachusetts, USA. 1923

**Tsiolkovsky, Konstantin Eduardovich** 1857–1935

Russian research scientist

All that which is marvelous, and which we anticipate with such thrill, already exists but we cannot see it because of the remote distances and the limited power of our telescopes...

In Adam Starchild (ed.)

*The Science Fiction of Konstantin Tsiolkovsky*

Dreams of the Earth and Sky (p. 154)

University Press of the Pacific, Inc. Seattle, Washington, USA. 1979

**Vehrenberg, Hans** 1910–91

German astronomer

It is a fundamental human instinct to collect, whether berries and roots in the prehistoric past or knowledge of the universe today. For several decades, my favorite pastime

has been to collect celestial objects in photographs. I will never forget the many thousands of hours I have spent with my instruments, working peacefully in my telescope shelter as I listened to good music and dreamed about the infinity of the universe.

*Atlas of Deep Sky Splendors*

Preface

Treugesell-Verlag. Düsseldorf, Germany. 1978

### **Vezzoli, Dante**

No biographical data available

Cyclopean eye that sweeps the sky,  
Whose silvered iris gathers light  
From galaxies that unseen pierce  
The silent blanket of the night.

Eye of Palomar

*The Sky*, January 1940 (p. 8)

### **Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

A curious analogy could be based on the fact that even the hugest telescope has to have an eye-piece no larger than the human eye.

Translated by Peter Winch

*Culture and Value* (p. 17e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

### **Wordsworth, William** 1770–1850

English poet

WHAT crowd is this? what have we here! we must not pass it by;

A Telescope upon its frame, and pointed to the sky:  
Long is it as a barber's pole, or mast of little boat,  
Some little pleasure-skiff, that doth on Thames's waters float.

*The Complete Poetical Works of William Wordsworth*

Star-Gazers

Crowell. New York, New York, USA. 1888

### **Zwicky, Fritz** 1898–1974

Swiss astronomer and physicist

Only Galileo and I really knew how to use a small telescope.

In Richard Preston

*First Light*

Part 2 (p. 119)

Random House, Inc. New York, New York, USA. 1996

## TEMPERATURE

### **Feynman, Richard P.** 1918–88

American theoretical physicist

John and his father go out to look at the stars. John sees two blue stars and a red star. His father sees a green star, a violet star, and two yellow stars. What is the total temperature of the stars seen by John and his father?

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*

Judging Books by Their Covers (p. 293)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

## TEMPLE OF SCIENCE

### **Einstein, Albert** 1879–1955

German-born physicist

Many kinds of men devote themselves to Science, and not all for the sake of Science herself. There are some who come into her temple because it offers them the opportunity to display their particular talents. To this class of men science is a kind of sport in the practice of which they exult, just as an athlete exults in the exercise of his muscular prowess. There is another class of men who come into the temple to make an offering of their brain pulp in the hope of securing a profitable return. The men are scientists only by the chance of some circumstance which offered itself when making a choice of career... it is clear that if the men who have devoted themselves to science consisted only of the two categories I have mentioned, the edifice could never have grown to its present proud dimensions. ...

In Max Planck

*Where Is Science Going?*

Prologue (p. 7)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

I am inclined to agree with Schopenhauer in thinking that one of the strongest motives that lead people to give their lives to art and science is the urge to flee from everyday life, with its drab and deadly dullness, and thus to unshackle the chains of one's own transient desires, which supplant one another in interminable succession so long as the mind is fixed on the horizon of daily environment.

In Max Planck

*Where Is Science Going?*

Prologue (p. 7)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

In the temple of science are many mansions, and various indeed are they that dwell therein and the motives that have led them thither. Many take to science out of a joyful sense of superior intellectual power; science is their own special sport to which they look for vivid experience and the satisfaction of ambition; many others are to be found in the temple who have offered the products of their brains on this altar for purely utilitarian purposes. Were an angel of the Lord to come and drive all the people belonging to these two categories out of the temple, the assemblage would be seriously depleted, but there would still be some men, of both present and past times, left inside.

*Ideas and Opinions*

Principles of Research (p. 224)

Crown Publishers, Inc. New York, New York, USA. 1954

**Gregory, Sir Richard Arman** 1864–1952

British science writer and journalist

To qualify for admission into the temple of science it is necessary to offer sacrifices at the altar of knowledge; and only those with sincere regard for truth will find their gifts acceptable.

*Discovery; or, The Spirit and Service of Science*

Chapter III (p. 54)

Macmillan & Company Ltd. London, England. 1918

**Pasteur, Louis** 1822–95

French chemist

Preconceived ideas are like searchlights which illuminate the path of the experimenter and serve him as a guide to interrogate nature. They become a danger only if he transforms them into fixed ideas — this is why I should like to see these profound words inscribed on the threshold of all the temples of science: “The greatest derangement of the mind is to believe in something because one wishes it to be so”...

In René Dubos

*Louis Pasteur: Free Lance of Science*

Speech to the French Academy of Medicine, July 18, 1876, Chapter XIII (p. 376)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Planck, Max** 1858–1947

German physicist

Anybody who has been seriously engaged in scientific work of any kind realizes that over the entrance to the gates of the temple of science are written the words: *Ye must have faith*. It is a quality which the scientist cannot dispense with.

*Where Is Science Going?*

Epilogue (p. 214)

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**TENSOR****Bell, E. T. (Eric Temple)** 1883–1960

Scottish-American mathematician and educator

...the tensor calculus that cost Einstein an effort to master is now a regular part of an undergraduate course in the better technical schools. The subject has been so thoroughly emulsified that even an eighteen-year-old can swallow it without regurgitating. But this does not prove that wither his brain or his stomach is stronger than Einstein's was.

*Mathematics: Queen and Servant of Science*

A Metrical Universe (p. 211)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Benford, Gregory** 1941–

American physicist and science fiction novelist

There was a blithe certainty that came from first comprehending the full Einstein field equations, arabesques of Greek letters clinging tenuously to the page, a gossamer web. They seemed insubstantial when you first saw them, a string of squiggles. Yet to follow the delicate tensors as they contracted, as the superscripts paired with subscripts, collapsing mathematically into concrete classical entities — potential; mass; forces vectoring in a curved geometry — that was a sublime experience. The iron fist of the real, inside the velvet glove of airy mathematics.

*Timescape*

Chapter 15 (pp. 175–176)

Simon & Schuster. New York, New York, USA. 1980

**Bester, Alfred** 1913–87

American science fiction writer

Tensor, said the Tensor

Tensor, said the Tensor

Tensor, apprehension,

And dissension have begun.

*The Demolished Man*

Chapter iii (p. 48)

Shasta Publishers. Chicago, Illinois, USA. 1953

**Einstein, Albert** 1879–1955

German-born physicist

...the energy tensor can be regarded only as a provisional means of representing matter. In reality, matter consists of electrically charged particles...

*The Meaning of Relativity* (p. 82)

Princeton University Press. Princeton, New Jersey, USA. 1945

...in the case of the equations of gravitation it is the four-dimensionality and the symmetric tensor as expression for the structure of space that, together with the invariance with respect to the continuous transformation group, determine the equations all but completely.

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 85)

The Open Court Publishing Company. La Salle, Illinois, USA. 1979

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

We want to express physical laws in such a way that it shall be obvious when we are expressing the same law by reference to two different systems of co-ordinates, so that we shall not be misled into supposing we have different laws when we have one law in different words. This is accomplished by the method of tensors.

*The ABC of Relativity*

Chapter XII (p. 110)

George Allen & Unwin Ltd. London, England. 1958

**van Dine, S. S.** 1888–1939

American art critic and author

The tensor is known to all advanced Mathematicians. It is one of the technical expressions used in non-Euclidean geometry; and though it was discovered by Riemann in connection with a concrete problem in physics, it has now become of widespread importance in the mathematics of relativity. It's highly scientific in the abstract sense, and can have no direct bearing on Sprigg's murder.

*The Bishop Murder Case*

Chapter 9

Charles Scribner's Sons. New York, New York, USA. 1929

**Weyl, Hermann** 1885–1955

German mathematician

The conception of tensors is possible owing to the circumstance that the transition from one co-ordinate system to another expresses itself as a linear transformation in the differentials. One here uses the exceedingly fruitful mathematical device of making a problem “linear” by reverting to infinitely small quantities.

Translated by Henry L. Brose

*Space — Time — Matter*

Chapter II, Section 13 (p. 104)

Dover Publications, Inc. New York, New York, USA. 1922

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

The idea that physicists would in future have to study the theory of tensors created real panic amongst them following the first announcement that Einstein's predictions had been verified.

In Jean-Pierre Luminet

*Black Holes* (p. 47)

Cambridge University Press. New York, New York, USA. 1992

## TESTING

**Colton, Charles Caleb** 1780–1832

English sportsman and writer

Examinations are formidable, even to the best prepared, for the greatest fool may ask more than the wisest man can answer.

*Lacon; or Many Things in a Few Words* (p. 170)

William Gowans. New York, New York, USA. 1849

**da Vinci, Leonardo** 1452–1519

Italian High Renaissance painter and inventor

It is by testing that we discern fine gold.

*Leonardo da Vinci's Note Books* (p. 60)

Duckworth & Company. London, England. 1906

**Raleigh, Sir Walter** 1552–1618

Renaissance English courtier and poet

No instrument smaller than the World is fit to measure men and women: Examinations measure Examinees.

*Laughter from a Cloud*

Some Thoughts on Examinations (p. 120)

Constable. London, England. 1923

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

Examinations are pure humbug from beginning to end.

*Epigrams: Phrases and Philosophies for the Use of the Young*

Oscariana

A.R. Keller. London, England. 1907

In examinations the foolish ask questions that the wise cannot answer.

*Epigrams: Phrases and Philosophies for the Use of the Young*

Phrases and Philosophies

A.R. Keller. London, England. 1907

## THEOREM

**Feynman, Richard P.** 1918–88

American theoretical physicist

We decided that “trivial” means “proved.” So we joked with the mathematicians: “We have a new theorem — that mathematicians can prove only trivial theorems, because every theorem that's proved is trivial.”

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*

A Map of a Cat? (p. 70)

W.W. Norton & Company, Inc. New York, New York, USA. 1985

**Hofstadter, Douglas R.** 1945–

American academic

All the limitative Theorems of metamathematics and the theory of computation suggest that once the ability to represent your own structure has reached a certain critical point, that is the kiss of death: it guarantees that you can never represent yourself totally. Gödel's Incompleteness Theorem, Church's Undecidability Theorem, Turing's Halting Theorem, Tarski's Truth Theorem — all have the flavor of some ancient fairy tale which warns you that “To seek self-knowledge is to embark on a journey which...will always be incomplete, cannot be charted on any map, will never halt, cannot be described.”

*Gödel, Escher, Bach: An Eternal Golden Braid*

Part II, Chapter XX (p. 697)

Basic Books, Inc. New York, New York, USA. 1979

**Howe, Roger** 1945–

American mathematician

Everybody knows that mathematics is about Miracles, only mathematicians have a name for them: Theorems.

MAA address, Baltimore, January 9, 1998

**Huxley, Aldous** 1894–1963

English writer and critic

Too much theorizing, as we all know, is fatal to the soul...

*Tomorrow and Tomorrow and Tomorrow and Other Essays*

The Education of an Amphibian (p. 7)  
Harper & Brothers. New York, New York, USA. 1956

**Papert, Seymour** 1928–  
South African mathematician

For what is important when we give children a theorem to use is not that they should memorize it. What matters most is that by growing up with a few very powerful theorems one comes to appreciate how certain ideas can be used as tools to think with over a lifetime. One learns to enjoy and to respect the power of powerful ideas. One learns that the most powerful idea of all is the idea of powerful ideas.

*Mindstorms: Children, Computers and Powerful Ideas*  
Chapter 3 (p. 76)  
Basic Books, Inc. New York, New York, USA. 1980

**Planck, Max** 1858–1947  
German physicist

...Leibniz's theorem...sets forth fundamentally that of all the worlds that may be created, the actual world is that which contains, besides the unavoidable evil, the maximum good.

Translated by R. Jones and D.H. Williams  
*A Survey of Physics: A Collection of Lectures and Essays*  
The Principle of Least Action (p. 71)  
Methuen & Company Ltd. London, England. 1925

**Poincaré, Henri** 1854–1912  
French mathematician and theoretical astronomer

I beg your pardon; I am about to use some technical expressions, but they need not frighten you for you are not obliged to understand them. I shall say, for example, that I have found the demonstration of such a theorem under such circumstances. This theorem will have a barbarous name unfamiliar to many, but that is unimportant; what is of interest for the psychologist is not the theorem but the circumstances...

*The Foundations of Science*  
Science and Method. Book I  
Chapter III (p. 387)  
The Science Press. New York, New York, USA. 1913

**Sylvester, James Joseph** 1814–97  
English mathematician

No mathematician now-a-days sets any store on the discovery of isolated theorems, except as affording hints of an unsuspected new sphere of thought, like meteorites detached from some undiscovered planetary orb of speculation.

*The Collected Mathematical Papers of James Joseph Sylvester* (Volume 2)  
Notes to the Exeter Association Address (p. 717)  
University Press. Cambridge, England. 1904–1912

**Truesdell, Clifford** 1919–2000  
American mathematician, natural philosopher, historian of mathematics

**Noll, Walter**  
Mathematician

Pedantry and sectarianism aside, the aim of theoretical physics is to construct mathematical models such as to enable us, from the use of knowledge gathered in a few observations, to predict by logical processes the outcomes in many other circumstances. Any logically sound theory satisfying this condition is a good theory, whether or not it be derived from "ultimate" or "fundamental" truth. It is as ridiculous to deride continuum physics because it is not obtained from nuclear physics as it would be to reproach it with lack of foundation in the Bible.

*The Non-Linear Field Theories of Mechanics* (2<sup>nd</sup> edition)  
Introduction, Section 2 (p. 4)  
Springer-Verlag. Berlin, Germany. 1992

**Veblen, Oswald** 1880–1960  
American mathematician

The abstract mathematical theory has an independent, if lonely existence of its own. But when a sufficient number of its terms are given physical definitions it becomes a part of a vital organism concerning itself at every instant with matters full of human significance. Every theorem can be given the form "if you do so and so, such and such will happen."

Remarks on the Foundation of Geometry  
*Bulleting of the American Mathematical Association*, Volume 31, 1925  
(p. 135)

## THEORIST

**Boltzmann, Ludwig Edward** 1844–1906  
Austrian physicist

A friend of mine has defined the practical man as one who understands nothing of theory and the theoretician as an enthusiast who understands nothing at all.

*Theoretical Physics and Philosophical Problems. Selected Writings*  
On the Significance of Theories (p. 33)  
Reidel Publishing Company. Boston, Massachusetts, USA. 1974

**Cardozo, Benjamin N.** 1870–1938  
American jurist

The theorist has a hard time to make his way in an ungrateful world. He is supposed to be indifferent to realities; yet his life is spent in the exposure of realities, which, till illuminated by his searchlight, were hidden and unknown.

*The Growth of the Law*  
Chapter II (p. 21)  
Yale University Press. New Haven, Connecticut, USA. 1924

**Crick, Francis Harry Compton** 1916–2004  
English biochemist



Theorists almost always become too fond of their own ideas, often simply by living with them too long. It is difficult to believe that one's cherished theory, which really works rather nicely in some respects, may be completely false.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 13 (p. 141)  
Basic Books, Inc. New York, New York, USA. 1988

Theorists will often complain that experimentalists ignore their work. Let a theorist produce just one theory of the type sketched above (i.e., one that makes non-obvious verified predictions) and the world will jump to the conclusion (not always true) that he has a special insight into difficult problems.

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 13 (p. 142)  
Basic Books, Inc. New York, New York, USA. 1988

[I]t is virtually impossible for a theorist, by thought alone, to arrive at the correct solution to a set of biological problems.... The best a theorist can hope to do is to point an experimentalist in the right direction....

*What Mad Pursuit: A Personal View of Scientific Discovery*  
Chapter 10 (pp. 109–110)  
Basic Books, Inc. New York, New York, USA. 1988

**Lederman, Leon** 1922–  
American high-energy physicist

The sequence of theorist, experimenter, and discovery has occasionally been compared to the sequence of farmer, pig, truffle. The farmer leads the pig to an area where there might be truffles. The pig searches diligently for the truffles. Finally, he locates one, and just as he is about to devour it, the farmer snatches it away.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 1 (p. 16)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Marshall, Alfred** 1842–1924  
English economist

...the most reckless and treacherous of all theorists is he who professes to let facts and figures speak for themselves.

In A.C. Pigou (ed.)  
*Memorials of Alfred Marshall*  
Chapter VI (p. 168)  
Macmillan & Company Ltd. London, England. 1925

**Spencer-Brown, George** 1923–  
English mathematician and polymath

A theorem is no more proved by logic and computation than a sonnet is written by grammar and rhetoric, or than a sonata is composed by harmony and counterpoint, or a picture painted by balance and perspective. ...[T]hese forms are, in the final analysis, parasitic on — they have no existence apart from — the creativity of the work

itself. Thus the relation of logic to mathematics is seen to be that of an applied science to its pure ground, and all applied science is seen as drawing sustenance from a process of creation with which it can combine to give structure, but which it cannot appropriate.

*Laws of Form*  
Chapter 12 (p. 102)  
George Allen & Unwin Ltd. London, England. 1969

**Truesdell, Clifford** 1919–2000  
American mathematician, natural philosopher, historian of mathematics  
**Noll, Walter**  
Mathematician

The task of the theorist is to bring order into the chaos of the phenomena of nature, to invent a language by which a class of these phenomena can be described efficiently and simply.

*The Non-Linear Field Theories of Mechanics* (2nd edition)  
Introduction, Section 2 (p. 4)  
Berlin: Springer-Verlag. 1992

## THEORY

**Adams, Douglas** 1952–2001  
English author, comic radio dramatist, and musician

There is a theory which states that if ever anyone discovers exactly what the Universe is for and why it is here, it will instantly disappear and be replaced by something even more bizarre and inexplicable.

There is another which states that this has already happened.

*The Ultimate Hitchhiker's Guide to the Galaxy*  
The Restaurant at the End of the Universe  
Chapter 1 (p. 148)  
Ballantine Books. New York, New York, USA. 2002

**Asimov, Isaac** 1920–92s  
American writer and biochemist

Theories are not so much wrong as incomplete.

*The Relativity of Wrong*  
The Relativity of Wrong (p. 222)  
Doubleday & Company, Inc. New York, New York, USA. 1988

Once we learn to expect theories to collapse and to be supplanted by more useful generalizations, the collapsing theory becomes not the gray remnant of a broken today, but the herald of a new and brighter tomorrow.

In Timothy Ferris (ed.)  
*The World Treasury of Physics, Astronomy, and Mathematics*  
The Nature of Science (p. 783)  
Little, Brown & Company. Boston, Massachusetts, USA. 1991

Scientific theories have a tendency to fit the intellectual fashions of the time.

*Asimov on Chemistry*  
The Weighting Game (p. 3)  
Anchor Press/Doubleday. Garden City, New York, USA. 1974

**Ayer, Alfred Jules** 1910–89  
English philosopher

There never comes a point where a theory can be said to be true. The most that one can claim for any theory is that it has shared the successes of all its rivals and that it has passed at least one test which they have failed.

*Philosophy in the Twentieth Century*  
Chapter IV (p. 133)  
Random House, Inc. New York, New York, USA. 1982

**Berkeley, Edmund C.** 1909–88  
American computer theoretician

The World is more complicated than most of our theories make it out to be.

Right Answers — A Short Guide for Obtaining Them  
*Computers and Automation*, Volume 18, Number 10, September 1969 (p. 20)

**Bernard, Claude** 1813–78  
French physiologist

A theory is merely a scientific idea controlled by experiment.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part One, Chapter I, Section vi (p. 26)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Bernstein, Jeremy** 1929–  
American physicist, educator, and writer

I would insist that any proposal for a radically new theory in physics or in any other science, contain a clear explanation of why the precedent science worked. What new domain of experience is being explored by the new science, and how does it meld with the old?

*Cranks, Quarks, and the Cosmos: Writings on Science*  
Chapter I (p. 18)  
Basic Books, Inc. New York, New York, USA. 1993

**Berzelius, Jöns Jacob** 1779–1848  
Swedish chemist

All our theory is but a means of consistently conceptualizing the inward processes of phenomena, and it is presumable and adequate when all scientifically known facts can be deduced from it.

In Edward O. Wilson  
*The Diversity of Life*  
Chapter One (p. 8)  
W.W. Norton & Company, Inc. New York, New York, USA. 1992

This mode of conceptualization [theorizing] can...well be false and...is so frequently. Even though, at a certain period in the development of science, it may match the purpose just as well as a true theory. Experience is augmented, facts appear which do not agree with it, and one is forced to go in search of a new mode of conceptualization within which these facts can also be accommodated;

and in this manner, no doubt, modes of conceptualization will be altered from age to age, as experience is broadened, and the complete truth may ever be attained.

In Edward O. Wilson  
*The Diversity of Life*  
Chapter One (pp. 8–9)  
W.W. Norton & Company, Inc. New York, New York, USA. 1992

**Bethe, Hans** 1906–2005  
American physicist

Scientific theories are not overthrown; they are expanded, refined, and generalized.

In Victor F. Weisskopf  
*Physics in the Twentieth Century: Selected Essays*  
Forward (p. x)  
The MIT Press. Cambridge, Massachusetts, USA. 1972

**Bigelow, S. Lawrence** 1870–1947  
American physical chemistry professor

Our laws summarize our knowledge, our theories summarize our beliefs.... Laws codify established facts, they are history; theories contain the possibilities of the future. Theories may be considered as knowledge in the state of flux.

*Theoretical and Physical Chemistry*  
Section I, Chapter II (pp. 15–16)  
The Century Company. New York, New York, USA. 1917

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

...your theory is crazy. The question which divides us is whether it is crazy enough to have a chance of being correct.

In Martin Gardner  
*The Ambidextrous Universe* (p. 280)

**Bondi, Sir Hermann** 1919–2005  
English mathematician and cosmologist

No theory, however attractive, merits scientific consideration unless it sticks out its neck sufficiently to be disproved by experiment or observation.

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today, 1966*  
Astronomy and the Physical Sciences (p. 263)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1966

**Born, Max** 1882–1970  
German-born English physicist

The human mind is conservative, and the scientist makes no exception from this rule. He will accept a new theory only if it stands the trial of many experimental tests.

*Les Prix Nobel. The Nobel Prizes in 1954*  
Nobel banquet speech for award received in 1954  
Nobel Foundation. Stockholm, Sweden. 1955

A theory, to be of any real use to us, must satisfy two tests. In the first place, it must not make use of any ideas which

are not confirmed by experiment. Special assumptions must not be dragged in merely to meet some particular difficulty. In the second place, the theory must not only explain all the facts known already, but must also enable us to foresee other facts which were not known before and can be tested by further experiment.

*The Restless Universe*

Chapter I (pp. 5–6)

Dover Publications, Inc. New York, New York, USA. 1951

### **Bradbury, Ray** 1920–

American writer

Theories are invigorating and tonic. Give me an ounce of fact and I will produce you a ton of theory by tea this afternoon.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and Walter Sullivan

*Mars and the Mind of Man*

Foreword (p. x)

Harper & Row, Publishers. New York, New York, USA. 1973

### **Bradley, Jr., John Hodgdon** 1898–1962

American geologist

But alas for theories that germinate in the minds of men! They wilt in the bright light of advancing knowledge.

*Parade of the Living*

Part I, Chapter I (pp. 6–7)

Coward-McCann, Inc. New York, New York, USA. 1930

### **Bridgman, Percy Williams** 1882–1961

American physicist

Every new theory as it arises believes in the flush of youth that it has the long-sought goal; it sees no limits to its applicability, and believes that at long last it is the fortunate to achieve the “right” answer.

*The Nature of Physical Theory*

Chapter X (p. 136)

Princeton University Press. Princeton, New Jersey, USA. 1936

### **British Association for the Advancement of Science**

Great physical theories with their trains of practical consequences, are pre-eminently national objects, whether for glory or utility.

In John Frederick William Herschel

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Meeting, Newcastle, 1838 (p. 109)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

### **Buckland, Frank**

No biographical data available

Your theory is most excellent, and I shall endeavor to collect facts for you with a view to its elucidation.

In Karl Pearson

*The Life, Letters, and Labours of Francis Galton* (Volume 2) (p. 87)

At The University Press. Cambridge, England. No date

### **Burroughs, Edgar Rice** 1875–1950

American writer

...even theories must have foundations.

*Pirates of Venus*

Chapter Four (p. 44)

University of Nebraska Press. Lincoln, Nebraska, USA. 2001

### **Campbell, Norman R.** 1880–1949

English physicist and philosopher

To those who have not the power to think, theory will always be dangerous.

*Physics: The Elements*

Chapter VI (p. 121)

At The University Press. Cambridge, England. 1920

Space and time are the conceptions of theory, not of laws. They are neither necessary nor useful in the statement of the results of any experiment.

Theory and Experiment in Relativity

*Nature*, Volume 106, Number 2677, February 17, 1921 (p. 804)

### **Cantor, Georg** 1845–1918

German mathematician

My theory stands as firm as a rock; every arrow directed against it will return quickly to its archer. How do I know this? Because I have studied it from all sides for many years; because I have examined all objections which have ever been made against the infinite numbers; and above all because I have followed its roots, so to speak, to the first infallible cause of all created things.

In Joseph Dauben

*Georg Cantor: His Mathematics and Philosophy of the Infinite*

Chapter 12 (p. 298)

Princeton University Press. Princeton, New Jersey, USA. 1990

### **Chamberlin, T. C.** 1843–1928

American geologist

The moment one has offered an original explanation for a phenomenon which seems satisfactory, that moment affection for his intellectual child springs into existence, and as the explanation grows into a definite theory his parental affections cluster about his offspring and it grows more and more dear to him.... There springs up also unwittingly a pressing of the theory to make it fit the facts and a pressing of the facts to make them fit the theory...

*Journal of Geology*, Volume 5, 1897 (p. 837)

The mind lingers with pleasure upon the facts that fall happily into the embrace of the theory, and feels a natural coldness toward those that seem refractory....

The Method of Multiple Working Hypotheses

*Science*, Volume 148, Number 3671, 7 May 1965 (p. 755)

### **Charlie Chan**

Fictional character

Theory like mist on eyeglasses. Obscure facts.

*Charlie Chan in Egypt*  
Film (1935)

**Charcot, Jean-Martin** 1825–93  
French neurologist

Theory is good, but it doesn't prevent things from existing.

*The Complete Psychological Works of Sigmund Freud* (Volume 3)  
Charcot (p. 13)  
The Hogarth Press. London, England. 1962

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

A man warmly concerned with any large theories has always a relish for applying them to any triviality.

*The Wisdom of Father Brown*  
The Absence of Mr. Glass (p. 16)  
Dodd, Mead & Company. New York, New York, USA. 1927

**Crichton, Michael** 1942–  
American novelist

Most areas of intellectual life have discovered the virtues of speculation, and have embraced them wildly. In academia, speculation is usually dignified as theory.

Why Speculate  
Talk, International Leadership Forum, La Jolla, California, April 26, 2002

**Clarke, Arthur C.** 1917–  
English science and science fiction writer

"I'd be glad to settle without the theory," remarked Kimball, "if I could even understand what this thing is — or what it's supposed to do."

*The Lost Worlds of 2001*  
Chapter 31 (p. 179)  
New American Library. New York, New York, USA. 1972

**Colton, Charles Caleb** 1780–1832  
English sportsman and writer

Theory is worth little, unless it can explain its own phenomena, and it must effect this with out contradicting itself; therefore, the facts are sometimes assimilated to the theory, rather than the theory to the facts.

*Lacon; or Many Things in a Few Words* (p. 77)  
William Gowans. New York, New York, USA. 1849

Professors in every branch of the sciences prefer their own theories to truth: the reason is, that their theories are private property, but truth is common stock.

*Lacon; or Many Things in a Few Words* (p. 189)  
William Gowans. New York, New York, USA. 1849

**Cooper, Leon** 1930–  
American physicist

A theory is a well-defined structure that we hope is in correspondence with what we observe. It's an architecture, a cathedral.

In George Johnson  
*In the Palaces of Memory: How We Build the Worlds Inside Our Heads*  
The Memory Machine (pp. 114–115)  
Alfred A. Knopf. New York, New York, USA. 1991

**Couderc, Paul**  
No biographical data available

The only conceptions that succumb are those that pretend to fix the image of a profound reality: true relations among things survive, united to the true new relations in the burgeoning theory. Let us then rejoice at the massacre of old theories because this is the criterion of progress. There is, I think, no ground for fear that nature will undernourish the seekers. Nothing should diminish our enthusiasm for the experimental victories, decisive and definitive, of the past thirty years.

In Lucienne Felix  
*The Modern Aspect of Mathematics* (p. 31)  
Basic Books, Inc. New York, New York, USA. 1960

**Couper, Archibald Scott** 1831–92  
Scottish scientist

The end of chemistry is its theory. The guide in chemical research is a theory. It is therefore of the greatest importance to ascertain whether the theories at present adopted by chemists are adequate to the explanation of chemical phenomena, or are at least based upon the true principles which ought to regulate scientific research.

*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*, Volume 16, Number 4, 1858

**Crease, Robert P.**  
American science historian  
**Mann, Charles C.**  
American journalist and science writer

[P.A.M.] Dirac said often he was beset by fears when he came up with his new theory.... [H]e soon discovered that his fear was justified. Quantum electrodynamics was indeed a great step forward, but it came at a great price. Dirac had set down the beginnings of the modern theory of electromagnetism — the first solid piece of the standard model — but he had also unwittingly let loose an onslaught of conceptual demons that would change our views of space and matter.

In T. Ferris (ed.)  
*World Treasury of Physics, Astronomy, and Mathematics*  
Uncertainty and Complementarity (p. 69)  
Little, Brown & Company. Boston, Massachusetts, USA. 1991

**Crick, Francis Harry Compton** 1916–2004  
English biochemist

...a theory will always command more attention if it is supported by unexpected evidence, particularly evidence of a different kind.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Chapter 10 (p. 115)  
Basic Books, Inc. New York, New York, USA. 1988

**Cromer, Alan** 1935–  
American physicist and educator

The word theory, as used in the natural sciences, doesn't mean an idea tentatively held for purposes of argument — that we call a hypothesis. Rather, a theory is a set of logically consistent abstract principles that explain a body of concrete facts. It is the logical connections among the principles and the facts that characterize a theory as truth. No one element of a theory...can be changed without creating a logical contradiction that invalidates the entire system. Thus, although it may not be possible to substantiate directly a particular principle in the theory, the principle is validated by the consistency of the entire logical structure.

*Uncommon Sense: The Heretical Nature of Science*  
Chapter 7 (p. 137)  
Oxford University Press, Inc. New York, New York, USA. 1993

**d'Abro, Abraham**  
No biographical data available

...a theory of mathematical physics is not one of pure mathematics. Its aim and its *raison d'être* are not solely to construct the rational scheme of some possible world, but to construct that particular rational scheme of the particular real world in which we live and breathe. It is for this reason that a theory of mathematical physics, in contradistinction to one of pure mathematics, is constantly subjected to the control of experiment.

*The Evolution of Scientific Thought*  
Chapter XXI (p. 215)  
Dover Publications, Inc., New York, New York, USA. 1950

**Dark, K. R.**  
No biographical data available

It would be easy to imagine that archaeological theory is daunting, or irrelevant, or both. Theorists often use jargon-laden sentences, quote obscure works, discuss periods and areas distant from those of one's own interest, and are keen to promote their own views.

*Theoretical Archaeology*  
Introduction (p. 1)  
Duckworth & Company. London, England. 1995

**Darwin, Charles Robert** 1809–82  
English naturalist

Let theory guide your observations, but till your reputation is well established, be sparing in publishing theory. It makes persons doubt your observations.

In Francis Darwin (ed.)  
*More Letters of Charles Darwin* (Volume 2)  
Letter 646, Darwin to Scott, June 6, 1863 (p. 323)  
D. Appleton & Company. New York, New York, USA. 1903

In October 1838, that is, fifteen months after I had begun my systematic inquiry, I happened to read for amusement Malthus on Population, and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. The results of this would be the formation of a new species. Here, then I had at last got a theory by which to work.

*Autobiography*  
...for without the making of theories I am convinced there would be no observation.

In Francis Darwin (ed.)  
*The Life and Letters of Charles Darwin* (Volume 2)  
C. Darwin to C. Lyell, June 1<sup>st</sup> [1860] (p. 108)  
D. Appleton & Company. New York, New York, USA. 1896

**Darwin, G. H.** 1809–82  
No biographical data available

A theory is, then, a necessity for the advance of science, and we may regard it as the branch of a living tree, of which facts are the nourishment.

Address to British Association, Section A  
*Nature*, Volume 34, Number 879, September 2, 1886 (p. 420)

**Davies, John Tasman** 1924–  
Chemist

Theories are generalizations and unifications, and as such they cannot logically follow only from our experiences of a few particular events. Indeed we often generalize from a single event, just as a dog does who, having once seen a cat in a certain driveway, looks eagerly around whenever he passes that place in future. Evidently this latter activity is equivalent to testing the theory...that "there is always a cat in that driveway."

*The Scientific Approach*  
Chapter 1 (p. 11)  
Academic Press. London, England. 1965

...a theory arises from a leap of the imagination...

*The Scientific Approach*  
Chapter 1 (p. 11)  
Academic Press. London, England. 1965

**Davies, Paul Charles William** 1946–  
British-born physicist, writer, and broadcaster

The basis of this theory is that in nature there is an inherent uncertainty or unpredictability that manifests itself only on an atomic scale. For example, the position of a subatomic particle such as an electron may not be a well-defined concept at all; it should be envisaged as jiggling around in a random sort of a way. Energy, too, becomes a slightly nebulous concept, subject to capricious and unpredictable changes.

*The Edge of Infinity: Where the Universe Came from and How It Will*

End

Chapter 4 (p. 90)

Simon & Schuster. New York, New York, USA. 1981

**Davis, Philip J.** 1923–

American mathematician

**Hersh, Reuben** 1927–

American mathematician

If the number of theorems is larger than one can possibly survey, who can be trusted to judge what is “important?” One cannot have survival of the fittest if there is no interaction.

*The Mathematical Experience*

Ulam’s Dilemma (p. 21)

Birkhäuser. Boston, Massachusetts, USA. 1981

**Davy, Sir Humphry** 1778–1829

English chemist

Theories ought to be made for time, and be considered capable of improvement.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter II (p. 70)

London, England. 1839–1840

**de Fermat, Pierre** 1601–65

French mathematician

We have found a beautiful and most general proposition, namely, that every integer is either a square, or the sum of two, three or at most four squares. This theorem depends on some of the most recondite mysteries of number, and is not possible to present its proof on the margin of this page.

In Tobias Dantzig

*Number: The Language of Science* (4<sup>th</sup> edition) (p. 269)

The Macmillan Company. New York, New York, USA. 1954

I have found a very great number of exceedingly beautiful theorems.

In E.T. Bell

*Men of Mathematics* (p. 56)

Simon & Schuster. New York, New York, USA. 1937

**de Grasse Tyson, Neil** 1958–

American astrophysicist and writer

Scientific evidence in support of a theory sometimes takes you places where your senses have never been. Twentieth-century science has largely been built upon data collected with all manner of tools that enable us to see the universe in decidedly uncommon ways. As a consequence, while we have always required that a theory make mathematical sense, we no longer require that a theory make common sense. We simply demand that it be consistent with the results of observations and experiments....

In Defense of the Big Bang

*Natural History*, Volume 105, Number 12, December 1996 (p. 76)

A well-constructed theory must explain some of what is not understood, predict previously unknown phenomena, and, to be successful, have its predictions consistently confirmed. Furthermore, skeptics should not hesitate to question every possible assumption, no matter how basic.

In Defense of the Big Bang

*Natural History*, Volume 105, Number 12, December 1996 (p. 76)

**Dingle, Herbert** 1890–1978

English astrophysicist

Success in scientific theory is won, not by rigid adherence to the rules of logic, but by bold speculation which dares even to break those rules if by that means new regions of interest may be opened up.

*Through Science to Philosophy*

Part II, Chapter XV (p. 346)

At The Clarendon Press. Oxford, England. 1937

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

One forms provisional theories and waits for time or fuller knowledge to explode them. A bad habit, Mr. Ferguson, but human nature is weak.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

The Adventure of the Sussex Vampire (pp. 467–468)

Wings Books. New York, New York, USA. 1967

I don’t mean to deny that the evidence is in some ways very strong in favor of your theory, I only wish to point out that there are other theories possible.

In William S. Baring-Gould (ed.)

*The Annotated Sherlock Holmes* (Volume 2)

Adventures of the Norwood Builder (p. 421)

Wings Books. New York, New York, USA. 1967

**Duhem, Pierre-Maurice-Marie** 1861–1916

French physicist and mathematician

A physical theory is not an explanation. It is a system of mathematical propositions, deduced from a small number of principles, which aim...to represent as simply, as completely, and as exactly as possible a group of experimental laws.

*The Aim and Structure of Physical Theory*

Part I, Chapter II (p. 19)

Princeton University Press. Princeton, New Jersey, USA. 1954

The sole purpose of physical theory is to provide a representation and classification of experimental laws; the only test permitting us to judge a physical theory and pronounce it good or bad is the comparison between the consequences of this theory and the experimental laws it has to represent and classify.

*The Aim and Structure of Physical Theory*

Part II, Chapter VI (p. 180)

Princeton University Press. Princeton, New Jersey, USA. 1954

Unlike the reduction to absurdity employed by geometers, experimental contradiction does not have the power to transform a physical hypothesis into an indisputable truth; in order to confer this power on it, it would be necessary to enumerate completely the various hypotheses which may cover a determinate group of phenomena; but the physicist is never sure he has exhausted all the imaginable assumptions. The truth of a physical theory is not decided by heads or tails.

*The Aim and Structure of Physical Theory*

Part II, Chapter VI (p. 190)

Princeton University Press. Princeton, New Jersey, USA. 1954

When several taps of the beak break the shell of an egg from which the chick escapes, a child may imagine that this rigid and immobile mass, similar to the white shells he picks up on the edge of a stream, had suddenly taken life and produced the bird who runs away with a chirp; but just where his childish imagination sees a sudden creation, the naturalist recognizes the last stage of a long development; he thinks back to the first fusion of two microscopic nuclei in order to review next the series of divisions, differentiations, and reabsorptions which, cell by cell, have built up the body of the chick. The ordinary layman judges the birth of [scientific] theories as the child the appearance of the chick.

*The Aim and Structure of Physical Theory*

Part II, Chapter VII (p. 221)

Princeton University Press. Princeton, New Jersey, USA. 1954

Contemplation of a set of experimental laws does not, therefore, suffice to suggest to the physicist what hypotheses he should choose in order to give a theoretical representation of these laws; it is also necessary that the thoughts habitual with those among whom he lives and the tendencies impressed on his own mind by his previous studies come and guide him, and restrict the excessively great latitude left to this day a merely empirical form until circumstances prepare the genius of a physicist to conceive the hypothesis which will organize them into a theory!

*The Aim and Structure of Physical Theory*

Part II, Chapter VII (p. 255)

Princeton University Press. Princeton, New Jersey, USA. 1954

### **Duschl, Richard Alan** 1951–

American science education professor and researcher

In order to say we have developed a knowledge of science, we must be able to say we have an understanding of the function, structure, and generation of scientific theories.

*Restructuring Science Education: The Importance of Theories and Their Development*

Chapter 6 (p. 96)

Teachers College Press. New York, New York, USA. 1990

### **Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

... a reasoned theory is preferable to blind extrapolation.

*The Expanding Universe*

Chapter I, Section IV (p. 18)

The University Press. Cambridge. 1933

There was just one place where the theory did not seem to work properly, and that was — infinity. I think Einstein showed his greatness in the simple and drastic way in which he disposed of difficulties at infinity. He abolished infinity. He slightly altered his equations so as to make space at great distances bend round until it closed up. So that, if in Einstein's space you kept going right on in one direction, you do not get to infinity; you find yourself back at your starting-point again. Since there was no longer any infinity, there could be no difficulties at infinity. Q. E. D.

*The Expanding Universe*

Chapter I, Section V (pp. 21–22)

The University Press. Cambridge. 1933

The relativity theory of physics reduces everything to relations; that is to say, it is structure, not material, which counts. The structure cannot be built up without material; but the nature of the material is of no importance.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter XII (p. 197)

At The University Press. Cambridge, England. 1953

We have found a strange footprint on the shores of the unknown. We have devised profound theories, one after another to account for its origin. At last, we have succeeded in reconstructing the creature that made the footprint. And lo! It is our own.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter XII (p. 201)

At The University Press. Cambridge, England. 1921

### **Einstein, Albert** 1879–1955

German-born physicist

These fundamental concepts and postulates, which cannot be further reduced logically, form the essential part of a theory, which reason cannot touch. It is the grand object of all theory to make these irreducible elements as simple and as few in number as possible, without having to renounce the adequate representation of any empirical content whatever.

Translated by Alan Harris

*Essays in Science*

On the Method of Theoretical Physics (p. 15)

Philosophical Library. New York, New York, USA. 1934

No fairer destiny could be allotted to any physical theory, than that it should of itself point out the way to the introduction of a more comprehensive theory, in which it lives on as a limiting case.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Part II, Chapter 22 (pp. 98–99)  
Pi Press. New York, New York, USA. 2005

Of the general theory of relativity you will be convinced, once you have studied it. Therefore I am not going to defend it with a single word.

In Paul Arthur Schlipp (ed.)

*Albert Einstein: Philosopher-Scientist*

Letter to A. Sommerfeld, 8 February 1916 (p. 101)

The Library of Living Philosophers, Inc. Evanston, Illinois, USA. 1949

Physical theory has two ardent desires, to gather up as far as possible all pertinent phenomena and their connections, and to help us not only to know how Nature is and how her transactions are carried through, but also to reach as far as possible the perhaps utopian and seemingly arrogant aim of knowing why Nature is thus and not otherwise. Here lies the highest satisfaction of a scientific person.

In G. Holton

*Thematic Origins of Scientific Thought*

Chapter 8 (p. 242)

Harvard University Press. Cambridge, Massachusetts, USA. 1973

Theories are evolved and are expressed in short compass as statements of a large number of individual observations in the form of empirical laws, from which the general laws can be ascertained by comparison. Regarded in this way, the development of a science bears some resemblance to the compilation of a classified catalogue. It is, as it were, a purely empirical enterprise.

Translated by Robert W. Lawson

*Relativity: The Special and General Theory*

Appendix III, The Experimental Confirmation of the General Theory of Relativity

Pi Press. New York, New York, USA. 2005

For the creation of a theory the mere collection of recorded phenomena never suffices — there must always be added a free invention of the human mind that attacks the heart of the matter. And: the physicist must not be content with the purely phenomenological considerations that pertain to the phenomenon. Indeed, he should press on to the speculative method, which looks for the underlying pattern.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Lecture at the Berlin Planetarium, 4 October 1931 (pp. 29–30)

Princeton University Press. Princeton, New Jersey, USA. 1979

The scientific theorist is not to be envied. For Nature, or more precisely experiment, is an inexorable and not very friendly judge of his work. It never says “Yes” to a theory. In the most favorable cases it says “Maybe,” and in the great majority of cases simply “No.” If an experiment agrees with a theory it means for the latter “Maybe,” and if it does not agree it means “No.” Probably every theory will some day experience its “No” — most theories [do], soon after conception.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Note dated 11 November 1922 (p. 18)

Princeton University Press. Princeton, New Jersey, USA. 1979

If my theory of relativity is proven successful, Germany will claim me as a German and France will declare that I am a citizen of the world. Should my theory prove untrue, France will say that I am a German, and Germany will declare that I am a Jew.

*The Great Quotations*

Address at the Sorbonne (p. 226)

New York Times, 16 February 1930

A theory is the more impressive the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability.

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 31)

Open Court. La Salle, Illinois, USA. 1979

I have learned something else from the theory of gravitation: no collection of empirical facts however comprehensive can ever lead to the setting up of such complicated equations. A theory can be tested by experience, but there is no way from experience to the construction of a theory. Equations of such complexity as are the equations of the gravitational field can be found only through the discovery of a logically simple mathematical condition that determines the equations completely or almost completely. Once one has obtained those sufficiently strong formal conditions, one requires only little knowledge of facts for the construction of the theory...

Translated by Paul Arthur Schlipp

*Albert Einstein: Autobiographical Notes* (p. 31)

Open Court. La Salle, Illinois, USA. 1979

**Einstein, Albert** 1879–1955

German-born physicist

**Infeld, Leopold** 1898–1968

Polish physicist

There are no eternal theories in science. It always happens that some of the facts predicted by a theory are disproved by experiment. Every theory has its period of gradual development and triumph, after which it may experience a rapid decline.

*The Evolution of Physics*

The Two Electric Fluids (p. 77)

Simon & Schuster. New York, New York, USA. 1961

Creating a new theory is not like destroying an old barn and erecting a skyscraper in its place. It is rather like climbing a mountain, gaining new and wider views, discovering unexpected connections between our starting point and its rich environment. But the point from which we started out still exists and can be seen, although it appears smaller and forms a tiny part of our broad view gained by the mastery of the obstacles on our adventurous way up.



*The Evolution of Physics*

The Mechanical Scaffold (pp. 158–159)

Simon &amp; Schuster. New York, New York, USA. 1961

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

The possession of an original theory which has not yet been assailed must certainly sweetens the temper of a man who is not beforehand ill-natured.

*Impressions of Theophrastus Such*

How We Encourage Research (p. 26)

William Blackwood. London, England. 1879

**Faraday, Michael** 1791–1867  
English physicist and chemist

The world little knows how many of the thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and secrecy; that in the most successful instances not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized.

In W.I.B. Beveridge

*The Art of Scientific Investigation*

Chapter Five (p. 58)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1957

**Feynman, Richard P.** 1918–88  
American theoretical physicist

Another thing I must point out is that you cannot prove a vague theory wrong. If the guess that you make is poorly expressed and rather vague, and the method that you use for figuring out the consequences is a little vague — you are not sure, and you say, “I think everything’s right because it’s all due to so and so, . . . and I can sort of explain how this works” . . . then you see that this theory is good, because it cannot be proved wrong! Also if the process of computing the consequences is indefinite, then with a little skill any experimental results can be made to look like the expected consequences.

*The Character of Physical Law*

Chapter 7 (pp. 158–159)

BBC. London, England. 1965

If someone were to propose that the planets go around the sun because all planet matter has a kind of tendency for movement, a kind of motility, let us call it an “oomph,” this theory could explain a number of other phenomena as well. So this is a good theory, is it not? It is nowhere near as good as the proposition that the planets move around the sun under the influence of a central force which varies exactly inversely as the square of the distance from the center. The second theory is better because it is so specific; it is so obviously unlikely to be the result of chance. It is so definite that the barest error in the movement can show that it is wrong; but the planets could wobble all over the place, and, according

to the first theory, you could say, “Well, that is the funny behavior of the oomph.”

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (pp. 19–20)

Perseus Books. Reading, Massachusetts, USA. 1998

This is the key of modern science and . . . the beginning of the true understanding of Nature — this idea to look at the thing, to record the details, and to hope that in the information thus obtained might lie a clue to one or another theoretical interpretation.

*The Character of Physical Law*

Chapter 1 (p. 15)

BBC. London, England. 1965

**Fischer, Martin H.** 1879–1962  
German-American physician

Don’t confuse hypothesis and theory. The former is a possible explanation; the latter, the correct one. The establishment of theory is the very purpose of science.

In Howard Fabing and Ray Marr

*Fischerisms*

C.C. Thomas. Springfield, Illinois, USA. 1944

**Frost, Robert** 1874–1963  
American poet

A theory if you hold it hard enough

And long enough gets rated as a creed. . . .

*Complete Poems of Robert Frost*

Etherealizing

Henry Holt &amp; Company. New York, New York, USA. 1949

**Gay-Lussac, Joseph Louis** 1778–1850  
French chemist and physicist

In order to draw any conclusion . . . it is prudent to wait until more numerous and exact observations have provided a solid foundation on which we may build a rigorous theory.

In Maurice Crosland

*Gay-Lussac: Scientist and Bourgeois*

Chapter 4 (p. 71)

Cambridge University Press. Cambridge, England. 1978

**George, William H.**  
No biographical data available

Theories come into fashion and theories go out of fashion, but the facts connected with them stay.

*The Scientist in Action: A Scientific Study of His Methods*

Chapter XII (p. 218)

Williams &amp; Norgate Ltd. London, England. 1936

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

About binomial theorem I'm teeming with a lot o' news — With many cheerful facts about the square of the hypotenuse.

*The Complete Plays of Gilbert and Sullivan*

The Pirates of Penzance

Act I (p. 133)

W.W. Norton & Company, Inc. New York, New York, USA. 1976

**Glashow, Sheldon L.** 1932–  
American physicist

No matter how compelling or elegant it is, a theory of physics must be subjected to experimental verification or it differs little from medieval theology.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*

Chapter 4 (p. 77)

Warner Books. New York, New York, USA. 1988

**Goddard, Robert H.** 1882–1945  
American physicist

In this present age of science, when no problem seems too baffling for the inventor, and no mysterious phenomenon too much in the dark for elucidation by the discoverer, it is surprising that so few fundamental scientific theories can be proved.

*The Papers of Robert H. Goddard* (Volume 1)

On Taking Things for Granted (p. 63)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1970

**Goldhaber, Maurice** 1911–  
Austrian-American physicist

Antaeus was the strongest person alive, invincible as long as he was in contact with his mother, the earth. Once he lost contact with the earth, he grew weak and was vanquished. Theories in physics are like that. They have to touch the ground for their strength.

In Robert P. Crease and Charles C. Mann

How the Universe Works

*The Atlantic Monthly*, August 1984 (p. 91)

**Goodman, Nicholas P.**  
No biographical data available

There are no deep theorems — only theorems that we have not understood very well.

Reflections on Bishops Philosophy of Mathematics

*The Mathematical Intelligence*, Volume 5, Number 3, 1983 (p. 63)

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

As the new Darwinian orthodoxy swept through Europe, its most brilliant opponent, the aging embryologist Karl Ernst von Baer, remarked with bitter irony that every triumphant theory passes through three stages: first it is dismissed as untrue; then it is rejected as contrary to religion; finally, it is accepted as dogma and each scientist claims that he had long appreciated its truth.

*Ever Since Darwin: Reflections in Natural History*

Chapter 20. The Validation of Continental Drift (pp. 161–162)

W.W. Norton & Company, Inc. New York, New York, USA. 1977

I would say usually, theories act as straitjackets to channel observations toward their support, and to forestall data that might refute them. Such theories cannot be rejected from within, for we will not conceptualize the disapproving observations.

*Dinosaur in a Haystack: Reflections in Natural History*

Part Three, Chapter 12 (p. 151)

Random House, Inc. New York, New York, USA. 1995

All great theories are expansive, and all notions so rich in scope and implication are underpinned by visions about the nature of things. You may call these visions “philosophy,” or “metaphor,” or “organizing principle,” but one thing they are surely not — they are not simple inductions from observed facts of the natural world.

*Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*

Chapter 1 (p. 9)

Harvard University Press. Cambridge, Massachusetts, USA. 1987

**Gratzer, Walter Bruno** 1932–  
English science writer

It is also of course difficult to renounce a cherished theory, the product of costly intellectual and emotional investment, and to accept the cost to ambition, reputation and pride of a humiliating retraction. As the economist J. K. Galbraith put it, “faced with the choice between changing one’s mind and proving that there is no need to do so, almost everyone gets busy with the proof.” And so a fatuous optimism triumphs over the caution that must guide all scientists through most of their working lives.

*The Undergrowth of Science: Delusion, Self-Deception and Human Frailty*

Chapter 3 (p. 81)

Oxford University Press, Inc. Oxford, England. 2000

**Gribbin, John** 1946–  
British science writer and astronomer

Good theories are the ones that get those predictions right; the best theories enable us to “get right” the calculation of how the Universe came into being and then exploded into its present form. But that doesn’t mean that they convey ultimate truth, or that there “really are” little hard particles rattling around against each other inside the atom. Such truth as there is in any of this work lies in the mathematics; the particle concept is simply a crutch ordinary mortals can use to help them towards an understanding of the mathematical laws.

*The Search of Superstrings, Symmetry, and the Theory of Everything* (pp. 51–52)

Little, Brown & Company. Boston, Massachusetts, USA. 1998

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

“The results so far obtained are consistent with the view that...” has taken the place of “Thus saith the Lord...” as an introduction to a new theory.

*Possible Worlds and Other Papers*

Chapter XXX (p. 223)

Harper & Brothers. New York, New York, USA. 1928

**Hamilton, Edith** 1868–1963

German-born classicist and educator

Theories that go counter to the facts of human nature are foredoomed.

*The Roman Way*

Comedy's Mirror

W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Hawking, Stephen William** 1942–

English theoretical physicist

...a good theory is characterized by the fact that it makes a number of predictions that could in principle be disproved or falsified by observation.

*A Brief History of Time: The Updated and Expanded Edition*

Chapter 1 (p. 10)

Bantam Books. Toronto, Ontario, Canada. 1988

**Heaviside, Oliver** 1850–1925

English electrical engineer, mathematician, and physicist

Theory always tends to become more abstract as it emerges successfully from the chaos of facts by processes of differentiation and elimination, whereby the essentials and their connections become recognized, while minor effects are seen to be secondary or unessential, and are ignored temporarily, to be explained by additional means.

In J.W. Mellor

*Higher Mathematics for Students of Chemistry and Physics* (p. 370)

Dover Publications. New York, New York, USA. 1955

**Heinlein, Robert A.** 1907–88

American science fiction writer

Permit me to say, speaking from experience, all theories are empty.

*Time Enough for Love*

Chapter XIII (p. 390)

G.P. Putnam's Sons. New York, New York, USA. 1973

Modern theory did not arise from revolutionary ideas which have been, so to speak, introduced into the exact sciences from without. On the contrary, they have forced their way into research which was attempting consistently to carry out the program of classical physics — they arise out of its very nature.

In Heinz R. Pagels

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part I, Chapter 3 (p. 67)

Simon & Schuster. New York, New York, USA. 1982

**Heitler, W.** 1904–1981

German theoretical physicist

It is usually the fate of good physical theory that after its initial success, difficulties or limitations of its applicability become apparent. Eventually it is superseded by a better theory in which some of the difficulties are removed or which has a wider field of application, as the case may be.

*The Quantum Theory of Radiation*

Introduction (p. xi)

At The Clarendon Press. Oxford, England. 1954

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

A philosophical theory does not shoot up like the tall and spiry pine in graceful and unencumbered natural growth, but, like a column built by men, ascends amid extraneous apparatus and shapeless masses of materials...

*Essays from the Edinburgh and Quarterly Reviews with Addresses and Other Pieces*

Terrestrial Magnetism (p. 67)

Longman, Brown, Green, Longmans & Roberts. London, England. 1857

**Hilton, James** 1900–1954

English-born novelist

And I believe that the Binomial Theorem and a Bach Fugue are, in the long run, more important than all the battles of history.

*This Week Magazine*, 1937

**Holt, Michael**

No biographical data available

Nobody knows why, but [the only] scientific theories that really work are the mathematical ones.

*Mathematics in Art*

Chapter 2 (p. 33)

Studio Vista. London, England. 1971

**Horton, Robin**

British anthropologist and philosopher

To say of the traditional African thinker that he is interested in supernatural rather than natural causes makes little more sense...than to say of the physicist that he is interested in nuclear rather than natural causes. In fact, both are making the same use of theory to transcend the limited vision of natural causes provided by common sense.

*African Traditional Thought and Western Science*

*Africa*, Volume 37, Number 1, 1967 (p. 57)

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

It is true that we must not accept a theory on the basis of emotional preference but it is not an emotional preference to attempt to establish a theory that would place us in a position to obtain a complete understanding of the Universe. The stakes are high, and win or lose, are worth playing for.

*Frontiers of Astronomy*

Epilogue (pp. 354–355)  
Harper & Row, Publishers. New York, New York, USA. 1955

**Hoyle, Sir Fred** 1915–2001  
English mathematician and astronomer

**Hoyle, Geoffrey** 1942–  
English science fiction writer

Be suspicious of a theory if more and more hypotheses are needed to support it as new facts become available, or as new considerations are brought to bear.

*Evolution from Space* (p. 135)  
Simon & Schuster. New York, New York, USA. 1982

**Hubble, Edwin Powell** 1889–1953  
American astronomer

Many theories are formulated but relatively few endure the tests. The survivors, in general, must be occasionally revised to conform with the growing body of knowledge. The ability to theorize is highly personal; it involves art, imagination, logic, and something more. An outstanding genius may invent a successful new type of theory; first-rate men may follow the lead and develop other theories on the same pattern; less competent minds are embarrassed by the custom of testing predictions.

*The Realm of the Nebulae*  
Introduction (p. 5)  
Dover Publications, Inc. New York, New York, USA. 1958

No theory is sacred. When a theory fails to meet the test of verified predictions, it is modified to include the larger field, or, vary rarely, it may be abandoned completely.

*The Nature of Science and Other Lectures*  
Part I, Experiment and Experience (p. 41)  
The Huntington Library. San Marino, California, USA. 1954

**Huggins, Sir William** 1824–1910  
English astronomer

A theory which sweeps the astronomical horizon of so many mysteries must not only arouse our profound interest, but claim the respectful consideration of men of science.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1902*  
Stellar Evolution in the Light of Recent Research (p. 192)  
Government Printing Office. Washington, D.C. 1903

**Hutton, James** 1726–97  
Scottish geologist, chemist, and naturalist

But when, in framing a theory of the earth, a geologist shall indulge his fancy in framing, without evidence, that which had preceded the present order of things, he then either misleads himself, or writes a fable for the amusement of his reader.

*The Theory of the Earth* (Volume 1)  
Part I, Chapter III (pp. 280–281)  
Messrs. Cadwell, Junior & Davies. London, England. 1795

**Huxley, Thomas Henry** 1825–95  
English biologist

The struggle for existence holds as much in the intellectual as in the physical world. A theory is a species of thinking, and its right to exist is coextensive with its power of resisting extinction by its rivals.

*Collected Essays* (Volume 2)  
*Darwiniana*  
The Coming of Age of “The Origin of Species” (p. 229)  
Macmillan & Company Ltd. London, England. 1904

**James, William** 1842–1910  
American philosopher and psychologist

Theories thus become instruments, not answers to enigmas, in which we can rest. We don’t lie back upon them, we move forward, and, on occasion, make nature over again by their aid.

*Pragmatism: A New Name for Some Old Ways of Thinking*  
Lecture II (p. 53)  
Longmans, Green & Company London, England. 1914

...the classic stages of a theory’s career. First, you know, a new theory is attacked as absurd; then it is admitted to be true, but obvious and insignificant; finally it is seen to be so important that its adversaries claim that they themselves discovered it.

*Pragmatism: A New Name for Some Old Ways of Thinking*  
Lecture VI (p. 198)  
Longmans, Green & Company London, England. 1914

**Jastrow, Joseph** 1863–1944  
Polish-born psychologist

Theories without facts or based on uncritically selected facts are vain, and facts without theoretical interpretation, blind.

In Joseph Jastrow (ed.)  
*The Story of Human Error*  
Introduction (p. 33)  
D. Appleton-Century Company, Inc. New York, New York, USA. 1936

**Joos, Georg** 1894–1959  
German physicist

While it is true that theory often sets difficult, if not impossible tasks for the experiment, it does, on the other hand, often lighten the work of the experimenter by disclosing cogent relationships which make possible the indirect determination of inaccessible quantities and thus render difficult measurements unnecessary.

*Theoretical Physics*  
Introduction (p. 1)  
Blackie & Son Ltd. London, England. 1968

**Kelvin, Lord William Thomson** 1824–1907  
Scottish engineer, mathematician, and physicist

A scientific theory is a tool and not a creed.

In Richard Willstätter  
*From My Life: The Memoirs of Richard Willstätter*

Chapter 12 (p. 388)

W.A. Benjamin. New York, New York, USA. 1965

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

For scientific theories are, each and all of them, and they will continue to be, built upon and about notions which, however sublimated, are nevertheless derived from common sense.

*Mathematics* (pp. 5–6)

Columbia University Press. New York, New York, USA. 1907

**Kitaigorodski, Aleksandr Isaakovich** 1914–  
No biographical data available

A first-rate theory predicts; a second-rate theory forbids and a third-rate theory explains after the event.

Lecture, ICU, Amsterdam, August 1975

**Koestler, Arthur** 1905–83  
Hungarian-born English writer

The history of cosmic theories...may without exaggeration be called a history of collective obsessions and controlled schizophrenias.

*The Sleepwalkers*

Preface (p. 15)

The Macmillan Company. New York, New York, USA. 1966

**Kuhn, Thomas S.** 1922–96  
American historian of science

The scientist must...be concerned to understand the world and to extend the precision and scope with which it has been ordered. That commitment must, in turn, lead them to scrutinize, either for themselves or through colleagues, some aspect of nature in great empirical detail. And, if that scrutiny displays pockets of apparent disorder, then these must challenge the scientist to a new refinement of their observational techniques or to a further articulation of their theories.

*The Structure of Scientific Revolutions*

Chapter IV (p. 42)

The University of Chicago Press. Chicago, Illinois, USA. 1970

...no theory ever solves all the puzzles with which it is confronted at a given time; nor are the solutions already achieved often perfect.

*The Structure of Scientific Revolutions*

Chapter XII (p. 146)

The University of Chicago Press. Chicago, Illinois, USA. 1970

One often hears that successive theories grow ever closer to, or approximate more and more closely to, the truth. Apparently generalizations like that refer not to the puzzle-solutions and the concrete predictions derived from a theory but rather to its ontology, to the match, that is, between the entities with which the theory populates nature and what is “really there.”

*The Structure of Scientific Revolutions*

Postscript–1969 (p. 206)

The University of Chicago Press. Chicago, Illinois, USA. 1970

**Lakatos, Imre** 1922–74  
Hungarian-born philosopher

No theory forbids some state of affairs specifiable in advance; it is not that we propose a theory and Nature may shout No. Rather, we propose a maze of theories, and Nature may shout INCONSISTENT.

Criticism and the Methodology of Scientific Research Programmes

*Proceedings of the Aristotelian Society*, Volume 69, 1968–1969 (p. 162)

Scientists want to make their theories respectable, deserving of the title “science”, that is genuine knowledge. Now the most relevant knowledge in the seventeenth century, when science was born, concerned God, the Devil, Heaven and Hell. If one got one’s conjectures about matters of divinity wrong, the consequences of one’s mistake was eternal damnation.

*The Methodology of Scientific Research Programmes* (p. 2)

Cambridge University Press. Cambridge, England. 1978

**Laszlo, E.**

No biographical data available

Ours is a complex world. But human knowledge is finite and circumscribed. “Nature does not come as clean as you can think it,” warned Alfred North Whitehead, and went on to propound an extremely clean and elegant cosmology. Since theories, like window panes, are clear only when they are clean, and the world does not come as cleanly as all that, we must know where we perform a clean-up operation.

*The Systems View of the World: The Natural Philosophy of the New Developments in the Sciences*

Chapter 1, Section 2 (p. 13)

George Braziller. New York, New York, USA. 1972

Scientific theories, while simpler than reality, must nevertheless reflect its essential structure. Science then must beware of rejecting the structure for the sake of simplicity; that would be to throw out the baby with the bath water.

*The Systems View of the World: The Natural Philosophy of the New Developments in the Sciences*

Chapter 1, Section 2 (p. 13)

George Braziller. New York, New York, USA. 1972

**Lauden, Larry** 1945–  
American philosopher of science

...the rationale for accepting or rejecting any theory is thus fundamentally based on the idea of problem-solving progress. If one research tradition has solved more important problems than its rivals, then accepting that tradition is rational precisely to the degree that we are aiming to “progress,” i.e., to maximize the scope of solved problems. In other words, the choice of one tradition over its rivals is a progressive (and thus a rational) choice

precisely to the extent that the chosen tradition is a better problem solver than its rivals.

*Progress and Its Problems: Toward a Theory of Scientific Growth*  
Chapter Three (p. 109)  
University of California Press. Berkeley, California, USA. 1977

**Lederman, Leon** 1922–  
American high-energy physicist

...a comment on the word “theory,” which lends itself to popular misconceptions. “That’s your theory” is a popular sneer. Or “That’s only a theory.” Our fault for sloppy use. The quantum theory and the Newtonian theory are well-established, well-verified components of our world view. They are not in doubt. It’s a matter of derivation. Once upon a time it was Newton’s (as yet unverified) “theory.” Then it was verified, but the name stuck. “Newton’s theory” it will always be. On the other hand, superstrings and GUTs are speculative efforts to extend current understanding, building on what we know.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 9 (p. 389)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

The better theories are verifiable. Once upon a time that was the sine qua non of any theory. Nowadays, addressing events at the Big Bang, we face, perhaps for the first time, a situation in which a theory may never be experimentally tested.

*The God Particle: If the Universe Is the Answer, What Is the Question?*  
Chapter 9 (p. 389)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Lewontin, Richard C.** 1929–  
American evolutionary geneticist and philosopher of science

Theory generally should not be an attempt to say how the world is. Rather, it is an attempt to construct the logical relations that arise from various assumptions about the world.

In E. Mayr and W.B. Provine (eds.)  
*The Evolutionary Synthesis*

Part One, Chapter 1  
Theoretical Population Genetics in the Evolutionary Synthesis (p. 65)  
Harvard University Press. Cambridge, Massachusetts, USA. 1980

It is not always appreciated that the problem of theory building is a constant interaction between constructing laws and finding an appropriate set of descriptive state variables such that laws can be constructed.

*The Genetic Basis of Evolutionary Change*  
Chapter 1 (p. 8)  
Columbia University Press. New York, New York, USA. 1974

...we cannot go out and describe the world in any old way we please and then sit back and demand that an explanatory and predictive theory be built on that description.

*The Genetic Basis of Evolutionary Change*  
Chapter 1 (p. 8)  
Columbia University Press. New York, New York, USA. 1974

**Libes, Antoine** 1752–1832  
French physicist

Let us add a word in favor of theories, which certain physicists still dare to present as invincible obstacles to the discovery of truth. It is incontestable that experience and observation ought to serve as the basis of our physical knowledge. But without the help of theory the most well-certified experiments, the most numerous observations will be only isolated facts in the hands of the physicist, isolated facts which cannot serve for the advancement of physics. The man of genius must seize upon these scattered links and bring them together skillfully to form a continuous chain. This continuity constitutes the theory, which alone can give us a glimpse of the relations which bind the facts to one another and of their dependence on the causes which have produced them.

In Russell McCormach (ed.)  
*Historical Studies in the Physical Sciences* (Volume 4)  
In Robert H. Silliman  
Fresnel and the Emergence of Physics as a Discipline (p. 143)  
Princeton University Press. Princeton, New Jersey, USA. 1974

**Lichtenberg, Georg Christoph** 1742–99  
German physicist and satirical writer

This whole theory is good for nothing except disputing about.

*Lichtenberg: Aphorisms & Letters*  
Aphorisms (p. 57)  
Jonathan Cape. London, England. 1969

**Lindley, David** 1956–  
English astrophysicist and author

Theoretical physicists can invent theories in which the speed of light is not an absolute limit, but those theories do not correspond to the world we inhabit. The speed of light does not have to be finite, but in our world, as distinct from all the imaginary worlds a mathematician might invent, it is. Some things in the end can be determined only empirically, by looking at the world and figuring out how it works.

*The End of Physics: The Myth of a Unified Theory*  
Prologue (p. 6)  
Basic Books, Inc. New York, New York, USA. 1993

Ultimately, theories must be useful and accurate, and in that sense it does not matter whether they were arrived at through piercing insight or blind luck.

*The End of Physics: The Myth of a Unified Theory*  
Prologue (p. 10)  
Basic Books, Inc. New York, New York, USA. 1993

**Lodge, Sir Oliver** 1851–1940  
English physicist

A physical theory cannot take the whole universe into account; but if it is to be complete enough to be

satisfactory, and to make trustworthy predictions, it must take all relevant factors into account.

Contributions to a British Association Discussion on the Evolution of the Universe  
*Nature*, Supplement, October 24, 1931 (p. 722)

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

The object of natural science is the connection of phenomena; but the theories are like dry leaves which fall away when they have long ceased to be the lungs of the tree of science.

*History and Root of the Principle of the Conservation of Energy*  
Chapter IV (p. 74)  
The Open Court Publishing Company, Chicago, Illinois, USA. 1911

**Maimonides, Moses** 1135–1204  
Spanish-born philosopher, jurist, and physician

Man knows only these poor mathematical theories about the heavens, and only God knows the real motions of the heavens and their causes.

In Phillip Frank  
*Modern Science and its Philosophy*  
Chapter 13 (p. 222)  
Harvard University Press, Cambridge, England. 1952

**Malthus, Thomas Robert** 1766–1834  
English economist

Each pursues his own theory, little solicitous to correct or improve it by an attention to what is advanced by his opponents.

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today, 1961*  
Essays on the Principle of Population (p. 473)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1961

**Matthew, William Diller** 1871–1930  
Canadian-American paleontologist

Many a false theory gets crystallized by time and absorbed into the body of scientific doctrine through lack of adequate criticism when it is formulated.

Supplementary Note  
*Climate and Evolution* (Volume 1) (p. 159)  
Special Publications of the New York Academy of Sciences. December 1950

**Mayes, Jr., Harlan**

Theory, glamorous mother of the drudge experiment.

In Eric M. Rogers  
*Physics for the Inquiring Mind*  
Chapter 40 (p. 648)  
Princeton University Press, Princeton, New Jersey, USA. 1960

**Mayo, John**  
No biographical data available

This theory of the learned author is certainly very ingenious, but I am not sure that it is in the same degree in accordance with truth.

*Medico-Physical Works*  
Fourth Treatise  
Chapter I (p. 231)  
The Alembic Club, Edinburgh, Scotland. 1907

**Medawar, Sir Peter Brian** 1915–87  
Brazilian-born English zoologist

Scientific theories...begin as imaginative constructions. They begin, if you like, as stories, and the purpose of the critical or rectifying episode in scientific reasoning is precisely to find out whether or not these stories are about real life.

*Pluto's Republic*  
Science and Literature, Section 4 (p. 53)  
Oxford University Press, Inc. Oxford, England. 1982

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

...for a professor must have a theory, as a dog must have fleas.

*Prejudices: First Series*  
Criticism of Criticism of Criticism (p. 12)  
Alfred A. Knopf, New York, New York, USA. 1923

**Merezhkovskii, Konstantine** 1855–1921  
Russian biologist

The Germans compare German science to a lighthouse. I would as well, but then to a lighthouse without sacred fire to light up the world. The Germans carry stones to construct a solid base without which there would be no lighthouse, and in this task no other nation surpasses them. But, it is left for others to arrive and light the fire. Now, without fire, there is no lighthouse.

In Jan Sapp  
*Evolution by Association: A History of Symbiosis*  
Chapter 4 (p. 56)  
Oxford University Press, Inc. New York, New York, USA. 1994

**Neumann, John von** 1903–57  
Hungarian-American mathematician

It must be emphasized that it is not a question of accepting the correct theory and rejecting the false one. It is a matter of accepting that theory which shows greater formal adaptability for a correct extension. This is a formalistic esthetic criterion, with a highly opportunistic flavor.

*Collected Works* (Volume 6)  
Method in the Physical Sciences (p. 498)  
Pergamon Press, New York, New York, USA. 1961–1963

**Newell, A.**  
No biographical data available

Working with theories is not like skeet shooting, where theories are lofted up and bang, they are shot down with

a falsification bullet, and that's the end of that theory. Theories are more like graduate students—once admitted you try hard to avoid flunking them out, it being much better for them and for the world if they can become long-term contributors to society.

*Unified Theories of Cognition*

Introduction (p. 14)

Harvard University Press. Cambridge, Massachusetts, USA. 1990

**Nietzsche, Friedrich** 1844–1900

German philosopher

It is certainly not the least charm of a theory that it is refutable...

*Beyond Good and Evil*

Chapter I, 18 (pp. 18–19)

The Modern Library. New York, New York, USA. 1917

**Nizer, Louis** 1902–94

English-born American lawyer

The argument seemed sound enough, but when a theory collides with a fact, the result is a tragedy.

*My Life in Court* (p. 433)

Doubleday & Company, Inc. New York, New York, USA. 1961

**Novalis (Friederich von Hardenberg)** 1772–1801

German poet

Theories are like fishing: it is only by casting into unknown waters that you may catch something.

In Jean-Pierre Luminet

*Black Holes* (p. 1)

Cambridge University Press. New York, New York, USA. 1992

**Oman, John** 1860–1939

English Presbyterian theologian

To refuse to consider any possibility is merely the old habit of making theory the measure of reality.

*The Natural and the Supernatural*

Chapter XV (p. 269)

The Macmillan Company. New York, New York, USA. 1931

**Oppenheimer, J. Robert** 1904–67

American theoretical physicist

The theory of our modern technical [era] shows that nothing is as practical as theory.

*Reflex*, July 1977

**Papoulis, Athanasios** 1921–2002

Greek-American engineer and applied mathematician

Scientific theories deal with concepts, never with reality. All theoretical results are derived from certain axioms by deductive logic. In physical sciences the theories are so formulated as to correspond in some useful sense to the real world, whatever that may mean. However, this correspondence is approximate, and the physical justification of all theoretical conclusions is based on some form of inductive reasoning.

*Probability, Random Variables, and Stochastic Processes*

Chapter 1 (p. 3)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1965

**Parsons, Talcott** 1902–79

American sociologist

Theory not only formulates what we know but also tells us what we want to know, that is, the questions to which an answer is needed.

*The Structure of Social Action*

Part I, Chapter I (p. 9)

The Free Press. Glencoe, Illinois, USA. 1949

**Pasteur, Louis** 1822–95

French chemist

Without theory, practice is but routine born of habit. Theory alone can bring forth and develop the spirit of invention.

In René Dubos

*Louis Pasteur: Free Lance of Science*

Chapter I (p. 11)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Petit, Jean-Pierre** 1937–

French astrophysicist

Sir, please believe me, it's the first time this has ever happened. Have another try, don't get upset. You know our Theorems are GUARANTEED.

*Euclid Rules OK?* (p. 11)

John Murray Ltd. London, England. 1982

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

A theory is never more unfairly dealt with, than when those parts are separated which were meant to support one another, and each left to stand or fall by itself.

*Illustrations of the Huttonian Theory of the Earth*

Section 303 (p. 340)

Dover Publications, Inc. New York, New York, USA. 1964

The want of theory, then, does not secure the candor of an observer, and it may very much diminish his skill. The discipline that seems best calculated to promote both is a thorough knowledge of the methods of inductive investigation; an acquaintance with the history of physical discovery; and the careful study of those sciences in which the rules of philosophizing have been most successfully applied.

*Illustrations of the Huttonian Theory of the Earth*

Note XXVI, 459 (p. 528)

Dover Publications, Inc. New York, New York, USA. 1964

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

It is not sufficient for a theory to affirm no false relations; it must not hide true relations.

*The Foundations of Science*



Science and Hypothesis, Part IV  
Chapter X (p. 145)  
The Science Press. New York, New York, USA. 1913

At the first blush it seems to us that theories last only a day and that ruins upon ruins accumulate.... But if we look more closely, we see that what thus succumb are the theories properly so called, those which pretend to teach us what things are. But there is in them something which usually survives. If one of them taught us a true relation, this relation is definitively acquired, and it will be found again under a new disguise in the other theories which will successively come to reign in place of the old.

*The Foundations of Science*  
The Value of Science, Science and Reality (p. 351)  
The Science Press. New York, New York, USA. 1913

**Popper, Karl R.** 1902–94  
Austrian/British philosopher of science

...scientific theories, if they are not falsified, for ever remain hypotheses or conjectures.

*Unended Quest: An Intellectual Autobiography*  
Chapter 16 (p. 79)  
Open Court Publishing Company. La Salle, Illinois, USA. 1976

The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it. The question how it happens that a new idea occurs to a man — whether it is a musical theme, or a dramatic conflict, or a scientific theory — may be of great interest to empirical psychology; but it is irrelevant to the logical analysis of scientific knowledge.

*The Logic of Scientific Discovery*  
Part I, Chapter I, Section 2 (p. 31)  
Basic Books, Inc. New York, New York, USA. 1959

Theories are nets cast to catch what we call “the world”: to rationalize, to explain, and to master it. We endeavor to make the mesh ever finer and finer.

*The Logic of Scientific Discovery*  
Part II, Chapter III (p. 59)  
Basic Books, Inc. New York, New York, USA. 1959

Never let yourself be goaded into taking seriously problems about words and their meanings. What must be taken seriously are questions of fact, and assertions about facts: theories and hypotheses; the problems they solve; and the problems they raise.

*Unended Quest: An Intellectual Autobiography*  
Chapter 7 (p. 19)  
Open Court Publishing Company. La Salle, Illinois, USA. 1976

Scientific theories are not the digest of observations, but they are inventions — conjectures boldly put forward for trial, to be eliminated if they clashed with observations; with observations which were rarely accidental, but as a rule undertaken with the definite intention of testing a theory by obtaining, if possible, a decisive refutation.

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 1, Section IV (p. 46)  
Harper & Row, Publishers. New York, New York, USA. 1963

As with our children, so with our theories, and ultimately with all the work we do: our products become largely independent of their makers. We may gain more knowledge from our children or from our theories than we ever imparted to them.

*Unended Quest: An Intellectual Autobiography*  
Chapter 40 (p. 196)  
Open Court Publishing Company. La Salle, Illinois, USA. 1976

Every “good” scientific theory is one which forbids certain things to happen; the more a theory forbids, the better it is.

In C.A. Mace (ed.)  
*British Philosophy in the Mid-Century*  
Philosophy of Science: A Personal Report I (p. 159)  
George Allen & Unwin Ltd. London, England. 1957

...our critical examinations of our theories lead us to attempts to test and to overthrow them; and these lead us further to experiments and observations of a kind which nobody would ever have dreamed of without the stimulus and guidance both of our theories and of our criticisms of them. For indeed, the most interesting experiments and observations were carefully designed in order to test our theories, especially our new theories.

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 10, Section I (pp. 215–216)  
Harper & Row, Publishers. New York, New York, USA. 1963

We have no reason to regard the new theory as better than the old theory — to believe that it is nearer to the truth — until we have derived from the new theory new predictions which were unobtainable from the old theory (the phases of Venus...) and until we have found that these new predictions were successful.

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 10 (p. 246)  
Harper & Row, Publishers. New York, New York, USA. 1963

...a high probability cannot be one of the aims of science. For the scientist is most interested in theories with a high content. He does not care for highly probable trivialities but for bold and severely testable (and severely tested) hypotheses. If (as Carnap tells us) a high degree of confirmation is one of the things we aim at in science, then degree of confirmation cannot be identified with probability. ...if high probability were an aim of science, then scientists should say as little as possible, and preferably utter tautologies only. But their aim is to “advance” science, that is to add to its content. Yet this means lowering its probability. And in view of the high content of universal laws, it is [not] surprising to find that their probability is zero...

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 11, Section VI (p. 286)  
Harper & Row, Publishers. New York, New York, USA. 1963

The dogmatic attitude of sticking to a theory as long as possible is of considerable significance. Without it we could never find out what is in a theory — we should give the theory up before we had real opportunity of finding out its strength; and in consequence no theory would ever be able to play its role of bringing order into the world, of preparing us for future events, of drawing our attention to events we should otherwise never observe.

*Conjectures and Refutations: The Growth of Scientific Knowledge*  
Chapter 15, fn 1 (p. 312)  
Harper & Row, Publishers. New York, New York, USA. 1963

**Pratchett, Terry** 1948–  
English author

...theories, diverse as they are, have two things in common. They explain the observed facts, and they are completely and utterly wrong.

*The Light Fantastic* (p. 165)  
Colin Smythe. Gerrards Cross, England. 1986

**Priestley, J. B.**  
No biographical data available

A first encounter with any grand fantastic theory, not political or economic, delights me.

*Delight*  
Fantastic Theories (p. 52)  
William Heinemann. London, England. 1949

**Raup, David Malcolm** 1933–  
American geophysicist and paleontologist

[A] new theory is guilty until proven innocent, and the pre-existing theory is innocent until proven guilty. ... Continental drift was guilty until proven innocent.

*The Nemesis Affair: A Story of the Death of the Dinosaurs and the Ways of Science*  
Chapter 12 (pp. 195, 205)  
W.W. Norton & Company, Inc. New York, New York, USA. 1986

**Reiser, Anton** 1628–86  
German Lutherischer theologian

Our experience and observations alone never lead to finalities. Theory, however, creates reliable roads over which we may pursue our journeys through the world of observations.

In Bernard Jaffe  
*New World of Chemistry*  
Chapter 11 (p. 133)  
Silver, Burdett & Company. New York, New York, USA. 1935

**Richards, Dickinson W.** 1895–1973  
American physician and physiologist

The problems are the ones that we have always known. The little gods are still with us, under different names. There is conformity: of technique, leading to repetition; of language, encouraging if not imposing conformity of thought. There is popularity: it is so easy to ride along on

an already surging tide; to plant more seed in an already well-ploughed field; so hard to drive a new furrow into stony ground. There is laxness: the disregard of small errors, of deviations, of the unexpected response; the easy worship of the smooth curve. There is also fear: the fear of speculation; the overprotective fear of being wrong. We are forgetful of the curious and wayward dialectic of science, whereby a well-constructed theory even if it is wrong, can bring a signal advance.

*Transactions of the Association of American Physicians*, Volume 75, 1962 (p. 1)

**Richet, Charles** 1850–1935  
French physiologist

I often recall to my students the history of Don Quixote, who, having constructed a helmet of cardboard and wood, wished to prove its solidity. Alas, the poor helmet flew to bits when his own good sword struck it. Then the knight, no whit discouraged, made a new and stronger helmet. He raised his sword.

*The Natural History of a Savant*  
Chapter II (p. 17)  
J.M. Dent & Sons Ltd. London, England. 1927

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

A theory is worthless without good supporting data.

*Encyclopedia of Thoughts*  
Aphorisms 2410  
Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Rota, Gian-Carlo** 1932–99  
Italian-born American mathematician

**Pringsheim, Alfred** 1850–1941  
German mathematician

Theorems are not to mathematics what successful courses are to a meal. The nutritional analogy is misleading.

In Philip J. Davis and Reuben Hersh  
*The Mathematical Experience*  
Introduction (pp. xviii–xix)  
Birkhäuser. Boston, Massachusetts, USA. 1981

**Rothman, Tony** 1953–  
American cosmologist

**Sudarshan, George** 1931–  
Indian physicist

The everyday usage of “theory” is for an idea whose outcome is as yet undetermined, a conjecture, or for an idea contrary to evidence. But scientists use the word in exactly the opposite sense. [In science] “theory”...refers only to a collection of hypotheses and predictions that is amenable to experimental test, preferably one that has been successfully tested. It has everything to do with the facts.

*Doubt and Certainty: The Celebrated Academy: Debates on Science, Mysticism, Reality, in General on the Knowable and Unknowable*  
First Debate (p. 2)  
Perseus Books. Reading, Massachusetts, USA. 1998

It is not difficult to calculate that if one inflated the world to keep up with the current rate of population growth, then after 2598 years the earth would be expanding at the speed of light. The growth of science is proceeding even faster. Several years ago, in physics at least, we crossed the point at which the expected lifetime of a theory became less than the lead time for publication in the average scientific journal. Consequently, most theories are born dead on arrival and journals have become useless, except as historical documents.

*A Physicist on Madison Avenue*  
Chapter 8 (p. 118)  
Princeton University Press. Princeton, New Jersey, USA. 1991

A theory is accepted only when the last of its opponents dies off. The Copernican Revolution was a great shift in mankind's thinking, but did not take place overnight.

*Instant Physics: From Aristotle to Einstein, and Beyond*  
Chapter 1 (p. 15)  
Ballantine Books. New York, New York, USA. 1995

**Russell, Bertrand Arthur William** 1872–1970  
British philosopher, logician, and social reformer

...it is only theory that makes men completely incautious.

*Unpopular Essays*  
Ideas that Have Harmed Mankind (p. 210)  
George Allen & Unwin Ltd. London, England. 1950

**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952  
Spanish-born American philosopher

Theory helps us to bear our ignorance of facts.  
*The Sense of Beauty*  
Part III, Section 30 (p. 125)  
Transaction Publishers. New Brunswick, New Jersey, USA. 2000

**Sayers, Dorothy L.** 1893–1957  
English novelist and essayist

Very dangerous things, theories.  
*The Unpleasantness at the Bellona Club*  
Chapter 4 (p. 27)  
HarperPaperback. New York, New York, USA. 1995

**Schegel, Richard**  
No biographical data available

We must accept, I think, that there is an inherent limitation in the structure of science that prevents a scientific theory from ever giving us an adequate total explanation of the universe. Always, there is a base in nature (or, correspondingly, a set of assumptions in theory) which cannot be explained by reference to some yet more fundamental

property. This feature of science has been commented on by many writers in the philosophy of science; and, certainly the limitation is a point of difference between science and those religious or metaphysical systems in which there is an attempt to present a doctrine that gives answers for all ultimate questions.

*Completeness in Science*  
Chapter 14, Section 2 (p. 252)  
Appleton-Century-Crofts. New York, New York, USA. 1967

**Schiller, Ferdinand Canning Scott** 1864–1937  
English philosopher

It is the business of theories to forecast “facts”, and of facts to form points of departure for theories, which again, when verified by the new facts to which they have successfully led, will extend the borders of knowledge.

In Charles Singer (ed.)  
*Studies in the History and Method of Science* (Volume 1)  
Scientific Discovery and Logical Proof (p. 275)  
At The Clarendon Press. Oxford, England. 1917

**Schön, Donald A.** 1930–97  
American philosopher of practice and learning theory

...there is a high, hard ground where practitioners can make effective use of research-based theory and technique, and there is a swampy lowland where situations are confusing “messes” incapable of technical solution. ...[I]n the swamp are the problems of greatest human concern.

*The Reflective Practitioner: How Professionals Think in Action* (p. 42)  
Aldershot Press. Avebury, England. 1983

**Schramm, David N.** 1945–97  
American astrophysicist

**McKee, Christopher F.** 1942–  
American astrophysicist

When theory runs too far ahead of what can be measured, a field becomes more philosophy than science.

*Astronomy in the Mind and the Lab*  
*Sky and Telescope*, Volume 82, Number 4, October 1991 (p. 352)

**Seeger, Raymond J.**

It is noteworthy that the etymological root of the word theatre is the same as that of the word theory, namely a view. A theory offers us a better view.

*Journal of the Washington Academy of Sciences*, Volume 36, 1946 (p. 286)

**Shaw, George Bernard** 1856–1950  
Irish comic dramatist and literary critic

The weakness of the man who, when his theory works out into a flagrant contradiction of the facts, concludes “so much the worse for the facts: let them be altered,” instead of “so much the worse for my theory.”

*Liberty*

New York

A Degenerate's View of Nordau, July 27, 1895

### Silver, Brian L.

Israeli professor of physical chemistry

Some see the fragility of scientific theory as an indication of a basic inability of science to explain the universe. But scientific change is almost always accompanied by an increase in our ability to rationalize and predict the course of nature. Newton could explain far more than Aristotle, Einstein far more than Newton. Science frequently stumbles, but it gets up and carries on. The road is long.

*The Ascent of Science*

Preface (p. xiii)

Solomon Press Book. New York, New York, USA. 1998

Facts may be regarded as indisputable; theories are not.

*The Ascent of Science*

Part I, Chapter 2 (p. 19)

Solomon Press Book. New York, New York, USA. 1998

### Skolimowski, Henryk 1930–

Polish philosopher

Theories, like old soldiers, fade away rather than being killed on the scientific battlefield.

In A.J. Ayala (ed.)

*Studies in the Philosophy of Biology: Reduction and Related Problems*

Problems of Rationality in Biology (p. 217)

Macmillan & Company Ltd. London, England. 1974

### Slater, John C. 1900–76

American physicist and theoretical chemist

A theoretical physicist in these days asks just one thing of his theories: if he uses them to calculate the outcome of an experiment, the theoretical prediction must agree, within limits, with the result of the experiment. He does not ordinarily argue about philosophical implications of his theory. Almost his only recent contribution to philosophy has been the operational idea, which is essentially only a different way of phrasing the statement I have just made, that the one and only thing to be done with a theory is to predict the outcome of an experiment. As a physicist, I find myself very well satisfied with this attitude.

Electrodynamics of Ponderable Bodies

*Journal of the Franklin Institute*, Volume 225, Number 3, March 1938

(pp. 277–287)

Questions about a theory which do not affect its ability to predict experimental results correctly seem to me quibbles about words, rather than anything more substantial, and I am quite content to leave such questions to those who derive some satisfaction from them.

Electrodynamics of Ponderable Bodies

*Journal of the Franklin Institute*, Volume 225, Number 3, March 1938

(pp. 277–287)

### Slosson, Edwin E. 1865–1929

American chemist and journalist

The scientist does not abandon a theory because it has inconsistencies any more than he divorces his wife because she has inconsistencies.

*Easy Lesson in Einstein: A Discussion of the More Intelligible Features of the Theory of Relativity*

Scientific Versus Legal Laws (p. 106)

Harcourt, Brace & Company. New York, New York, USA. 1920

### Stenger, Victor J. 1935–

American physicist

The fact that a theory may eventually test wrong does not detract from its original merit as a worthy try. On the other hand, if an idea is poorly formulated, often because the terms used are not clearly defined, then how can we even test it? . . . We cannot determine that gibberish is anything but gibberish.

*Physics and Psychics: The Search for a World Beyond the Senses*

Chapter 3 (p. 58)

Prometheus Books. Buffalo, New York, USA. 1990

### Stevenson, Robert Louis 1850–94

Scottish essayist and poet

It is better to emit a scream in the shape of a theory than to be entirely insensible to the jars and incongruities of life and take everything as it comes in a forlorn stupidity.

*Virginibus Puerisque and Familiar Studies of Men and Books*

Crabbed Age and Youth (p. 42)

J.M. Dent & Sons Ltd. London, England. No date

### Sussmann, Hector 1946–

Argentinean-American mathematician

A mark of a good theory is that it proves even the most trivial results.

Gelfand Workshop

Rutgers University, February 11, 2002

### Synge, John L. 1897–1995

Irish mathematician and physicist

A well built theory has three merits: (i) it has an aesthetic appeal, (ii) it is comparatively easy to understand, and (iii), if its postulates are clearly stated, it may be taken out of its original physical context and applied in another.

The Hamiltonian Method and Its Application to Water Waves

*Proceedings of the Irish Academy*, Volume 63, Section A, Number 1,

May 1962 (p. 1)

### Teall, Sir J. J. Harris 1849–1924

British geologist

It is only when a theory has proved its usefulness as a coordinator of fact that it becomes worthy of the dignity of publication. It may be true or false, most likely the latter; but if it coordinates more facts than any other it is at any rate useful and may be conveniently retained until replaced by a better.

*Annual Report of the Board of Regents of the Smithsonian Institution*, 1902

The Evolution of Petrological Ideas (p. 289)  
Government Printing Office. Washington, D.C. 1903

**Toulmin, Stephen** 1922–  
English philosopher

It is part of the art of the sciences, which has to be picked up in the course of the scientist's training, to recognize the situations in which any particular theory or principle can be applied to, and when it will cease to hold.

*The Philosophy of Science: An Introduction*  
Chapter III (pp. 92–93)  
Harper & Row, Publishers. New York, New York, USA. 1960

**Turner, Michael S.**  
American astrophysicist

If all you have are observations, that's botany. If all you have is theory, that's philosophy.

In John Hogan  
Universal Truths  
*Scientific American*, Volume 264, Number 4, October 1990 (p. 117)

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910  
American author and humorist

...the trouble about arguments is, they ain't nothing but theories, after all, and theories don't prove nothing, they only give you a place to rest on, a spell, when you are tuckered out butting around and around trying to find out something there ain't no way to find out. ... There's another trouble about theories: there's always a hole in them somewhere, sure, if you look close enough.

*Tom Sawyer Abroad; Tom Sawyer, Detective and Other Stories, etc., etc.*  
Tom Sawyer Abroad  
Chapter IX (p. 70)  
Harper & Brothers. New York, New York, USA. 1902

**van Fraassen, Bas C.** 1941–  
Dutch-born philosopher

Science aims to give us, in its theories, a literally true story of what the world is like; and acceptance of a scientific theory involves the belief that it is true.

*The Scientific Image*  
Chapter 2, section 1.1 (p. 8)  
Clarendon Press. Oxford, England. 1990

...the success of current scientific theories is no miracle. It is not even surprising to the scientific (Darwinist) mind. For any scientific theory is born into a life of fierce competition, a jungle red in tooth and claw. Only the successful theories survive — the ones which in fact latched on to the actual regularities in nature.

*The Scientific Image*  
Chapter 2, Section 7 (p. 40)  
Clarendon Press. Oxford, England. 1980

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright and natural philosopher

No phenomenon can be explained in and of itself; only many comprehended together, methodically arranged, in the end yield something that could be regarded as theory.

In Karl J. Fink  
*Goethe's History of Science*  
Chapter 2 (p. 26)  
Cambridge University Press. Cambridge, England. 1991

Dear friend, all theory is grey  
And green the golden tree of life.

In *Great Books of the Western World* (Volume 47)  
*Faust*  
The First Part  
*Faust's Study* (2), I. 2038–2039  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Waddington, Conrad Hal** 1905–75  
British biologist and paleontologist

A scientific theory cannot remain a mere structure within the world of logic, but must have implications for action and that in two different ways. In the first place, it must involve the consequence that if you do so and so, such and such results will follow. That is to say it must give, or at least offer the possibility of controlling the process; and secondly — and this is a point not so often mentioned by those who discuss the nature of scientific theories — its value is quite dependent on its power of suggesting the next step in scientific advance.

*The Nature of Life*  
Chapter I (pp. 11–12)  
Harper & Row, Publishers. New York, New York, USA. 1960

**Weinberg, Steven** 1933–  
American nuclear physicist

This is often the way it is in physics — our mistake is not that we take our theories too seriously, but that we do not take them seriously enough.

*The First Three Minutes*  
Chapter VI (p. 131)  
Basic Books, Inc. New York, New York, USA. 1988

Our theories are very esoteric — necessarily so, because we are forced to develop these theories using a language, the language of mathematics, that has not become part of the general equipment of the educated public. Physicists generally do not like the fact that our theories are so esoteric. On the other hand, I have occasionally heard artists talk proudly about their work being accessible only to a band of cognoscenti and justify this attitude by quoting the example of physical theories like general relativity that also can be understood only by initiates. Artists like physicists may not always be able to make themselves understood by the general public, but esotericism for its own sake is just silly.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*  
Chapter VI (p. 150)  
Pantheon Books. New York, New York, USA. 1992

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Very simple was my explanation, and plausible enough  
— as most wrong theories are!

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today*, 1971

The Time Machine

Chapter Four (p. 468)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Whewell, William** 1794–1866  
English philosopher and historian

It is a test of true theories not only to account for, but to  
predict phenomena.

*The Philosophy of the Inductive Sciences Founded upon Their History*  
(Volume 2)

Aphorisms, Aphorisms Concerning Science, XII (p. 468)

John W. Parker. London, England. 1847

...there is a mask of theory over the whole face of na-  
ture...

*The Philosophy of the Inductive Sciences Founded upon Their History*  
(Volume 1)

Part I, Book I, Chapter II, sect. 10 (p. 42)

John W. Parker. London, England. 1847

**Winchell, Alexander** 1824–91  
American geologist

When a great theory has grown into existence, and  
the general assent of competent judges has converted  
a sublime conception from the state of a provisional  
hypothesis to the position of a strengthening doctrine,  
there is unusual interest in glancing over the progress of  
science and noting the actual steps by which the guess  
became theory, and the theory, doctrine.

*World-Life or Comparative Geology*

Part IV (p. 550)

S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**White, Henry S.**  
No biographical data available

The accepted truths of today, even the commonplace  
truths of any science, were the doubtful or the novel  
theories of yesterday.

*Bulletin of the American Mathematical Society*, Volume 15, 1909  
(p. 325)

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

On the absolute theory, bare space and bare time are such  
very odd existences, half something and half nothing.

The Idealistic Interpretations of Einstein's Theory

*Proceedings of the Aristotelian Society*, N.S. Volume 22, Part III,  
(p. 131)

...to come very near a true theory and to grasp its precise  
application are two very different things.

*The Organization of Thought*

Chapter VI (p. 127)

Greenwood Press Publishers. Westport, Connecticut, USA. 1974

**Wilson, Edward O.** 1929–  
American biologist and author

Nothing in science — nothing in life, for that matter,  
makes sense without theory. It is our nature to put all  
knowledge into context in order to tell a story, and to  
re-create the world by this means. ... We are enchanted by  
the beauty of the natural world. Our eye is caught by the  
dazzling visual patterns of polar star trails, for example,  
and the choreography of chromosomes in dividing root  
tip cells of plant. Both disclose processes that are also  
vital to our lives. In unprocessed form, however, with-  
out theoretical frameworks of heliocentric astronomy  
and Mendelian heredity, they are no more than beautiful  
patterns of light.

*Consilience: The Unity of Knowledge* (p. 58)

Alfred A. Knopf. New York, New York, USA. 1998

**Wisdom, John O.**  
No biographical data available

Sometimes [the word theory] is used for a hypothesis,  
sometimes for a confirmed hypothesis; sometimes for a  
train of thought; sometimes for a wild guess at some fact,  
or for a reasoned claim of what some fact is — or even  
for a philosophical speculation.

*Foundations of Inference in Natural Sciences*

Chapter III (p. 33)

Methuen & Company Ltd. London, England. 1952

**Woodbridge, Frederick James Eugene** 1867–1940  
American philosopher

It is a theory of nature, that system of things which allows  
a plant to grow, an animal to graze, and a man to think,  
fully as much as it allows the sun to be eclipsed or bodies  
to be in motion or at rest.

*Aristotle's Vision of Nature*

Chapter III (p. 49)

Columbia University Press. New York, New York, USA. 1965

**Woodger, Joseph Henry** 1894–1981  
English biologist

Theoretical statements, it is clear, cannot be verified  
because we can never know whether they are true. All  
we can do is to go on testing their consequences until  
an observation record turns up which contradicts them.  
Then we have the choice of two courses: we can say that  
the theoretical statement is false and reject it; or we can  
assume that we have been mistaken in our observation  
and retain the theoretical statements.

*Biology and Language*

Lecture II (p. 57)

At The University Press. Cambridge, England. 1952

**Wurtz, Charles Adolphe** 1817–84  
French organic chemist

The triumph of a theory is to embrace the greatest number and the greatest variety of facts.

*A History of Chemical Theory from the Age of Lavoisier to the Present Time*

Lavoisier

I (p. 7)

Macmillan & Company Ltd. London, England. 1869

**Wyndham, John** 1903–69  
English science fiction writer

...I do refuse to accept a bad theory simply on the grounds that there is not a better [one]...

*The Midwich Cuckoos*

Chapter Twenty (p. 221)

M. Joseph. London, England. 1977

**Ziman, John M.** 1925–2005  
British physicist

The verb “to theorize” is now conjugated as follows: “I built a model; you formulated a hypothesis; he made a conjecture.”

*Reliable Knowledge*

Chapter 2 (fn 20, p. 22)

Cambridge University Press. Cambridge, England. 1978

...a significant fraction of the ordinary scientific literature in any field is concerned with essentially irrational theories put forward by a few well-established scholars who have lost touch with reality.

Some Pathologies of the Scientific Life

*Nature*, Volume 227, 5 September 1970

...the sooner we all face up to the fact that theory and practice are indissoluble, and that there is no contradiction between the qualities of usefulness and beauty, the better.

Growth and Spread of Science

*Nature*, Volume 221, Number 5180, February 8, 1969 (p. 521)

## THEORY OF FUNCTIONS

**Keyser, Cassius Jackson** 1862–1947  
American mathematician

The Modern Theory of Functions — that stateliest of all the pure creations of the human intellect.

In Columbia University

*Lectures on Science, Philosophy and Art 1907–1908* (p. 16)

New York, New York, USA. 1908

**Volterra, Vito** 1860–1940  
Italian mathematician

The theory that has had the greatest development in recent times is without any doubt the theory of functions.

In Stanley Gudder

*A Mathematical Journey* (p. 32)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1976

## THERMODYNAMICS

**Allen, Woody** 1935–

American film director and actor

It’s the Second Law of Thermodynamics — sooner or later everything turns to shit. That’s my phrasing, not the Encyclopedia Britannica’s.

*Husbands and Wives*

Film (1992)

**Atkins, Peter William** 1940–

English physical chemist and writer

Everything is driven by motiveless, purposeless decay.

*The Creation*

Chapter 2 (p. 23)

W.H. Freeman. San Francisco, California, USA. 1981

**Barnett, Lincoln** 1909–79

American science writer

Although it is true that the amount of matter in the universe is perpetually changing, the change appears to be mainly in one direction — toward dissolution. The sun is slowly but surely burning out, the stars are dying embers, and everywhere the cosmos heart is turning to cold; matter is dissolving into radiation, and energy is being dissipated into empty space. “The universe is thus progressing toward an ultimate ‘heat death’ or, as it is technically defined, a condition of maximum entropy” [quoting Einstein]... And there is no way of avoiding this destiny.

[T]he fateful principle known as the Second Law of Thermodynamics, which stands today as the principal pillar of classical physics left intact by the march of science, proclaims that the fundamental processes of nature are irreversible. Nature moves only one way.

*The Universe and Dr. Einstein*

Chapter 14 (p. 99)

William Sloane Associates. New York, New York, USA. 1948

**Blum, Harold** 1899–?

No biographical data available

No matter how carefully we examine the energetics of living systems we find no evidence of defeat of thermodynamic principles.

*Time’s Arrow and Evolution*

Princeton University Press. Princeton, New Jersey, USA. 1951

**Bohr, Niels Henrik David** 1886–1962

Danish physicist

The old thermodynamics... is to statistical thermodynamics what classical mechanics is to quantum mechanics.

In Werner Heisenberg

*Physics and Beyond: Encounters and Conversations*

Chapter 9 (p. 107)

Harper & Row, Publishers. New York, New York, USA. 1971

**Boltzmann, Ludwig Edward** 1844–1906

Austrian physicist

General thermodynamics proceeds from the fact that, as far as we can tell from our experience up to now, all natural processes are irreversible. Hence according to the principles of phenomenology, the general thermodynamics of the second law is formulated in such a way that the unconditional irreversibility of all natural processes is asserted as a so-called axiom.

Translated by Stephen G. Brush

*Lectures on Gas Theory* (pp. 444–445)

University of California Press. Berkeley, California, USA. 1964

The Second Law can never be proved mathematically by means of the equations of dynamics alone.

On Certain Questions of the Theory of Gases

*Nature*, Volume 51, 1895 (p. 413)

**Bridgman, Percy Williams** 1882–1961

American physicist

...the laws of thermodynamics have a different feel from most of the other laws of the physicist...they smell more of their human origin.

*The Nature of Thermodynamics*

Chapter I (p. 3)

Harvard University Press. Cambridge, Massachusetts, USA. 1941

**Cardenal, Ernesto** 1925–

Nicaraguan poet and Roman Catholic priest

The second law of thermodynamics!:

energy is indestructible in quantity

but continually changes in form.

And it always runs down like water.

Translated by John Lyons

*Cosmic Canticle*

Cantigua 3, Autumn Fugue (p. 29)

Curbstone Press. Willimantic, Connecticut, USA. 1993

**Dickerson, Richard E.**

American molecular biologist

It is possible to know thermodynamics without understanding it...

*Molecular Thermodynamics*

Chapter 7 (p. 387)

W.A. Benjamin. New York, New York, USA. 1969

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

The law of entropy always increases — the Second Law of Thermodynamics — holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in

disagreement with Maxwell's equation — then so much the worse for Maxwell's equations. If it is found to be contradicted by observation — well, these experimentalists do bungle things sometimes. But if your theory is found to be against the Second Law of Thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation.

*The Nature of the Physical World*

Chapter IV (p. 74)

The Macmillan Company. New York, New York, USA. 1930

**Epstein, P. S.** 1883–1966

German-born physicist

Thermodynamics deals with systems which, in addition to mechanical and electromagnetic parameters, are described by a specifically thermal one, namely, the temperature or some equivalent of it. Thermodynamics is essentially a science about the conditions of equilibrium of systems and about the processes which can go on in states little different from the state of equilibrium.

*Textbook of Thermodynamics*

Chapter I (p. 2)

John Wiley & Sons, Inc. New York, New York, USA. 1937

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

In doing a problem involving a given mass of some substance, the condition of the substance at any moment can be described by telling what its temperature is and what its volume is. If we know the temperature and volume of a substance, and that the pressure is some function of the temperature and volume, then we know the internal energy. One could say, "I do not want to do it that way. Tell me the temperature and the pressure and I will tell you the volume. I can think of the volume as a function of temperature and pressure, and so on." That is why thermodynamics is hard, because everyone uses a different approach. If we could only sit down once and decide on our variables, and stick to them, it would be fairly easy.

*The Feynman Lectures on Physics* (Volume 1)

Chapter 44–5 (p. 44–9)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA.

1983

**Hoffmann, Roald** 1937–

Polish-born American chemist

My second law, your second law, ordains that local order, structure in space and time, be crafted in ever-so-losing contention with proximal disorder in this neat but getting messier universe.



*The Metamict State*

The Devil Teaches Thermodynamics (p. 3)  
University of Central Florida Press. Orlando, Florida, USA. 1987

**Hogan, Graig J.**

No biographical data available

Everything that happens in the universe consists of the same basic stuff, “mass-energy,” transfigured in space and time from one form into another.

*The Little Book of the Big Bang: A Cosmic Primer* (p. 25)  
Copernicus. New York, New York, USA. 1998

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects.

On the Dynamical Theory of Heat, with Numerical Results Deduced from Mr. Joule’s Equivalent of a Thermal Unit, and M. Regnault’s Observations on Steam

*Transactions of the Royal Society of Edinburgh*, March 1851

**Lewis, Gilbert Newton** 1875–1946

American chemist

**Randall, Merle** 1888–1950

American chemist

The fascination of a growing science lies in the work of the pioneers at the very borderland of the unknown, but to reach this frontier one must pass over well traveled roads; of these one of the safest and surest is the broad highway of thermodynamics.

Revised by Kenneth S. Pitzer and Leo Brewer

*Thermodynamics* (p. x)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1961

The second law of thermodynamics not only is a principle of wide reaching scope and application, but also is one which has never failed to satisfy the severest test of experiment. The numerous quantitative relations derived from this law have been subjected to more and more accurate experimental investigation without the detection of the slightest inaccuracy.

*Thermodynamics* (p. 87)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1961

**Maxwell, James Clerk** 1831–79

Scottish physicist

I do not think...that the perfect identity which we observe between different portions [of molecules] of the same kind of matter can be explained on the statistical principle of the stability of the averages of large numbers of quantities each of which may differ from the mean. For if of the molecules of some substance such as hydrogen, some were of slightly greater mass than others, we have the means of producing a separation between molecules

of different masses, and in this way we should be able to produce two kinds of hydrogen, one of which would be somewhat denser than the other. As this cannot be done, we must admit that the equality which we assert to exist between the molecules of hydrogen applies to each individual molecule, and not merely to the average of groups of millions of molecules.

*Theory of Heat*

Limitation of the Second Law of Thermodynamics (p. 309)

Longmans, Green & Company. London, England. 1871

**Meixner, J.** 1908–94

German theoretical physicist

A careful study of the thermodynamics of electrical networks has given considerable insight into these problems and also produced a very interesting result: the non-existence of a unique entropy value in a state which is obtained during an irreversible process.... I would say, I have done away with entropy. The next step might be to let us also do away with temperature.

In Edward B. Stuart, Benjamin Gal-Or and Alan J. Brainard (eds.)

*A Critical Review of Thermodynamics: The Proceedings of the International Symposium*

University of Pittsburgh. Pittsburgh, Pennsylvania, April 7–8, 1969

**Morowitz, Harold J.** 1927–

American biophysicist

The use of thermodynamics in biology has a long history rich in confusion...

*Beginnings of Cellular Life: Metabolism Recapitulates Biogenesis*

Chapter 6 (p. 69)

Yale University Press. New Haven, Connecticut, USA. 1992

**Pippard, A. B.** 1920–

English physicist

It may be objected by some that I have concentrated too much on the dry bones [of thermodynamic theory], and too little on the flesh which clothes them, but I would ask such critics to concede at least that the bones have an austere beauty of their own.

*Classical Thermodynamics*

Preface (p. vii)

Cambridge University Press. Cambridge, England. 1966

**Reiss, H.**

No biographical data available

Almost all books on thermodynamics contain some errors which are not purely typographical.

*Methods of Thermodynamics*

Preface (p. ix)

Blaisdell Publishing Company, New York, New York, USA. 1965

...the almost certain truth [is] that nobody (authors included) understands thermodynamics completely. The writing of a book therefore becomes a kind of catharsis in which the author exorcises his own demon of incomprehension and prevents it from occupying the soul of another.

*Methods of Thermodynamics*

Preface (p. vii)

Blaisdell Publishing Company. New York, New York, USA. 1965

**Ross, John** 1920–

American physical chemist

I have written that there are no known violations of the second law of thermodynamics (*Chemical and Engineering News*, July 27, 1980). Unfortunately I have been intentionally misinterpreted by creationists who say that this quote proves that evolution is impossible. This is nonsense: evolution is in no way a violation of the second law.

Letter to Carl Gaither

19 June 2007

**Seifert, H. S.** 1911–77

American aeronautics and astronautics scientist

The first and second laws of thermodynamics are of course known to us as well as the Ten Commandments, and probably obeyed more consistently.

Can We Decrease Our Entropy?

*American Scientist*, Summer, June 1961 (p. 124A)

**Sommerfeld, Arnold** 1868–1951

German physicist

The science of thermodynamics introduces a new concept, that of temperature.

*Thermodynamics and Statistical Mechanics, Lectures on Theoretical Physics* (Volume 1)

Translated by J. Kestin (p. 1)

Academic Press. New York, New York, USA. 1956

**Stenger, Victor J.** 1935–

American physicist

Scientists speak of the Law of Inertia or the Second Law of Thermodynamics as if some great legislature in the sky once met and set down rules to govern the universe.

*Not by Design*

Chapter 1 (p. 14)

Prometheus Books. Buffalo, New York, USA. 1988

**Truesdell, Clifford** 1919–2000

American mathematician, natural philosopher, historian of mathematics

Every physicist knows exactly what the first and the second law mean, but...no two physicists agree about them.

In Mario Bunge (ed.)

*Delaware Seminar in the Foundations of Physics*

Foundations of Continuum Mechanics (p. 37)

...thermodynamics is the kingdom of deltas.

*The Tragicomical History of Thermodynamics*

Chapter 1 (p. 1)

Springer-Verlag. New York, New York, USA. 1980

## THERMOMETER

**Fahrenheit, Daniel Gabriel** 1686–1736

German physicist

It then came into my mind what that most careful observer of natural phenomena had written about the correction of the barometer; for he had observed that the height of the column of mercury in the barometer was a little (though sensibly enough) altered by the varying temperature of the mercury. From this I gathered that a thermometer might perhaps be constructed with mercury, which would not be so hard to construct, and by the use of which it might be possible to carry out the experiment which I so greatly desired to try.

*Experimenta Circa Gradum Caloris Liqueorum Nonnullorum*

*Ebullientium Instituta*

*Philosophical Transactions of the Royal Society of London*, Volume 33, Number 1, 1724

## THINKING

**Asimov, Isaac** 1920–92

American author and biochemist

Many adults, whether consciously or unconsciously, find it beneath their adult dignity to do anything as childish as read a book, think a thought, or get an idea. Adults are rarely embarrassed at having forgotten what little algebra or geography they once learned.

*The Roving Mind*

His Own Particular Drummer

Prometheus Books. Buffalo, New York, New York, USA. 1983

**Crick, Francis Harry Compton** 1916–2004

English biochemist

Some scientists work so hard there is no time left for serious thinking.

*What Mad Pursuit: A Personal View of Scientific Discovery*

Basic Books, Inc. New York, New York, USA. 1988

**Cromer, Alan** 1935–

American physicist and educator

Scientific thinking, which is analytic and objective, goes against the grain of traditional human thinking, which is associative and subjective.

*Uncommon Sense: The Heretical Nature of Science*

Chapter 1 (pp. 1–2)

Oxford University Press, Inc. New York, New York, USA. 1993

**Dewey, John** 1859–1952

American philosopher and educator

The first distinguishing characteristic of thinking is facing the facts — inquiry, minute and extensive scrutinizing, observation.

*Reconstruction in Philosophy*

Chapter VI (p. 140)

Beacon Press. Boston, Massachusetts, USA. 1920

Intelligent thinking means an increment of freedom in action — an emancipation from chance and fatality. “Thought” represents the suggestion of a way of response that is different from that which would have been followed if intelligent observation had not effected an inference as to the future.

*Reconstruction in Philosophy*

Chapter VI (p. 144)

Beacon Press. Boston, Massachusetts, USA. 1920

**Edison, Thomas** 1847–1931

American inventor

I am going to have a sign put up all over my plant, reading “There is no expedient to which a man will not resort to avoid the real labor of thinking.”

In Dogbert D. Runes (ed.)

*The Diary and Sundry Observations of Thomas Alva Edison*

Chapter XXIX (p. 167)

Philosophical Library. New York, New York, USA. 1948

**Einstein, Albert** 1879–1955

German-born physicist

Thinking for its own sake, as in music! When I have no special problem to occupy my mind, I love to reconstruct proofs of mathematical and physical theorems that have long been known to me. There is no goal in this, merely an opportunity to indulge in the pleasant occupation of thinking.

In Helen Dukas and Banesh Hoffman

*Albert Einstein: The Human Side: New Glimpses from His Archives*

Letter from Spring 1918 (p. 17)

Princeton University Press. Princeton, New Jersey, USA. 1979

**Harrington, John W.** 1918–

American naturalist

We cannot see without thinking; we cannot think without seeing.

*Dance of the Continents*

Epilogue (p. 232)

J.P. Tarcher. Los Angeles, California, USA. 1983

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...one extreme is the idea of an objective world, pursuing its regular course in space and time, independently of any kind of observing subject; this has been the guiding image from modern science. At the other extreme is the idea of a subject, mystically experiencing the unity of the world and no longer confronted by an object or by any objective world; this has been the guiding image of Asian mysticism. Our thinking moves somewhere in the middle, between these two limiting conceptions; we should maintain the tension resulting from these opposites.

*Across the Frontiers*

Chapter XVI (p. 227)

Harper & Row, Publishers. New York, New York, USA. 1974

**Rothman, Tony** 1953–

American cosmologist

**Sudarshan, George** 1931–

Indian physicist

...one result of unimaginative, mechanistic thinking was that societies eventually ceased to burn people at the stake for witchcraft.

*Doubt and Certainty: The Celebrated Academy: Debates on Science,*

*Mysticism, Reality, in General on the Knowable and Unknowable*

Fourth Debates (p. 74)

Perseus Books. Reading, Massachusetts, USA. 1998

**Sagan, Carl** 1934–96

American astronomer and science writer

The scientific way of thinking is at once imaginative and disciplined. This is central to its success. Science invites us to let the facts in, even when they don't conform to our preconceptions. It counsels us to carry alternative hypotheses in our heads and see which best fit the facts. It urges on us a delicate balance between no-holds-barred openness to new ideas, however heretical, and the most rigorous skeptical scrutiny of everything — new ideas and established wisdom. This kind of thinking is also an essential tool for a democracy in an age of change.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 2 (p. 27)

Random House, Inc. New York, New York, USA. 1995

**Steiner, Rudolf** 1861–1925

Austrian philosopher and scientist

In thinking, we have that element given us which welds our separate individuality into one whole with the cosmos.

*The Philosophy of Freedom: The Basis for a Modern World Conception*

Chapter 5 (p. 70)

Rudolf Steiner Press. London, England. 1999

## THOUGHT

**Baldwin, J. Mark** 1861–1934

American philosopher and psychologist

We do not scatter our thoughts as widely as possible in order to increase the chances of getting a true one; on the contrary, we call the man who produces the most thought-variations a “scatter-brain,” and expect nothing inventive from him... we succeed in thinking well by thinking hard; we get the valuable thought-variations by concentrating attention upon the body of related [data] which we already have; we discover new relations among the data of experience by running over and over the links and couplings of the apperceptive systems with which our minds are already filled.

On Selective Thinking

*The Psychological Review*, Volume 5, Number 1, 1889 (p. 4)

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

The power of Thought; — the magic of the Mind!

*The Complete Poetical Works of Byron*

The Corsair

Canto I, Stanza 8

Houghton Mifflin. Boston, Massachusetts, USA. 1933

**Carlyle, Thomas** 1795–1881

English historian and essayist

Thought once awakened does not again slumber.

*On Heroes and Hero Worship*

Lecture I (p. 24)

John B. Alden, Publisher. New York, New York, USA. 1887

And what is that Science, which the scientific head alone, were it screwed off, and (like the Doctor's in the Arabian Tale) set in a basin to keep it alive, could prosecute without a heart, but one other of the mechanical and menial handicrafts, for which the Scientific Head (having a Soul in it) is too noble an organ? I mean that Thought without Reverence is barren, perhaps poisonous; at best, dies like cookery with the day that called it forth; does not live, like sowing, in successive tilts and wider-spreading harvests, bringing food and plenteous increase to all Time.

*Sartor Resartus*

Sartor Resartus

**Coman, Dale Rex** 1906–

American research physician and wildlife writer

Thoughts are timid things. They are frightened away by noise and they make none themselves. They flutter as silently as do owls on soft-edged wings.

*The Endless Adventure*

Sanctuaries (p. 176)

Henry Regnery Company. Chicago, Illinois, USA. 1972

**Davy, Sir Humphry** 1778–1829

English chemist

My real, my working existence is among the objects of scientific research. Common amusements and enjoyments are necessary to me only as dreams to interrupt the flow of thoughts too nearly analogous to enlighten and vivify.

In Sir William Ramsay

*Essays Biographical and Chemical*

The Great London Chemists

Section II (pp. 47–48)

Archibald Constable &amp; Company Ltd. London, England. 1908

**Douglas, A. Vibert** 1894–1988

Canadian astronomer

Guided by some of the great thinkers of today, our thoughts have traversed aeons of time, contemplating some of the changes taking place with majestic

deliberation throughout the vastness of space. "Time rolls his ceaseless course." A million million years suffice for the birth of a star and its early development; a few hundred thousand years will tell the tale of the life of mankind upon this planet; and as for man, an individual man, the years of his life are three score years and ten, and yet such is the power of a great mind that, despite the brevity of its allotted span, it can wrestle with the problems of nature and learn something at least of the immensities of space and time.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1925*

Time and Space (p. 155)

Government Printing Office. Washington, D.C. 1926

**Einstein, Albert** 1879–1955

German-born physicist

Scientific thought is a development of pre-scientific thought.

Translated by Alan Harris

*Essays in Science*

The Problem of Space, Ether, and the Field in Physics (p. 61)

Philosophical Library. New York, New York, USA. 1934

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Look sharply after your thoughts. They come unlooked for, like a new bird seen on your trees, and, if you turn to your usual task, disappear; and you shall never find that perception again; never, I say — but perhaps years, ages, and I know not what events and worlds may lie between you and its return!

*Journals of Ralph Waldo Emerson 1864–1876*

October 1872 (p. 365)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The crystal sphere of thought is as concentric as the geological structure of the globe. As our soils and rocks lie in strata, concentric strata, so do all men's thinkings run laterally, never vertically.

*Ralph Waldo Emerson: Essays and Lectures*

The Method of Nature (p. 117)

The Library of America. New York, New York, USA. 1983

**Haldane, John Scott** 1860–1936

Scottish physiologist

...scientific thought does not involve physical realism...

*The Philosophical Basis of Biology: Donnellan Lectures, University of Dublin, 1930*

Lecture III, The Deeper Meaning of Berkeley's Reasoning (p. 120)

Doubleday, Doran &amp; Company, Inc. Garden City, New York, USA. 1931

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

...when new groups of phenomena compel changes in the pattern of thought...even the most eminent of physicists find immense difficulties. For the demand for change in

the thought pattern may engender the feeling that the ground is to be pulled from under one's feet. . . . I believe that the difficulties at this point can hardly be overestimated. Once one has experienced the desperation with which clever and conciliatory men of science react to the demand for a change in the thought pattern, one can only be amazed that such revolutions in science have actually been possible at all.

In Robert M. Augros & George N. Stanciu  
*The New Story of Science: Mind and the Universe*  
Chapter III (p. 45)  
Bantam Books, Inc. New York, New York, USA. December 1986

**Hobbes, Thomas** 1588–1679

English philosopher and political theorist

From desire ariseth the thought of some means we have seen produce the like of that which we aim at; and from the thought of that, the thought of means to that mean; and so continually till we come to some beginning within our own power.

In *Great Books of the Western World* (Volume 23)  
*Leviathan*  
Chapter III (p. 53)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

A thought is often original, though you have uttered it a hundred times.

*The Autocrat of the Breakfast-Table*  
Chapter I (p. 7)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

...little-minded people's thoughts move in such small circles that five minutes' conversation gives you an arc long enough to determine their whole curve. An arc in the movement of a large intellect does not sensibly differ from a straight line.

*The Autocrat of the Breakfast-Table*  
Chapter I (p. 10)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Jespen, G. L.**

No biographical data available

Habits of thought in the tradition of a science are not readily changed; it is not easy to deviate from the customary channels of accumulated experience in the conventionalized subjects.

In G.L. Jespen, E. Mayr, and G.G. Simpson (eds.)  
*Genetics, Paleontology and Evolution*  
Foreword (p. v)  
Princeton University Press. Princeton, New Jersey, USA. 1949

**Keynes, John Maynard** 1883–1946

British economist

Anyone who has ever attempted pure scientific or philosophical thought knows how one can hold a problem

momentarily in one's mind and apply all one's powers of concentration to piercing through it, and how it will dissolve and escape and you find what you are surveying is a blank.

*Essays in Biography*  
Newton the Man (p. 312)  
Horizon Press, Inc. New York, New York, USA. 1951

**Ludmerer, Kenneth M.** 1947–

American physician and professor of medicine and history

Critical thinking, in short, offers the way to keep science and technology in harness.

*Learning to Heal: The Development of American Medical Education*  
Chapter 14 (p. 280)  
Basic Books, Inc. New York, New York, USA. 1985

**Martin, Charles-Noël** 1923–

French physicist

It is always extremely difficult to express thoughts. Words and phrases are so many fretters by which our spirit is bound. Words are mere symbols of reality, and the written word is not more than a one-dimensional flow across the two-dimensional page of a three-dimensional book.

Translated by A.J. Pomerans  
*The Role of Perception in Science*  
Chapter 1 (p. 15)  
Hutchinson of London. London, England. 1963

**Moore, H. P.**

No biographical data

...today, there are many guardians of culture who are more shocked at a misspelled word (even in our quite unsystematic English spelling) than at a hazily expressed thought.

*Engineering Culture*  
*Science*, Volume 73, Number 1881, January 16, 1931 (p. 51)

**Nash, John F.** 1928-

American mathematician

Rationality of thought imposes a limit on a person's concept of his relation to the cosmos.

*Les Prix Nobel. The Nobel Prizes in 1994*  
Autobiography  
Nobel Foundation. Stockholm, Sweden. 1995

**Planck, Max** 1858–1947

German physicist

Is there something in the nature of man, some inner realm, that science cannot touch? ...Or to speak more concretely, is there a point at which the causal line of thought ceases and beyond which science cannot go?

*Where Is Science Going?*  
Chapter V (p. 160)  
W.W. Norton & Company, Inc. New York, New York, USA. 1932

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Flout ‘em and scout ‘em  
 And scout ‘em and flout ‘em;  
 Thought is free.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
*The Tempest*  
 Act III, Scene ii, l. 130–133  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947  
 English mathematician and philosopher

...the first man who noticed the analogy between a group of seven fishes and a group of seven days made a notable advance in the history of thought.

*Science and the Modern World*  
 Chapter II (p. 30)  
 The Macmillan Company. New York, New York, USA. 1929

**Wittgenstein, Ludwig Josef Johann** 1889–1951  
 Austrian-born English philosopher

Thoughts rise to the surface slowly, like bubbles. (Sometimes it’s as though you could see a thought, an idea, as an indistinct point far away on the horizon; and then it often approaches with astonishing swiftness.)

Translated by Peter Winch  
*Culture and Value* (p. 63e)  
 The University of Chicago Press. Chicago, Illinois, USA. 1980

## THUNDERBOLT

**Lewis, Edwin Herbert** 1866–1938  
 American rhetorician, novelist, and poet

The thunderbolts were imprisoned in crucibled crystalline ore,  
 And locked in the laughing ocean, and shut in the shining shore,  
 And lulled in the light of evening, and hushed in gentle grain  
 And unimperiled lilies imperaled with quiet rain.

*White Lightning*  
 Cover page  
 Covici-McGee. Chicago, Illinois, USA. 1923

## TIDAL BORE

**Adam, John A.**  
 No biographical data

What is a bore? The answer will vary depending on whether one is at a cocktail party...or the Bay of Fundy in Nova Scotia.

*Mathematics in Nature: Modeling Patterns in the Natural World*  
 Chapter Nine (p. 194)  
 Princeton University Press. Princeton, New Jersey, USA. 2003

## TIDE

**Coman, Dale Rex** 1906–  
 American research physician and wildlife writer

It does not take long to realize that, instead of clocks, the tides beat out the measure of the marsh and shore, and that all you see, plant and animal, must adapt to the periodic changes of water level.

*The Endless Adventure*  
 The Sand Dunes and Salt Marshes in November (p. 62)  
 Henry Regnery Company. Chicago, Illinois, USA. 1972

**Defant, Albert** 1884–1974  
 Austrian meteorologist and oceanographer

The tides are the heartbeat of the ocean, a pulse that can be felt all over the world.

*Ebb and Flow: The Tides of Earth, Air, and Water*  
 Chapter I (p. 9)  
 The University of Michigan Press. Ann Arbor, Michigan, USA. 1958

**Harrington, Thomas**  
 No biographical data available

The benefit which God designed for man by the Tides in giving a perpetual motion to the Waters was to prevent their corrupting, and thereby breeding any infection that might arise from too long a stagnation of them.

*Science Improved; or the Theory of the Universe*  
 Section III (p. 18)  
 Printed for the Author. London, England. 1774

**Kelvin, Lord William Thomson** 1824–1907  
 Scottish engineer, mathematician, and physicist

The subject on which I have to speak this evening is the tides, and at the outset I feel in a curiously difficult position. If I were asked to tell what I mean by the Tides I should feel it exceedingly difficult to answer the question. The tides have something to do with motion of the sea. Rise and fall of the sea is sometimes called a tide; but I see, in the Admiralty Chart of the Firth of Clyde, the whole space between Ailsa Craig and the Ayrshire coast marked “very little tide here.” Now, we find there a good ten feet rise and fall, and yet we are authoritatively told there is very little tide. The truth is, the word “tide” as used by sailors at sea means horizontal motion of the water; but when used by landmen or sailors in port, it means vertical motion of the water.

Lecture  
 The British Association at the Southampton Meeting, Friday, August 25, 1882

## TIME

**Adams, George** 1750–95  
 English instrument maker

Nothing can be more shocking to reason than eternal time; infinite divisibility is not less absurd.

*Lectures on Natural and Experimental Philosophy* (Volume 3)  
Chapter XXIV (p. 12)  
Printed by R. Hindmarsh. London, England. 1794

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

...time is “number of movement in respect to the before and after”, and is continuous since it is an attribute of what is continuous.

In *Great Books of the Western World* (Volume 8)  
*Physics*  
Book IV, Chapter 11 (p. 300)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Aurelius Antoninus, Marcus** 121–180  
Roman emperor

Time is like a river made up of the events which happen, and a violent stream; for as soon as a thing has been seen, it is carried away, and another comes in its place, and this will be carried away too.

In *Great Books of the Western World* (Volume 12)  
*The Meditations of Marcus Aurelius*  
Book IV, #43 (p. 267)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

...time is the greatest innovator...

In Fred Allison Howe (ed.)  
*The Essays or Counsels*  
Civil and Moral, XXIV, Of Innovations (p. 75)

...time, which is the author of authors, be not deprived of his due, which is, further and further to discover truth.

In *Great Books of the Western World* (Volume 30)  
*Advancement of Learning*  
First Book, Chapter IV, Section 12  
Section IV, 12 (p. 15)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Barnett, Lincoln** 1909–79  
American science writer

Time itself will come to an end. For entropy points the direction of time. Entropy is the measure of randomness. When all system and order in the universe have vanished, when randomness is at its maximum, and entropy cannot be increased, when there is no longer any sequence of cause and effect, in short when the universe has run down, there will be no direction to time — there will be no time.

*The Universe and Dr. Einstein*  
Chapter 14 (p. 100)  
William Sloane Associates. New York, New York, USA. 1948

**Barrow, Isaac** 1630–77  
English clergyman and mathematician

Because Mathematicians frequently make use of Time, they ought to have a distinct idea of the meaning of that Word, otherwise they are Quacks...

In Paul Davies  
*About Time: Einstein's Unfinished Revolution*  
Header (p. 183)  
Simon & Schuster. New York, New York, USA. 1995

**Bergson, Henri** 1859–1941  
French philosopher

Whereever anything lives, there is, open somewhere, a register in which time is being inscribed.

Translated by Arthur Mitchell  
*Creative Evolution*  
Chapter I (p. 17)  
The Modern Library. New York, New York, USA. 1944

Time is an invention or it is nothing at all. But of time-invention physics can take no account. ... Modern physics...rests altogether on a substitution of time-length for time-invention.

Translated by Arthur Mitchell  
*Creative Evolution*  
Chapter IV (p. 361)  
The Modern Library. New York, New York, USA. 1944

**Blake, William** 1757–1827  
English poet, painter, and engraver

I see the Past, Present, and Future existing all at once before me.

*The Complete Poetry and Prose of William Blake*  
Jerusalem, l. 15  
University of California Press. Berkeley, California, USA. 1982

**Bohm, David** 1917–92  
American physicist

Eternity can be affected by what happens in time.

Quoted by Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity* (p. 91)  
Routledge & Kegan Paul. London, England. 1986

But the puzzle is, what happened before time began?

Quoted by Renée Weber  
*Dialogues with Scientists and Sages: The Search for Unity* (p. 199)  
Routledge & Kegan Paul. London, England. 1986

**Bondi, Sir Hermann** 1919–2005  
English mathematician and cosmologist

Time must never be thought of as pre-existing in any sense; it is a manufactured quantity.

In Paul Davies  
*About Time: Einstein's Unfinished Revolution*  
Header (p. 21)  
Simon & Schuster. New York, New York, USA. 1995

**Borges, Jorge Luis** 1899–1986  
Argentine writer

Time is a river which sweeps me along, but I am the river; it is a tiger which mangles me, but I am the tiger; it

is a fire which consumes me, but I am the fire. The world, unfortunately, is real; I, unfortunately, am Borges.

Translated by Anthony Kerrigan, Alastair Reid et al.  
*A Personal Anthology*  
 A New Refutation of Time (p. 64)  
 Grove Press. New York, New York, USA. 1967

Our destiny...is not frightful because it is unreal; it is frightful because it is irreversible and ironbound. Time is the substance of which I am made. Time is a river which sweeps me along, but I am the river; it is a tiger which mangles me, but I am the tiger; it is a fire which consumes me, but I am the fire. The world, unfortunately, is real; I unfortunately, am Borges.

Translated by Anthony Kerrigan, Alastair Reid and others  
*A Personal Anthology*  
 A New Refutation of Time (p. 64)  
 Grove Press. New York, New York, USA. 1967

...he believed in an infinite series of times, a growing, dizzying web of divergent, convergent, and parallel times. That fabric of times that approach one another, fork, are snipped off, or are simply unknown for centuries, contains all possibilities. In most of those times, we do not exist; in some, you exist but I do not; in others, I do and you do not; in others still, we both do. In this one, which the favouring hand of chance has dealt me, you have come to my home; in another, when you come through my garden you find me dead; in another, I say these same words, but I am an error, a ghost.

In Donald A. Yates & James E. Irby (eds.)  
*Labyrinths: Short Stories & Other Writings*  
 The Garden of Forking Paths (p. 28)  
 A New Direction Book. New York, New York, USA. 1964

### **Borland, Hal** 1900–78

American writer

Forget that second-ticking clock.

Time is the seed

Waiting to fly from the milkweed pod.

Time is the speed

Of a dragonfly.

Time is the rabbit's desperate scut.

Time's dimensions are hidden in rocks,

In wind and rain, but never in clocks.

*Borland Country*

Foreword (p. 5)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1971

### **Bradbury, Ray** 1920–

American writer

There was a smell of Time in the air tonight. He smiled and turned the fancy in his mind. There was a thought. What did Time smell like? Like dust and clocks and people. And if you wondered what Time sounded like it sounded like water running in a dark cave and voices crying and dirt dropping down upon hollow box lids, and rain. And, going further, what it looked like a silent film

in an ancient theater, one hundred billion faces falling like those New Year balloons, down and down into nothing. That was how Time smelled and looked and sounded. And tonight...tonight you could almost touch Time.

*The Martian Chronicles*

### **Bridgman, Percy Williams** 1882–1961

American physicist

But in no case is there any question of time flowing backward, and in fact the concept of backward flow of time seems absolutely meaningless. ... If it were found that the entropy of the universe were decreasing, would one say that time was flowing backward, or would one say that it was a law of nature that entropy decreases with time?

*Reflections of a Physicist*

Chapter 8 (p. 165)

Philosophical Library. New York, New York, USA. 1950

It seems to me that in any operational view of the meaning of natural concepts the notion of time must be used as a primitive concept, which cannot be analysed but must be accepted, so that it is meaningless to speak of a reversal of the direction of time.

*Reflections of a Physicist*

Chapter 8 (p. 165)

Philosophical Library. New York, New York, USA. 1950

### **Brillouin, Léon** 1889–1969

French physicist

...one of the most important features about time is its irreversibility. Time flows on and never comes back. When the physicist is confronted with this fact he is greatly disturbed. All the laws of physics in their elementary forms are reversible.

In Walter Buckley and Anatol Rapaport (eds.)

*Modern Systems Research for the Behavioral Scientist: A Sourcebook*  
 Life, Thermodynamics, and Cybernetics (p. 150)

Aldine Publishing Company. Chicago, Illinois, USA. 1968

### **Browne, Sir Thomas** 1605–82

English author and physician

Time which antiquates antiquities, and hat an art to make dust of all things.

*Hydriotophia*

Chapter V (p. 69)

Printed for Hen. Brome. London, England. 1658

### **Carlyle, Thomas** 1795–1881

English historian and essayist

That great mystery of Time, were there no other; the illimitable, silent, never-resting thing called Time, rolling, rushing on, swift, silent, like an all-embracing ocean-tide, on which we and all the Universe swim like exhalations, like apparitions which are, and then are not. ...

*On Heroes and Hero Worship*

Lecture I (p. 12)

John B. Alden, Publisher. New York, New York, USA. 1887



...no hammer in the Horologe of Time peals through the universe when there is a change from Era to Era. Men understand not what is among their hands...

*On Heroes and Hero Worship*

John B. Alden, Publisher. New York, New York, USA. 1887

**Carroll, Lewis (Charles Dodgson)** 1832–98

English writer and mathematician

Alice sighed wearily. “I think you might do something better with the time,” she said, “than wasting it in asking riddles with no answers.”

“If you knew Time as well as I do,” said the Hatter, “you wouldn’t talk about wasting it.”

*The Complete Works of Lewis Carroll*

Alice’s Adventures in Wonderland

Chapter VII (p. 78)

The Modern Library. New York, New York, USA. 1936

**Chaucer, Geoffrey** 1343–1400

English poet

The tyme, that may not sojourne  
But goth, and never may retourne,  
As water that down runneth ay,  
But never drope retourne may;  
Ther may no-thing as tyme endure,  
Metal, nor erthely creature;  
For alle thing it fret, and shal:  
The tyme eek, that chaungeth al,  
And all doth waxe and fostred be,  
And alle thing destroyeth he.

*The Romaunt of the Rose*

**Christianson, Gale E.**

No biographical data available

Historical time is a tricky thing; it flows at an ever accelerating speed, like a river approaching a great waterfall. We must soon learn to cope with the awesome power given to us by the heirs of Copernicus or our species, and all others on the planet, are doomed to a painful and purposeless extinction. Were this to happen, only the stars would remain; and what are the stars, after all, without the eyes of man to gaze upon them or the human mind to contemplate the vastness of their wonders?

*This Wild Abyss: The Story of the Men Who Made Modern Astronomy*

Chapter 9 (p. 434)

The Free Press. New York, New York, USA. 1978

**Clemence, G. M.**

No biographical data available

The measurement of time is essentially a process of counting.

Time and Its Measurement

*American Scientist*, Volume 40, Number 2, April 1952 (p. 261)

**Cleugh, Mary F.**

Psychologist

It cannot be too often emphasized that physics is concerned with the measurement of time, rather than with the essentially metaphysical question as to its nature. ... We must not believe that physical theories can ultimately solve the metaphysical problems that time raises.

*Time and Its Importance in Modern Thought*

Chapter II (p. 51)

Methuen & Company Ltd. London, England. 1937

**Cummings, Ray** 1887–1957

American science fiction writer

This same Space; the spread of this lawn...what would it be in another hundred years? Or a thousand? This little Space, from the Beginning to the End so crowded with events and only Time to hold them apart.

*The Shadow Girl*

Gerald G. Swan. London, England. 1946

“Time,” said George, “why I can give you a definition of time. It’s what keeps everything from happening at once.”

*The Man Who Mastered Time*

Chapter I (p. 1)

A.L. Burt Company. New York, New York, USA. 1929

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Relativity physics has shifted the moving present out from the superstructure of the universe, into the minds of human beings, where it belongs.

*The Physics of Time Asymmetry* (p. 2)

University of California Press. Berkeley, California, USA. 1976

**Davis, Philip J.** 1923–

American mathematician

**Hersh, Reuben** 1927–

American mathematician

Time, that mysterious something, that flow, that relation, that mediator, that arena for event, envelops us and confounds us all.

*Descartes’ Dream: The World According to Mathematics*

Chapter IV

Of Time and Mathematics (p. 189)

Harcourt Brace Jovanovich. San Diego, California, USA. 1986

...we still cannot say what time is; we cannot agree whether there is one time or many times, cannot even agree whether time is an essential ingredient of the universe or whether it is the grand illusion of the human intellect.

*Descartes’ Dream: The World According to Mathematics*

Chapter IV

Of Time and Mathematics (p. 189)

Harcourt Brace Jovanovich. San Diego, California, USA. 1986

**Dewey, John** 1859–1952

American philosopher and educator

Time and memory are true artists; they remold reality nearer to the heart's desire.

*Reconstruction in Philosophy*

Chapter V (p. 104)

Beacon Press. Boston, Massachusetts, USA. 1920

**Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

Time is the continuous loop, the snakeskin with scales endlessly overlapping without beginning or end, or time is an ascending spiral if you will, like a child's toy Slinky.

*Pilgrim at Tinker Creek*

Chapter 5 (p. 76)

Harper's Magazine Press. New York, New York, USA. 1974

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Whatever may be time *de jure*, the Astronomer Royal's time is time *de facto*. His time permeates every corner of physics.

*The Nature of the Physical World*

Chapter III (p. 36)

The Macmillan Company. New York, New York, USA. 1930

In any attempt to bridge the domains of experience belonging to the spiritual and physical sides of our nature, time occupies the key position.

*The Nature of the Physical World*

Chapter V (p. 91)

The Macmillan Company. New York, New York, USA. 1930

The great thing about time is that it goes on.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 25)

Simon & Schuster. New York, New York, USA. 1995

The philosopher discusses the significance of time; the astronomer measures time. The astronomer goes confidently about his business and does not think of asking the philosopher what exactly is this thing he is supposed to be measuring; nor does the philosopher always stop to consider whether time in his speculations is identical with the time which the world humbly accepts from the astronomer. In these circumstances it is not surprising that some confusion should have arisen.

The Relativity of Time

*Nature*, Volume CVI, Number 2677, February 17, 1921 (p. 802)

**Einstein, Albert** 1879–1955

German-born physicist

Till now it was believed that time and space existed by themselves, even if there was nothing — no Sun, no Earth, no stars — while now we know that time and space are not the vessel for the Universe, but could not exist at all if there were no contents, namely, no Sun, no Earth, and other celestial bodies.

*New York Times*, April 4, 1921

The distinction between past, present and future is only an illusion, even if a stubborn one.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 70)

Simon & Schuster. New York, New York, USA. 1995

Michele [Besso] has left this strange world just before me. This is of no importance. For us convinced physicists the distinction between past, present and future is an illusion, although a persistent one.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 283)

Random House, Inc. New York, New York, USA. 1991

**Eliot, George (Mary Ann Evans Cross)** 1819–80

English novelist

Men can do nothing without the make-believe of a beginning. Even Science, the strict measurer, is obliged to start with a make-believe unit, and must fix on a point in the stars' unceasing journey when his sidereal clock shall pretend that time is Nought. His less accurate grandmother Poetry has always been understood to start in the middle; but on reflection it appears that her proceeding is not very different from his; since Science, too, reckons backward as well as forward, divides his unit into billions, and with his clock-finger at Nought really sets off in medias res. No retrospect will take us to the true beginning; and whether our prologue be in heaven or on earth, it is but a fraction of that all-presupposing fact with which our story sets out.

*Daniel Deronda*

Book I, Chapter I (p. 5)

A.L. Burt Company. New York, New York, USA. 18??

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

Time present and time past

Are both perhaps present in time future,

And time future contained in time past.

*The Collected Poems and Plays 1909–1950*

Burnt Norton (p. 117)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Fraser, Julius Thomas**

No biographical data available

The resulting dichotomy between time felt and time understood is a hallmark of scientific-industrial civilization, a sort of collective schizophrasia.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 283)

Random House, Inc. New York, New York, USA. 1991

**Froude, James Anthony** 1818–94

English historian and biographer

Time has no relation to Being, conceived mathematically; it would be absurd to speak of circles or triangles as any older today than they were at the beginning of the world.

*Short Studies on Great Subjects* (Volume 1)

Spinoza (p. 359)

Longmans, Green & Company. London, England. 1879

### **Gale, Richard M.**

No biographical data available

...“time” is indefinable...due to the fact that temporal notions are implicitly involved in all of the basic concepts by means of which we think and talk about the world.

*The Language of Time*

Part One, Chapter I (p. 5)

Humanities Press. New York, New York, USA. 1968

### **Galton, Sir Francis** 1822–1911

English anthropologist, explorer, and statistician

It is difficult to withstand a suspicion that the three dimensions of space and the fourth dimension of time may be four independent variables of a system that is neither space nor time, but something else wholly unperceived by us. Our present enigma as to how a First Cause could itself have been brought into existence — how the tortoise of the fable, that bears the elephant that bears the world, is itself supported, — may be wholly due to our necessary mistranslation of the four or more variables of the universe, limited by inherent conditions, into the three unlimited variables of Space and the one of Time.

*Inquiries into Human Faculty and Its Development*

The Observed Order of Events (p. 196)

AMS Press. New York, New York, USA. 1973

### **Gardner, Earl Stanley** 1889–1970

American author

Time is really nothing but a huge circle. You divide a circle of three hundred and sixty degrees into twenty-four hours, and you get fifteen degrees of arc that is the equivalent of each hour.

*The Case of the Buried Clock* (p. 82)

Grosset & Dunlap. New York, New York, USA. 1943

### **Haughton, Samuel** 1821–97

Irish scientific writer

The infinite time of the geologists is in the past; and most of their speculations regarding this subject seem to imply the absolute infinity of time, as if the human imagination was unable to grasp the period of time requisite for the formation of a few inches of sand or feet of mud, and its subsequent consolidation into rock.

*Manual of Geology*

Lecture IV (p. 80)

Longmans, Green, Reader, and Dyer. London, England. 1866

### **Hawking, Stephen William** 1942–

English theoretical physicist

Imaginary time is another direction of time, one that is at right angles to ordinary, real time. We could get away from this one-dimensional, linelike behavior of time. ...

Ordinary time would be a derived concept we invent for psychological reasons. We invent ordinary time so that we can describe the universe as a succession of events in time, rather than as a static picture, like a surface map of the earth.... Time is just like another direction in space.

*Playboy*, Interview, April 1990

### **Heraclitus** ca. 540 BCE–ca. 475 BCE

Greek philosopher

Time is like a river flowing endlessly through the universe.

In Franzo H. Crawford

*Introduction to the Science of Physics*

Chapter 10 (p. 160)

Harcourt, Brace & World, Inc. New York, New York, USA. 1968

### **Høeg, Peter** 1957–

Danish author

Time refuses to be simplified or reduced. You cannot say that it is only found in the mind or only in the universe, that it runs only in one direction, or in every one imaginable. That it exists only in biological substructure, or is only a social convention. It is all of these things.

*Borderliners*

Chapter Seven (p. 259)

Farrar, Straus & Giroux. New York, New York, USA. 1994

### **Housman, A. E. (Alfred Edward)** 1859–1936

English poet, scholar, and satirist

Three minutes' thought would suffice to find this out; but thought is irksome and three minutes is a long time.

*Selected Prose*

Chapter II, Section 3 (p. 56)

At The University Press. Cambridge, England. 1961

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If there is one thing we can be sure enough of in physics it is that all time exists with equal reality.

*October the First Is Too Late*

Chapter Six (p. 75)

Harper & Row, Publishers. New York, New York, USA. 1966

### **Hurley, Patrick M.** 1912–2000

British geophysicist

How majestic are those broad reaches of time! Looking into an abyss, one senses the gigantic form of the void only in comparison to one's own minute stature. It is almost incomprehensible that only a few billion years ago our galaxy was born in a gigantic bomb-flash of nuclear energy. What an inspiring picture of the process of creation! But awesome and inspiring as it is to contemplate this mighty spectacle, the true reward is not to be found

in whether our calculations are correct, give or take a few million years; it lies in the discoveries, in the advancement of human knowledge and philosophy that are the inevitable products of scientific search for law in nature.

*How Old Is the Earth?*

Chapter VI (p. 152)

Greenwood Press, Publishers. Westport, Connecticut, USA. 1959

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

Time, which measures every thing in our idea, and is often deficient to our schemes, is to nature endless and as nothing.

Theory of the Earth

*Transactions of the Royal Society of Edinburgh*, Volume 1, 1788 (p. 215)

**Huxley, Thomas Henry** 1825–95

English biologist

Biology takes her time from geology. The only reason we have for believing in the slow rate of the change in living forms is the fact that they persist through a series of deposits which, geology informs us, have taken a long while to make. If the geological clock is wrong, all the naturalist will have to do is to modify his notions of the rapidity of change accordingly.

*Quarterly Journal of the Geological Society London*, Volume 25 (p. xxxviii)

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

...time figures as the mortar which binds the bricks of matter together...

*The Mysterious Universe*

Chapter V (p. 144)

The Macmillan Company. New York, New York, USA. 1932

...time leaves its mark, its wrinkles and its grey hairs, on the stars, so that we can guess their ages tolerable well, and the evidence is all in favor of stellar lives, not of thousands of millions, but of millions of millions, of years.

*The Universe Around Us*

Chapter I (p. 78)

The Macmillan Company. New York, New York, USA. 1929

**Kant, Immanuel** 1724–1804

German philosopher

Time is not an empirical conception. For neither coexistence nor succession would be perceived by us, if the representation of time did not exist as a foundation a priori. Without this presupposition we could not represent to ourselves that things exist together at one and the same time, or at different times, that is, contemporaneously, or in succession.

In *Great Books of the Western World* (Volume 42)

*Critique of Pure Reason*

First Part, Of Time, Metaphysical Exposition of this Conception, 5  
*Encyclopædia Britannica*, Inc. Chicago, Illinois, USA. 1952

**Krauss, Lawrence M.** 1954–

American theoretical physicist

The possibilities of space travel beckon us every time we gaze up at the stars, yet we seem to be permanent captives in the present. The question that motivates not only dramatic license but a surprising amount of modern theoretical physics research can be simply put: Are we or are we not prisoners on a cosmic temporal freight train that cannot jump the tracks?

*The Physics of Star Trek*

Chapter Two (p. 13)

HarperPerennial. New York, New York, USA. 1995

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

Time is insignificant and never a difficulty for Nature. It is always at her disposal and represents an unlimited power with which she accomplishes her greatest and smallest tasks.

Translated by Albert V. Carozzi

*Hydrogeology*

Chapter 3 (p. 61)

University of Illinois Press. Urbana, Illinois, USA. 1964

Oh, how very ancient the earth is!

Translated by Albert V. Carozzi

*Hydrogeology*

Chapter 3 (p. 75)

University of Illinois Press. Urbana, Illinois, USA. 1964

**Lapworth, Charles** 1842–1920

English geologist

Far be it from me to suggest that geologists should be reckless in their drafts upon the bank of Time; but nothing whatever is gained, and very much is lost, by persistent niggardliness in this direction.

*Proceedings of the Geological Society of London*, Volume 59, 1903 (p. lxxii)

**Lightman, Alan** 1948–

American physicist, novelist, and essayist

There is a place where time stands still...illuminated by only the most feeble red light, for light is diminished to almost nothing at the center of time, its vibrations slowed to echoes in vast canyons, its intensity reduced to the faint glow of fireflies.

*Einstein's Dreams*

14 May 1905 (p. 70, 72–73)

Pantheon Books. New York, New York, USA. 1993

**Lyll, Sir Charles** 1797–1875

English geologist

Such views of the immensity of past time, like those unfolded by the Newtonian philosophy in regard to space,

were too vast to awaken ideas of sublimity unmixed with a painful sense of our incapacity to conceive a plan of such infinite extent. Worlds are seen beyond worlds immeasurably distant from each other, and beyond them all innumerable other systems are faintly traced on the confines of the visible universe.

*Principles of Geology* (Volume 1)

Chapter IV (p. 63)

John Murray. London, England. 1830

...until we habituate ourselves to contemplate the possibility of an indefinite lapse of time having been comprised within each of the modern periods of earth's history, we shall be in danger of forming most erroneous and partial views of geology.

*Principles of Geology* (Volume 3)

Chapter VIII (p. 97)

John Murray. London, England. 1830

In vein do we aspire to assign limits to the works of creation in space, whether we examine the starry heavens, or that world of minute animalcules which is revealed to us by the microscope. We are prepared, therefore, to find that in time also the confines of the universe lie beyond the reach of mortal ken.

*Principles of Geology* (Volume 3)

Concluding Remarks (p. 384)

John Murray. London, England. 1830

### **Mann, Thomas** 1875–1955

German-born American novelist

Time has no division to mark its passage, there is never a thunder-storm or blare of trumpets to announce the beginning of a new month or year. Even when a new century begins it is only we mortals who ring bells and fire off pistols.

*The Magic Mountain*

Chapter V

Whims of Mercurius (p. 225)

Alfred A. Knopf. New York, New York, USA. 1966

### **Mason, Rick**

No biographical data available

With a bit of a mind slip  
You're in for a time slip  
And nothing can ever be the same.

*Time Warp*

Dance song

The Rocky Horror Picture Show

Film (1975)

### **Mehlberg, Henry** 1904–79

Polish-American philosopher of science

It seems to me that it would be either a miracle or an unbelievable coincidence if all the major scientific theories... somehow managed to co-operate with each other so as to conceal time's arrow from us. There would be neither a miracle nor an unbelievable coincidence in the

concealment of time's arrow from us only if there were nothing to conceal — that is, if time had no arrows.

In Robert S. Cohen (ed.)

*Time, Causality, and the Quantum Theory* (Volume 1) (p. 207)

Reidel. Dordrecht, Netherland. 1980

### **Milton, John** 1608–74

English poet

Fly envious Time, till thou run out thy race...

*The Complete Poetical Works of John Milton*

On Time, l. 1

Houghton Mifflin Company. Boston, Massachusetts, USA. 1924

### **Misner, Charles W.**

American physicist

### **Thorne, Kip S.** 1940–

American theoretical physicist

Time is defined so that motion looks simple.

In Charles W. Misner et al.

*Gravitation*

Part I, Chapter 1 (p. 23)

W.H. Freeman & Company. San Francisco, California, USA. 1973

### **Morris, Richard** 1939–2003

American physicist and science writer

Though science has not yet probed all the depths of the subject of time, it at least knows what we should be asking about the subject. Knowing what to ask is often the most significant step on the road to understanding.

*Time's Arrow: Scientific Attitudes Toward Time*

Chapter 12 (p. 218)

Simon & Schuster. New York, New York, USA. 1985

### **Nabokov, Vladimir** 1899–1977

Russian-American writer

Pure Time, Perceptual Time, Tangible Time, Time free of content, context, and running commentary — this is my time and theme. All the rest is numerical symbol or some aspect of Space. The texture of Space is not that of Time, and the piebald four-dimensional sport bred by relativists is a quadruped with one leg replaced by the ghost of a leg. My time is also Motionless Time (we shall presently dispose of "flowing" time, water-clock time, water-closet time).

*Ada or Ardor: A Family Chronicle*

Part Four (p. 539)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1969

### **Newton, Sir Isaac** 1642–1727

English physicist and mathematician

Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external.

*Mathematical Principles of Natural Philosophy*

Definitions, Scholium I

E.P. Dutton & Company. New York, New York, USA. 1922

**Penrose, Roger** 1931–

English mathematical physicist

...our present picture of physical reality, particularly in relation to the nature of time, is due for a grand shake-up — even greater, perhaps, than that which has already been provided by present-day relativity and quantum mechanics.

*The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*

Chapter 8 (p. 371)

Oxford University Press, Inc. Oxford, England. 1989

**Pirsig, Robert M.** 1928–

American writer

The past cannot remember the past. The future can't generate the future. The cutting edge of this instant right here and now is always nothing less than the totality of every thing there is.

*Zen and the Art of Motorcycle Maintenance: An Inquiry into Values*  
Part III, Chapter 24 (p. 283)

William Morrow & Company, Inc. New York, New York, USA. 1974

**Plato** 428 BCE–347 BCE

Greek philosopher

Time, then, and the heaven came into being at the same instant in order that, having been created together, if ever there was to be a dissolution of them, they might be dissolved together.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 38 (p. 451)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

...The creator...sought to make the universe eternal, so far as might be. Now the nature of the ideal being was everlasting, but to bestow this attribute in its fullness upon a creature was impossible. Wherefore he resolved to have a moving image of eternity, and when he set in order the heaven, he made this image eternal but moving according to number, while eternity itself rests in unity, and this image we call time.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 37 (p. 450)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Playfair, John** 1748–1819

Scottish geologist, physicist, and mathematician

The mind seemed to grow giddy by looking so far into the abyss of time.

Biographical Account of the Late James Hutton, F.R.S.

*Transactions of the Royal Society of Edinburgh*, Volume V, Part III, 1805 (p. 73)

**Plotinus** ca. 205–270

Egyptian-Roman philosopher

Time at first — in reality before that “first” was produced by desire of succession — Time lay, though not yet as Time, in the Authentic Existent together with the Cosmos itself; the Cosmos also was merged in the Authentic and motionless within it.

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Third Ennead VII.11 (p. 126)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The origin of Time, clearly, is to be traced to the first stir of the Soul's tendency towards the production of the sensible Universe with the consecutive act ensuing. This is how “Time” — as we read — “came into Being simultaneously with” this All: the Soul begot at once the Universe and Time; in that activity of the Soul this Universe sprang into being; the activity is Time, the Universe is the content of Time.

In *Great Books of the Western World* (Volume 17)

*The Six Enneads*

Third Ennead VII.11 (p. 127)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poinsoot, Louis** 1777–1859

French mathematician and physicist

If anyone asked me to define time, I should reply: “Do you know what it is that you speak of?” If he said “Yes,” I should answer, “Very well, let us talk about it.” If he said “No,” I should answer, “Very well, let us talk about something else.”

In William Maddock Bayliss

*Principles of General Physiology* (3<sup>rd</sup> edition)

Preface (p. xvii)

Longmans, Green & Company. London, England. 1920

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

Time is creation. The future is just not there.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 321)

Random House, Inc. New York, New York, USA. 1991

The irreversibility [of time] is the mechanism that brings order out of chaos.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 7 (p. 283)

Random House, Inc. New York, New York, USA. 1991

**Putnam, H.**

No biographical data available

I do not believe that there are any longer any philosophical problems about Time; there is only the physical problem of determining the exact physical geometry of the four-dimensional continuum that we inhabit.

Time and Physical Geometry

*Journal of Philosophy*, Volume 64, April 1967

**Reichenbach, Hans** 1891–1953

German philosopher of science

There is no other way to solve the problem of time than the way through physics. More than any other science, physics has been concerned with the nature of time. If time is objective the physicist must have discovered that fact.

*The Direction of Time* (p. 16)

University of California Press. Berkeley, California, USA. 1956

There is no other way to solve the problem of time than the way through physics. ... If time is objective the physicist must have discovered the fact. If there is Becoming, the physicist must know it. ... If there is a solution to the philosophical problem of time, it is written down in the equations of mathematical physics.

*The Direction of Time* (p. 16)

University of California Press. Berkeley, California, USA. 1956

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

...to realise the unimportance of time is the gate of wisdom.

*Our Knowledge of the External World*

Lecture VI (p. 167)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

...there is some sense — easier to feel than to state — in which time is an unimportant and superficial characteristic of reality. Past and future must be acknowledged to be as real as the present, and a certain emancipation from slavery to time is essential to philosophic thought.

*Mysticism and Logic and Other Essays*

Chapter I, Section III (p. 21)

Longmans, Green &amp; Company London, England. 1925

**Saint Augustine of Hippo** 354–430

Theologian and doctor of the Church

Time is like a river made up of events which happen, and its current is strong; no sooner does anything appear than it is swept away.

In Paul Davies

*Other Worlds: A Portrait of Nature in Rebellion, Space, Superspace, and the Quantum Universe*

Chapter 10 (p. 186)

Simon &amp; Schuster. New York, New York, USA. 1980

...all time past to be driven away by time to come; and all time to come, to follow upon the past; and that all both past and to come, is made up, and flows out of that which is always present? Who now shall so hold fast this heart of man, that it may stand, and see, how that eternity ever still standing, gives the word of command to the times past or to come, itself being neither past nor to come?

*St. Augustine's Confessions* (Volume 2)

Book XI, XI (p. 233)

William Heinemann. London, England. 1912

Clear now it is and plain, that neither things to come, nor things past, are. Nor do we properly say, there be three times, past, present, and to come; but perchance it might be properly said, there be three times: a present time of past things; a present time of present things; and a present time of future things. ... The present time of past things is our memory; the present time of present things is our sight; the present time of future things our expectation.

*St. Augustine's Confessions* (Volume 2)

Book XI, XX (p. 253)

William Heinemann. London, England. 1912

For what is time? Who is able easily and briefly to explain that? Who is so much as in thought to comprehend it, so as to express himself concerning it? And yet what in our usual discourse do we more familiarly and knowingly make mention of than time? And surely we understand it well enough, when we speak of it: we understand it also, when in speaking with another we hear it named.

*St. Augustine's Confessions* (Volume 2)

Book XI, XIV (p. 237, 239)

William Heinemann. London, England. 1912

What is time then? If nobody asks me, I know: but if I were desirous to explain it to one that should ask me, plainly I know not.

*St. Augustine's Confessions* (Volume 2)

Book XI, XIV (p. 237, 239)

William Heinemann. London, England. 1912

...if nothing were coming, there should be no time to come: and if nothing were, there should now be no present time. These two times therefore, past and to come, in what sort are they, seeing the past is now no longer, and that to come is not yet? As for the present, should it always be present and never pass into times past, verily it should not be time but eternity.

*St. Augustine's Confessions* (Volume 2)

Book XI, XIV (p. 239)

William Heinemann. London, England. 1912

**Santayana, George (Jorge Agustín Nicolás Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

The essence of nowness runs like a fire along the fuse of time.

*Realms of Being*

Chapter IX (p. 491)

Cooper-Square Publishers, Inc. New York, New York, USA. 1972

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Unless hours were cups of sack, and minutes capons, and clocks the tongues of bawds, and dials the signs of leaping-houses, and the blessed sun himself a fair hot wench in flame-colour'd taffeta, I see no reason why thou shouldst be so superfluous to demand the time of the day.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
 The First Part of King Henry the Fourth  
 Act I, Scene ii, l. 7–10  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

There are many events in the womb of time which will be delivered.

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 Othello, The Moor of Venice  
 Act I, Scene iii, l. 376  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

What seekest thou else

In the dark backward and abysm of time?

In *Great Books of the Western World* (Volume 27)  
*The Plays and Sonnets of William Shakespeare* (Volume 2)  
 The Tempest  
 Act VI, Scene ii, l. 50  
 Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### **Silesius, Angelus** 1624–77

German poet

Do not compute eternity  
 as light-year after year

One step across  
 that line called Time

Eternity is here.

*The Book of Angelus Silesius*  
 Of Time and Eternity (p. 42)  
 Alfred A. Knopf. New York, New York, USA. 1976

### **Stevenson, Robert Louis** 1850–94

Scottish essayist and poet

She is settling fast? said the First Lieutenant as he returned from shaving.

“Fast, Mr. Spoker?” asked the Captain. “The expression is a strange one, for Time (if you will think of it) is only relative.”

*Fables*  
 The Sinking Ship  
 Charles Scribner’s Sons. New York, New York, USA. 1923

### **Suess, Eduard** 1831–1914

Austrian geologist

The astronomer, in order to render conceivable the immensity of celestial space, points to the parallelism of the stellar rays or to the white clouds of the Milky Way. There is no such means of comparison by which we can illustrate directly the great length of cosmic periods, and we do not even possess a unit with which such periods might be measured. The distance in space of many stars from the earth has been determined; for the distance in time of the latest strand-line on Capri or the last shell-bed on Tromsø, we cannot suggest an estimate even in approximate figures.

*The Face of the Earth* (Volume 2)

Part III, Chapter XIV (p. 556)  
 At The Clarendon Press. Oxford, England. 1906

We hold the organic remains of the remote past in our hand and consider their physical structure, but we know not what interval of time separates their epoch from our own; they are like those celestial bodies without parallax, which inform us of their physical constitution by their spectrum, but furnish no clue to their distance. As Rama looks out upon the Ocean, its limits mingling and uniting with heaven on the horizon, and as he ponders whether a path might not be built into the Immeasurable, so we look over the Ocean of time, but nowhere do we see signs of a shore.

*The Face of the Earth* (Volume 2)  
 Part III, Chapter XIV (p. 556)  
 At The Clarendon Press. Oxford, England. 1906

### **Swinburne, Richard** 1843–

English philosopher

It would be an error to suppose that if the universe is infinitely old, and each state of the universe at each instant of time has a complete explanation which is a scientific explanation in terms of a previous state of the universe and natural laws (and so God is not invoked), that the existence of the universe throughout infinite time has a complete explanation, or even a full explanation. It has not. It has neither. It is totally inexplicable.

*The Existence of God*  
 Chapter 7 (p. 122)  
 At the Clarendon Press. Oxford, England. 1979

### **The X-Files**

SCULLY: No, wait a minute. You’re saying that, that time disappeared. Time can’t just disappear, it’s, it’s, it’s a universal invariant!

MULDER: Not in this zip code.

*Pilot*  
 Television program  
 Season 1 (1993)

### **Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

Time is but the stream I go a-fishin in.

*The Writings of Henry David Thoreau* (Volume 2)  
 Walden  
 Chapter II (p. 155)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

### **Tuttle, Hudson** 1836–1910

American spiritualist

Thousands of years are, in the chronometer of nature, one stroke of the pendulum — a moment.

In Ludwig Buchner  
*Force and Matter*  
 Chapter IX (p. 56)  
 Trubner & Company. London, England. 1864



**Urey, Harold Clayton** 1893–1981  
American chemist

However, the evolution from inanimate systems of biochemical compounds, e.g., the proteins, carbohydrates, enzymes and many others, of the intricate systems of reactions characteristic of living organisms, and the truly remarkable ability of molecules to reproduce themselves seems to those most expert in the field to be almost impossible. Thus a time from the beginning of photosynthesis of two billion years may help to accept the hypothesis of the spontaneous generation of life.

On the Early Chemical History of the Earth and the Origin of Life  
*Proceedings of the National Academy of Science*, Volume 38, 1952 (p. 362)

**Virgil** 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

Time is flying — flying never to return.

In Paul Davies

*Other Worlds: A Portrait of Nature in Rebellion, Space, Superspace, and the Quantum Universe*

Chapter 10 (p. 186)

Simon & Schuster. New York, New York, USA. 1980

**von Helmholtz, Hermann** 1821–94

German scientist and philosopher

Physico-Mechanical laws are, as it were, the telescopes of our spiritual eyes which can penetrate into the deepest night of time, past and to come.

In Alexander Winchell

*World-Life or Comparative Geology*

Part II, Chapter IV (p. 451)

S.C. Griggs & Company. Chicago, Illinois, USA. 1883

**Vyasa** ca. 3100 BCE

Vedic and Puranic scribe

Time does not sleep when all things sleep,  
Only Time stands straight when all things fall.

Is, was, and shall be are Time's Children.

Is, was, and shall be are Time's Children.

*The Mahabharata of Vyasa*

The Beginning (p. 65)

Publisher undetermined

**Weil, Simone** 1909–43

French philosopher and mystic

Time is an image of eternity, but it is also a substitute for eternity.

*Gravity and Grace*

Renunciation of Time (p. 18)

Routledge & Kegan Paul. London, England. 1952

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

“Can an instantaneous cube exist?”

“Don't follow you,” said Filby.

“Can a cube that does not last for any time at all, have a real existence?”

Filby became pensive. “Clearly,” the Time Traveler proceeded, “any real body must have extension in four directions: it must have Length, Breadth, Thickness, and — Duration. . . . There are really four dimensions, three which we call the three planes of Space and a fourth, Time. There is, however, a tendency to draw an unreal distinction between the former three dimensions and the latter, because it happens that our consciousness moves intermittently in one direction along the latter from the beginning to the end of our lives.”

In Robert M. Hutchins and Mortimer J. Adler (eds.)

*The Great Ideas Today, 1971*

The Time Machine, Chapter 1

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Wheeler, John Archibald** 1911–

American theoretical physicist and educator

Should we be prepared to see some day a new structure for the foundations of physics that does away with time?

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 178)

Simon & Schuster. New York, New York, USA. 1995

Time is nature's way to keep everything from happening at once.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 236)

Simon & Schuster. New York, New York, USA. 1995

Time ends. That is the lesson of the “big bang.” It is also the lesson of the black hole.

The Lesson of the Black Hole

*Proceedings of the American Philosophical Society*, Volume 125, 25

Of all the obstacles to a thoroughly penetrating account of existence, none looms up more dismayingly than “time.” Explain time? Not without explaining existence. Explain existence? Not without explaining time. To uncover the deep and hidden connection between time and existence, to close on itself our quartet of questions, is a task for the future.

Hermann Weyl and the Unity of Knowledge

*American Scientist*, Volume 74, July–August 1986 (p. 374)

**White, Henry Kirke** 1785–1806

English poet

...it is fearful then

To steer the mind in deadly solitude

Up the vague stream of probability

To wind the mighty secrets of the past

And turn the key of time.

*Poetical Works*

Time

Bell & Daldy. London, England. 1870

**Whitehead, Alfred North** 1861–1947

English mathematician and philosopher

Time and space express the universe as including the essence of transition and the success of achievement. The transition is real, and the achievement is real. The difficulty is for language to express one of them without explaining away the other.

*Modes of Thought*

Chapter II, Lecture Five (pp. 139–140)

The Macmillan Company. New York, New York, USA. 1938

Apart from time there is no meaning for purpose, hope, fear, energy. If there be no historic process, then everything is what it is, namely, a mere fact. Life and motion are lost.

*Modes of Thought*

Chapter II, Lecture Five (p. 139)

The Macmillan Company. New York, New York, USA. 1938

It is impossible to meditate on time and the mystery of the creative process of nature without an overwhelming emotion at the limitations of human intelligence.

*The Concept of Nature*

Chapter III (p. 73)

At The University Press. Cambridge, England. 1920

**Whitrow, G. J.** 1912–2000

English mathematician, cosmologist, and science historian

The basic objection to attempts to deduce the unidirectional nature of time from concepts such as entropy is that they are attempts to reduce a more fundamental concept to a less fundamental one.

*The Natural Philosophy of Time* (2<sup>nd</sup> ed.)

Chapter 7 (p. 338)

Clarendon Press. Oxford, England. 1980

...the history of natural philosophy is characterized by the interplay of two rival philosophies of time — one aiming at its “elimination” and the other based on the belief that it is fundamental and irreducible.

*The Natural Philosophy of Time* (2<sup>nd</sup> edition)

Chapter 7 (p. 370)

Clarendon Press. Oxford, England. 1980

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

What Eddington says about “the direction of time” and the law of entropy comes to this: time would change its direction if men should start walking backwards one day. Of course you can call it that if you like; but then you should be clear in your mind that you have said no more than that people have changed the direction they walk in.

Translated by Peter Winch

*Culture and Value* (p. 18e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Yeats, William Butler** 1865–1939

Irish poet and playwright

Time drops in decay,  
Like a candle burnt out.

*The Collected Poems of W.B. Yeats*

The Moods (p. 54)

The Macmillan Company. New York, New York, USA. 1956

**Zebrowski, George** 1945–

Polish-American science fiction writer

Time is a relationship that we have with the rest of the universe; or more accurately, we are one of the clocks, measuring one kind of time. Animals and aliens may measure it differently. We may even be able to change our way of marking time one day, and open up new realms of experience, in which a day today will be a million years.

*OMNI Magazine*, 1994**TIME TRAVEL****Allen, Elizabeth Akers** 1832–1911

Journalist and poet

Backward, turn backward, O Time, in your flight.

Make me a child again just for to-night.

*Rock Me to Sleep, Mother*

Rock Me to Sleep, Mother (p. 11)

Estes &amp; Lauriat. Boston, Massachusetts, USA. 1883

**Bester, Alfred** 1913–87

American science fiction writer

“We’re like millions of strands of spaghetti in the same pot. No time traveler can ever meet another time traveler in the past or the future. Each of us must travel up or down his own strand alone.”

“But we’re meeting each other now.”

“We’re no longer time travelers, Henry. We’ve become the spaghetti sauce.”

*Starlight: The Great Short Fiction of Alfred Bester*

The Man Who Murdered Mohammed (p. 100)

Doubleday &amp; Company, Inc. Garden City, New York, USA. 1976

**Clarke, Arthur C.** 1917–

English science and science fiction writer

The most convincing argument against time travel is the remarkable scarcity of time travelers. However unpleasant our age may appear to the future, surely one would expect scholars and students to visit us, if such a thing were possible at all. Though they might try to disguise themselves, accidents would be bound to happen — just as they would if we went back to Imperial Rome with cameras and tape-recorders concealed under our nylon togas.

*Profiles of the Future: An Inquiry into the Limits of the Possible*

Chapter 11 (p. 132)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

**Kaku, Michio** 1947–  
Japanese-American theoretical physicist

...imagine the chaos that would arise if time machines were as common as automobiles, with tens of millions of them commercially available. Havoc would soon break loose, tearing at the fabric of our universe. Millions of people would go back in time to meddle with their own past and the past of others, rewriting history in the process.... It would be impossible to take a simple census to see how many people there were at any given time.

*Hyperspace : A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10<sup>th</sup> Dimension*  
Chapter 11 (p. 234)  
Oxford University Press, Inc. New York, New York, USA. 1995

**Krauss, Lawrence M.** 1954–  
American theoretical physicist

While every one of us is a time traveler, the cosmic pathos that elevates human history to the level of tragedy arises precisely because we seem doomed to travel in only one direction — into the future.

*The Physics of Star Trek*  
Chapter Two (p. 13)  
Harp Perennial Publishers. New York, New York, USA. 1995

**Schickel, Richard**  
American film critic

Time travel is the thinking person's UFO, an improbability that nevertheless resonates with mysterious and sometimes marvelous possibilities.

Review  
Back to the Future, Part II  
*Time*, December 4, 1989

**Wells, H. G. (Herbert George)** 1866–1946  
English novelist, historian, and sociologist

Man...can go up against gravitation in a balloon, and why should he not hope that ultimately he may be able to stop or accelerate his drift along the Time-Dimension, or even turn about and travel the other way.

*The Great Ideas Today, 1971*  
The Time Machine  
Chapter One (p. 451)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

I'm afraid I cannot convey the peculiar sensations of time traveling. They are excessively unpleasant.

In Robert M. Hutchins and Mortimer J. Adler (eds.)  
*The Great Ideas Today, 1971*  
The Time Machine  
Chapter Three (p. 458)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

## TOOL

**Beecher, Henry Ward** 1813–87  
American Congregational preacher and orator

A tool is but the extension of a man's hand, and a machine is but a complex tool. He that invents a machine augments the power of a man and the well-being of mankind.

In Lenox R. Lohr  
*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*  
Historical Background (p. 340)  
Centennial of Engineering. Chicago, Illinois. 1952

**Bergson, Henri** 1859–1941  
French philosopher

Science has equipped man in less than fifty years with more tools than he had made during the thousands of years he had lived on earth. Each new machine being for man a new organ — an artificial organ — his body became suddenly and prodigiously increased in size, without his soul being at the same time able to dilate to the dimensions of his body.

In Lenox R. Lohr  
*Centennial of Engineering: History and Proceedings of Symposia: 1852–1952*  
Historical Background (p. 343)  
Centennial of Engineering. Chicago, Illinois. 1952

**Carlyle, Thomas** 1795–1881  
English historian and essayist

Man is a Tool-using Animal. Weak in himself, and of small stature, he stands on a basis, at most for the flattest-soled, of some half square foot, insecurely enough; Has to straddle out his legs, lest the very wind supplant him. Feeblest of bipeds! Three quintals are a crushing load for him; the steer of the meadow tosses him aloft like a waste rag. Nevertheless he can use Tools: with these the granite mountain melts into light dust before him, seas are his smooth highway, winds and fire his unwearied steeds. Nowhere do you find him without Tools; without Tools he is nothing, with Tools he is all.

*Sartor Resartus*  
Book I, Chapter V (pp. 35–36)  
Ginn & Company. Boston, Massachusetts, USA. 1897

## TOOTH

**Baxter, Richard**

No biographical data available

An aching tooth is better out than in.

To lose a rotten member is a gain.  
*Hypocrisy*

**Fischer, Martin H.** 1879–1962  
German-American scientist

I find that most men would rather have their bellies opened for five hundred dollars than have a tooth pulled for five.

In Howard Fabing and Ray Marr  
*Fischerisms*  
C.C. Thomas. Springfield, Illinois, USA. 1944

**Hazlitt, William Carew** 1834–1913  
English bibliographer

One said a tooth drawer was a kind of unconscionable trade, because his trade was nothing else but to take away those things whereby every man gets his living.

*Shakespeare Jest Books* (Volume 3)  
Conceit, Clichés, Flashes and Whimzies, Number 84  
Willis & Sotheran. London, England. 1864

**Mayo, Charles Horace** 1865–1939  
American physician

A crowned tooth is not a “crown of glory” and may cover a multitude of germs.

Problems of Infection  
*Minnesota Medicine*, Volume 1, 1918

## TOOTHACHE

**Burns, Robert** 1759–96  
English author

My curse upon your venom'd stang,  
That shoots my tortur'd gooms along,  
An' thro' my lug gies monie a twang  
Wi' gnawing vengeance,  
Tearing my nerves wi' bitter pang,  
Like racking engines!

*The Poems and Songs of Robert Burns* (Volume 2)  
Address to the Toothache, Stanza I  
Clarendon Press. Oxford, England. 1968

**Busch, Wilhelm** 1832–1908  
German cartoonist, painter, and poet

A toothache, not to be perverse,  
Is an unmitigated curse...

*German Satirical Writings*  
The Poet Thwarted (p. 161)  
Continuum. New York, New York, USA. 1984

**Carroll, Lewis (Charles Dodgson)** 1832–98  
English writer and mathematician

“Do I look very pale?” said Tweedledum, coming up to have his helmet tied on. (He called it a helmet, though it certainly looked much more like a saucepan.)

“Well — yes — a little”, Alice replied gently.

“I’m very brave generally”, he went on in a low voice: “only to-day I happen to have a headache.”

“And I’ve got a toothache!” said Tweedledee, who had overheard the remark. I’m far worse than you!”

*The Complete Works of Lewis Carroll*  
Through the Looking-Glass  
Chapter IV (p. 193)  
The Modern Library. New York, New York, USA. 1936

**Collins, John** 1742–1808  
No biographical data available

Maria one Morning was smitten full sore,  
With the Tooth-ache’s unmerciful Pang;  
And she vow’d, if she liv’d to the Age of Five-score,  
That she still should remember the Fang.

*Scriptscrapologia*  
Excuse for Oblivion, l. 1–4  
Published by the author. Birmingham, England. 1804

**Fuller, Thomas** 1608–61  
English clergyman and author

The tongue is ever turning to the aching tooth.

*Gnomologia: Adages and Proverbs, Wise Sentences, and Witty Sayings. Ancient and Modern, Foreign and British*  
No. 4796  
Printed for Thomas & Joseph Allman. London, England. 1816

**Gilbert, Sir William Schwenck** 1836–1911  
English playwright and poet

**Sullivan, Arthur** 1842–1900  
English composer

Roll on, thou ball, roll on!  
Through pathless realms of Space  
Roll on!  
What though I’m in a sorry case?  
What though I cannot meet my bills?  
What though I suffer toothache’s ills?  
What though I swallow countless pills?

In Helen and Lewis Melville  
*An Anthology of Humorous Verse*  
To the Terrestrial Globe  
Dodd, Mead & Company New York, New York, USA. 1924

**Heath-Stubbs, John** 1918–2006  
English critic, anthologist, translator, and poet

Venerable Mother Toothache  
Climb down from the white battlements,  
Stop twisting in your yellow fingers  
The fourfold rope of nerves.

*Collected Poems 1943–1987*  
A Charm Against the Toothache (p. 312)  
Carc Janet Press Ltd. Manchester, England. 1988

**Hood, Thomas** 1582–98  
English poet and editor

One tooth he had with many fangs,  
That shot at once as man pangs,  
It had an universal sting;  
One tough of that ecstatic stump  
Could jerk his limbs, and make him jump,  
Just like a puppet on a string.

*The Complete Poetical Works of Thomas Hood*  
A True Story  
Greenwood Press, Publishers. Westport, Connecticut, USA. 1980

**James, Henry** 1843–1916  
American novelist

He might have been a fine young man with a bad toothache; with the first even of his life. What ailed him above all, she felt, was that trouble was new to him...

*The Spoils of Poynton*

Chapter 8 (p. 102)

New Directions Houghton Mifflin Company. Norfolk, Connecticut, USA, 1924

**Josselyn, John** 1630–75

English gentleman

...for the Toothache I have found the following medicine very available, Brimstone and Gunpowder compounded with butter; rub the mandible with it, the outside being first warm'd.

*Two Voyages to New-England*

The Second Voyage (pp. 128–129)

**Mather, Cotton** 1663–1728

American minister and religious writer

O Man, Since the Hardest and Strongest Things thou hast about thee, are so fast Consuming; Do not imagine that the rest of thy Body will remain Long Unconsumed, or that any Bones of thy Body shall not soon Moulder into Dust.

*The Angel of Bethesda*

Capsula XI (p. 63)

American Antiquarian Society and Barre Publishers. Barre, Massachusetts, USA. 1972

a Thigh-bone of a Toad, applied unto an aking Tooth, rarely fails of easing the Pain.

*The Angel of Bethesda*

Capsula XI (p. 64)

American Antiquarian Society and Barre Publishers. Barre, Massachusetts, USA. 1972

**Melville, Herman** 1819–91

American novelist

Another [sailor] has the toothache: the carpenter out pin-cers, and clapping one hand upon his bench bids him be seated there; but the poor fellow unmanageably winces under the uncompleted operation; whirling round the handle of his wooden vice, the carpenter signs him to clap his jaw in that, if he would have him draw the tooth.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 107 (p. 344)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Proverb

The tooth-ache is more ease, than to deale with ill people.

In George Herbert

*Outlandish Proverbs*

#558

Printed by T. Maxey for T. Garthwait. London, England. 1651

**Ray, John** 1627–1705

English naturalist

Who hath aching teeth hath ill tenants.

*A Complete Collection of English Proverbs* (p. 26)

Printed for G. Cowie. London, England. 1813

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

For there was never yet philosopher

That could endure the toothache patiently.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

Much Ado About Nothing

Act V, Scene i, l. 35–36

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

He that sleeps feels not the toothache.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Cymbeline

Act V, Scene iv, l. 177

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

The man with toothache thinks everyone happy whose teeth are sound.

*The Revolutionist's Handbook & Pocket Companion*

Maxims for Revolutionists, Greatness (p. 56)

Publisher undetermined. USA. 1962

## TRACK

**Defoe, Daniel** 1660–1731

English pamphleteer, journalist, and novelist

...there was exactly the print of a foot, toes, heel and every part of a foot; how it came thither, I knew not, nor could I in the least imagine...

*Robinson Crusoe* (p. 113)

Dodd, Mead & Company. New York, New York, USA. 1946

**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

“Not a bird my dear Roxton — not a bird?”

“A beast?”

“No; a reptile — a dinosaur. Nothing else could have left such a track.”

*The Lost World*

Chapter X (p. 168)

The Colonial Press, Clinton, Massachusetts, USA. 1959

**Melville, Herman** 1819–91

American novelist

That turnpike earth! — that common highway all over dented with the marks of...heels and hoofs.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 13 (p. 44)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mills, Enos A.** 1870–1922  
Naturalist, writer and nature guide

The tracks and records in the snow which I read in passing made something of a daily newspaper for me. They told much of the news of the wilds.

In William H. Carr  
*The Stir of Nature*  
Chapter Three (p. 37)  
Oxford University Press, Inc. New York, New York, USA. 1930

## TRACKING

**Milne, A. A. (Alan Alexander)** 1882–1956  
English poet, children's writer, and playwright

"Hallo" said Piglet, "What are you doing?"  
"Tracking something" said Winnie-the Pooh very mysteriously.

"Tracking what?" said Piglet, coming closer.

"That's just what I ask myself. I ask myself, What?"

*The Complete Tales & Poems of Winnie-the-Pooh*  
Winnie-the-Pooh, Winnie-the-Pooh, Pooh and Piglet Go Hunting and Nearly Catch a Woozle (p. 34)  
Dutton Children's Books. New York, New York, USA. 2001

## TRADITION

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

It would have been good, if Bacon had not poured the child out with the bath water, if he had seen the value of existing tradition and had advanced this point of view, if he would have known how to value and to make use of existing experiences, rather than in his style to refer to that which is indeterminable and infinite. He knew of Gilbert's work on magnetism, for example, but seemed to have no idea of the monumental worth which already existed in this discovery.

In Karl J. Fink  
*Goethe's History of Science*  
Chapter 6 (p. 75)  
Cambridge University Press. Cambridge, England. 1991

## TRANSISTOR

**Landauer, Rolf** 1927–99  
German-American physicist

An ordinary transistor circuit is like a door.... You slam it open, you slam it shut. You don't have to have a delicate regard for the amount of force you use when you push it one way or the other. These quantum systems are not like that. Quantum computers don't use just an open door or a shut door. Both the open door and the shut door are present simultaneously. The problems all relate to the fact that the process is not perfect. It doesn't do exactly what you want it to do.

In Tim Folger  
The Best Computer in All Possible Worlds  
*Discover Magazine*, October 1995

## TREE

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

...unless the need were urgent, I could no more sink the blade of an ax into the tissues of a living tree than I could drive it into the flesh of a fellow human.

*The Journey Home: Some Words in Defense of the American West*  
Chapter 19 (p. 208)  
E.P. Dutton. New York, New York, USA. 1977

**Arnold, Sir Edwin** 1832–1904  
English poet

Almond blossom, sent to teach us  
That the spring days soon will reach us.

*Poems*  
Almond Blossoms  
Roberts Brothers. Boston, Massachusetts, USA. 1880

## Author undetermined

At that awful hour of the Passion, when the Savior of the world felt deserted in His agony, when —

The sympathizing sun, his light withdrew, and wonder'd how the stars their dying Lord could view — when earth shaking with horror, rung the passing bell for Deity, and universal nature groaned, then from the loftiest tree to the lowliest flower all felt a sudden thrill, and trembling, bowed their heads, all save the proud and obdurate aspen, which said, "Why should we weep and tremble, we trees, and plants, and flowers are pure and never sinned!"

Ere it ceased to speak, an involuntary trembling seized its every leaf, and the word went forth that it should never rest, but tremble on until the day of judgment.

Legend [of the quaking aspen tree]  
*Notes and Queries*, First Series, Volume 6, Number 161

**Bailey, William Whitman** 1843–1914  
American botanist

Nature is especially fond of tassels. With them she clothes many of her noblest trees.

Willows: "Pussy" and Other  
*The American Botanist*, Volume VI, Number 2, February 1904 (p. 23)

**Bailey, Liberty Hyde** 1858–1954  
American horticulturalist and botanist

The heavier palms are the big game of the plant world.

*Gentes Herbarium*  
Palms, and Their Characteristics, 3, Fasc. 1  
L.H. Bailey Hortorium of the New York State College of Agriculture and Life Sciences. Ithaca, New York, USA.

**Barrett-Browning, Elizabeth** 1806–61

English poet

A great acacia with its slender trunk  
 And overpoise of multitudinous leaves  
 (In which a hundred fields might spill their dew  
 And intense verdure, yet find room enough)  
 Stood reconciling all the place with green.

*The Complete Poetical Works of Elizabeth Barrett Browning*

Aurora Leigh, Book VI, l. 536–541

Houghton Mifflin Company. Boston, Massachusetts, USA. 1900

**Borland, Hal** 1900–78

American writer

Trees are the oldest living things we know. Rooted in the earth and reaching for the stars, they partake of immortality.

*Our Natural World*

The Woodlands (p. 4)

J.B. Lippincott Company. Philadelphia, Pennsylvania, USA. 1969

Only the unobservant sees nothing but trees in a forest. Any woodland is a complex community of plants and animal life with its own laws of growth and survival. But if you would know strength and majesty and patience, welcome the company of trees.

*Beyond Your Doorstep: A Handbook to the Country*

Chapter 4 (p. 75)

Alfred A. Knopf. New York, New York, USA. 1962

**Bronte, Emily** 1818–48

English novelist

My love for Linton is like the foliage in the woods. Time will change it, I'm well aware, as winter changes the trees — my love for Heathcliff resembles the eternal rocks beneath — a source of little visible delight, but necessary.

*Wuthering Heights*

Chapter IX (p. 88)

J.M. Dent &amp; Sons Ltd. London, England. 1907

**Bryant, Alice Franklin** 1900–77

No biographical data available

Like a cathedral in some old world town  
 Rising above all mundane buildings, rears  
 The banyan tree, a growth of long slow years,  
 Towering above the palms. Its verdant crown  
 Fashions a far-spread roof, from which falls down  
 A diamond and tinted light with jeweled spears  
 Of sunbeam piercing through. The whole appears  
 An ornate Gothic pile of world renown.

The Banyan Tree

*Nature Magazine*, Volume 50, Number 5, May 1957 (p. 265)**Bryant, William Cullen** 1794–1878

American poet

The tulip-tree, high up,  
 Opened, in airs of June, her multitude  
 Of golden chalices to humming-birds

And silken-winged insects of the sky.

*Poems*

The Fountain, Stanza 3

D. Appleton &amp; Company. New York, New York, USA. 1874

**Meredith, Owen (Edward Robert Bulwer-Lytton, 1<sup>st</sup> Earl Lytton)** 1831–91

English statesman and poet

Trees that, like the poplar, lift upwards all their boughs, give no shade and no shelter, whatever their height. Trees that most lovingly shelter and shade us, when, like the willow, the higher soar their summits, the lowlier droop their boughs.

*What Will He Do with It? (Volume 2)*

Book XI, Chapter X, Introductory lines (p. 359)

P.F. Collier &amp; Son. New York, New York, USA. 1902

**Burns, Robert** 1759–96

English author

Green, slender, leaf-clad holly-boughs  
 Were twisted graceful', round her brows;  
 I took her for some Scottish Muse,  
 By that same token;  
 And come to stop those reckless vows,  
 Would soon be broken.

*The Complete Poetical Works of Robert Burns*

The Vision, Duan First, Stanza 9

Houghton Mifflin Company. Boston, Massachusetts, USA. 1897

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

Dark tree — still sad when others' grief is fled,

The only constant mourner o'er the dead!

*The Complete Poetical Works of Byron*

The Giaour, l. 286

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Campbell, Thomas** 1777–1844

Scottish poet

Oh, leave this barren spot to me!  
 Spare, woodman, spare the beechen tree!

*The Complete Poetical Works*

The Beech-Tree's Petition, Stanza I

Chadwyck-Healey. Cambridge, England. 1992

**Comstock, Anna Botsford** 1854–1930

American illustrator, writer, and educator

The mortal who has never enjoyed a speaking acquaintance with some individual tree is to be pitied; for such an acquaintance, once established, naturally ripens into a friendliness that brings serene comfort to the human heart, whatever the heart of the tree may or may not experience. To those who know them, the trees, like other friends, seem to have their periods of reaching out for sympathetic understanding. How often this outreaching is met with repulse will never be told; for tree friends

never reproach us — but wait with calm patience for us to grow into comprehension.

*Trees at Leisure*

Comstock Publishing Company. Ithaca, New York, USA. 1916

**Dampier-Whetham, William** 1867–1952

English scientific writer

There was a young man who said, “God  
To you it must seem very odd

That a tree as a tree simply ceases to be  
When there’s no one about in the Quad.”...

Young man, your astonishment’s odd,  
I am always about in the Quad  
And that’s why the tree continues to be  
As observed by, Yours faithfully, God.

In Joseph Needham and Walter Pagel (eds.)

*Background to Modern Science*

From Aristotle to Galileo (pp. 40–41)

The Macmillan Company. New York, New York, USA. 1938

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

Now there were some terrible seeds on the planet that was the home of the little prince; and these were the seeds of the baobab. The soil of that planet was infested with them. A baobab is something you will never, never be able to get rid of if you attend to it too late. It spreads over the entire planet. It bores clear through it with its roots. And if the planet is too small, and the baobabs are too many, they split it to pieces...

Translated by Katherine Woods

*The Little Prince*

Chapter V (p. 21)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Dickens, Charles** 1812–70

English novelist

They whirled past the dark trees, as feathers would be swept before a hurricane. Houses, gates, churches, haystacks, objects of every kind they shot by, with a velocity and noise like roaring waters suddenly let loose. Still the noise of pursuit grew louder, and still my uncle could hear the young lady wildly screaming, “Faster! Faster!”

*The Posthumous Papers of the Pickwick Club*

Chapter XLIX (p. 597)

Dodd, Mead & Company. New York, New York, USA. 1944

The earth covered with a sable pall as for the burial of yesterday; the clumps of dark trees, its giant plumes of funeral feathers, waving sadly to and fro: all hushed, all noiseless, and in deep repose, save the swift clouds that skim across the moon, and the cautious wind, as, creeping after them upon the ground, it stops to listen, and goes rustling on, and stops again, and follows, like a savage on the trail.

*Martin Chuzzlewit*

Chapter XV (p. 232)

Dodd, Mead & Company. New York, New York, USA. 1944

**Douglas, Andrew Ellicott** 1867–1962

American astronomer

By translating the story told by tree rings, we have pushed back the horizons of history in the United States for nearly eight centuries before Columbus reached the shores of the New World...

The Secret of the Southwest Solved by Talkative Tree Rings

*National Geographic*, Volume 56, Number 6, 1929 (p. 737)

**Dryden, John** 1631–1700

English poet, dramatist, and literary critic

The monarch oak, the patriarch of the trees,  
Shoots rising up, and spreads by slow degrees.

Three centuries he grows, and three he stays  
Supreme in state; and in three more decays.

*The Poetical Works of Dryden*

Tales from Chaucer, Palamon and Arcite, Book III, l. 1058

The Riverside Press. Cambridge, Massachusetts, USA. 1949

**English, Thomas Dunn** 1819–1902

American lawyer, physician, and poet

That was a day of delight and of wonder,  
While lying the shade of the maple-trees under —  
He felt the soft breeze at its frolicsome play;  
He smelled the sweet odor of newly mown hay...

*The Select Poems of Dr. Thomas Dunn English*

Under the Trees

Published by private subscription. Newark, New Jersey, USA. 1894

**Forster, E. M. (Edward Morgan)** 1879–1970

English novelist

What is the good of your stars and trees, your sunrise and the wind, if they do not enter into our daily lives?

*Howards End*

Chapter XVI (p. 143)

Vintage Books. New York, New York, USA. 1954

The tree rustled. It had made music before they were born, and would continue after their deaths, but its song was of the moment.

*Howards End*

Chapter XL (p. 315)

Vintage Books. New York, New York, USA. 1954

**Hardy, Thomas** 1840–1928

English poet and regional novelist

To dwellers in a wood almost every species of tree has its voice as well as its feature. At the passing of the breeze the fir-trees sob and moan no less distinctly than they rock; the holly whistles as it battles with itself; the ash hisses amid its quiverings; the beech rustles while its flat boughs rise and fall.

*Under the Greenwood Tree; or The Mellstock Quire*

Part the First, Chapter I (p. 3)

Harper & Brothers. New York, New York, USA. 1939

The instinctive act of humankind was to stand and listen, and learn how the trees on the right and the trees on



the left wailed or chaunted to each other in the regular antiphonies of a cathedral choir; how hedges and other shapes to leeward then caught the note, lowering it to the tenderest sob; and how the hurrying gust then plunged into the south, to be heard no more.

*Far from the Madding Crowd*

Chapter 2 (p. 9)

Harper & Row, Publishers. New York, New York, USA. No date

**Hawthorne, Nathaniel** 1804–64

American novelist and short story writer

And what is more melancholy than the old apple-trees that linger about the spot where once stood a homestead, but where there is now only a ruined chimney rising out of a grassy and weed-grown cellar? They offer their fruit to every wayfarer — apples that are bitter-sweet with the moral of time's vicissitude.

*Mosses from an Old Manse: The Procession of Life*

The Old Manse (p. 8)

A.L. Burt Company, Publishers. New York, New York, USA. No date

**Hay, John**

No biographical data available

They [trees] hang on from a past no theory can recover. They will survive us. The air makes their music. Otherwise they live in savage silence, though mites and nematodes and spiders teem at their roots, and though the energy with which they feed on the sun and are able to draw water sometimes hundreds of feet up their trunks and into their twigs and branches calls for a deafening volume of sound.

*The Undiscovered Country*

Living with Trees (p. 110)

W.W. Norton & Company, Inc. New York, New York, USA. 1981

**Hayne, Paul H.** 1830–1886

American poet

Where drooping lotos-flowers, distilling balm,  
Dream by the drowsy streamlets sleep hath crown'd,  
While Care forgets to sigh, and Peace hath balsamed  
Pain.

*Sonnets, and Other Poems*

Pent in this Common Sphere

Harper & Calvo. Charleston, South Carolina, USA. 1857

**Heine, Heinrich** 1797–1856

German poet

If thou lookest on the lime-leaf,  
Thou a heart's form wilt discover;  
Therefore are the lindens ever  
Chosen seats of each fond lover.

*The Book of Songs*

New Spring, Number 23, Stanza 3 (p. 110)

The Roycrofters. East Aurora, New York, USA. 1903

A pine tree standeth lonely  
On a far norland height:

It slumbereth, while round it  
The snow falls thick and white.

*The Book of Songs*

Lyrical Interlude, Number 34 (pp. 63–64)

The Roycrofters. East Aurora, New York, USA. 1903

**Hemans, Felicia D.** 1793–1835

English poet

I have looked on the hills of the stormy North,  
And the larch has hung all his tassels forth...

*The Poetical Works of Mrs. Felicia Hemans*

The Voice of Spring, Stanza 3

Crosby, Nichols, Lee & Company. Boston, Massachusetts, USA. 1860

**Herbert, George** 1593–1633

English metaphysical poet

Great trees are good for nothing but shade.

*Outlandish Proverbs*

Printed by T. Maxey for T. Garthwait. London, England. 1651

**Ingemann, Bernhard S.** 1789–1862

Danish poet and novelist

What whispers so strange at the hour of midnight,  
From the aspen leaves trembling so wildly?  
Why in the lone wood sings it sad, when the bright  
Full moon beams upon it so mildly?

In George Barrow

*The Songs of Scandinavia and Other Poems and Ballads (Volume 2)*

The Aspen

Constable & Company Ltd. London, England. 1923

**Ingelow, Jean** 1820–97

English poet and novelist

And when I see the chestnut letting  
All her lovely blossoms falter down, I think  
“Alas the day!”

*Poems*

The Warbling of Blackbirds

Longmans, Green, Reader & Dyer. London, England. 1867

**Irving, Washington** 1783–1859

American essayist and short story writer

It was...a fine autumnal day; the sky was clear and serene, and nature wore that rich and golden livery which we always associate with the idea of abundance. The forests had put on their sober brown and yellow, while some trees of the tenderer kind had been nipped by the frosts into brilliant dyes of orange, purple, and scarlet.

*Essays from the Sketch Book*

The Legend of Sleepy Hollow (p. 55)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

**Leyden, John** 1775–1811

Scottish poet

Beneath a shivering canopy reclined,  
Of aspen leaves that wave without a wind,  
I love to lie, when lulling breezes stir  
The spiry cones that tremble on the fir.

*The Poetical Works of Dr. John Leyden*  
Scenes of Infancy  
W.P. Nimmo. London, England. 1875

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Sweet is the air with the budding haws, and the valley  
stretching for miles below

Is white with blossoming cherry-trees, as if just covered  
with lightest snow.

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 5)  
Christus, Golden Legend  
Part IV (p. 265)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

O hemlock-tree!

O hemlock-tree!

how faithful

are thy branches!

Green not alone in summer time,

But in the winter's frost and rime!

O hemlock-tree! O hemlock-tree! how faithful  
are thy branches!

*The Complete Writings of Henry Wadsworth Longfellow* (Volume 6)  
The Hemlock Tree  
Stanza 1  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904–1917

**Lowell, James Russell** 1819–91  
American poet, critic, and editor

The ash her purple drops forgivingly  
And sadly, breaking not the general hush;  
The maple's swamps glow like a sunset sea,  
Each leaf a ripple with its separate flush;  
All round the wood's edge creeps the skirting blaze,  
Of bushes low, as when, on cloudy days,  
Ere the rain falls, the cautious farmer burns his brush.

*The Poetical Works of James Russell Lowell*  
An Indian-Summer Reverie, 11  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

The pine is the mother of legends.

*The Poetical Works of James Russell Lowell*  
The Growth of a Legend  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1890

Rippling through thy branches goes the sunshine,  
Among thy leaves that palpitate forever,  
And in the sea, a pining nymph had prisoned  
The soul, once of some tremulous inland river,  
Quivering to tell her woe, but ah! dumb, dumb forever.

*The Poetical Works of James Russell Lowell*  
The Birch Tree  
Houghton, Mifflin and Company. Boston, Massachusetts, USA. 1890

**Melville, Herman** 1819–91  
American novelist

For, as when the red-cheeked, dancing girls, April and  
May, trip home to the wintry, misanthropic woods; even

the barest, ruggedest, most thunder-cloven old oak will at  
least send forth some few green sprouts, to welcome such  
glad-hearted visitants...

In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 28 (p. 91)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Milton, John** 1608–74  
English poet

Awake, the morning shines, and the fresh field  
Call us; we lose the prime, to mark how spring  
Our tended Plants, how blows the Citron Grove,  
What drops the Myrrhe, & what the balmie Reed,  
How Nature paints her colours, how the Bee  
Sits on the Bloom, extracting liquid sweet.

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book V, l. 20–25  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Moore, Thomas** 1779–1852  
Irish poet

And the wind, full of wantonness, woos like a lover  
The young aspen-trees till they tremble all over.

*The Poetical Works of Thomas Moore*  
Lalla Rookh, Light of the Harem  
Lee & Shepard. Boston, Massachusetts, USA. 1873

**Morris, George P.**  
No biographical data available

Woodman, spare that tree!  
Touch not a single bough!  
In youth it sheltered me,  
And I'll protect it now.

*Poems*  
Woodman, Spare that Tree  
Charles Scribner's Sons. New York, New York, USA. 1853

**Muir, John** 1838–1914  
American naturalist

When a man plants a tree he plants himself.

*Steep Trails*  
Chapter X (p. 141)  
Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

Few are altogether deaf to the preaching of pine trees.  
Their sermons on the mountains go to our hearts; and if  
people in general could be got into the woods, even for  
once, to hear the trees speak for themselves, all difficul-  
ties in the way of forest preservation would vanish.

The National Parks and Forest Reservations  
*Sierra Club Bulletin*, Volume 1, Number 7, January 1896

I have seen oaks of many species in many kinds of  
exposure and soil, but those of Kentucky excel in gran-  
deur all I had ever before beheld. They are broad and  
dense and green. In the leafy bowers and caves of their

long branches dwell magnificent avenues of shade, and every tree seems to be blessed with a double portion of strong exulting life.

*A Thousand Mile Walk to the Gulf*

Chapter I (p. 2)

Houghton Mifflin Company. Boston Massachusetts, USA. 1916

We all travel the milky way together, trees and men; but it never occurred to me until this stormday, while swinging in the wind, that trees are travelers, in the ordinary sense. They make many journeys, not extensive ones, it is true; but our own little journeys, away and back again, are only little more than tree wavings, many of them not so much.

*Mountains of California*

Chapter X (p. 256)

The Century Company. New York, New York, USA. 1911

There is something wonderfully attractive in this king tree, even when beheld from afar, that draws us to it with indescribable enthusiasm; its superior height and massive smoothly rounded outlines proclaiming its character in any company; and when one of the oldest attains full stature on some commanding ridge it seems the very god of the woods.

*Our National Parks*

Chapter IX (p. 287)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

The Big Tree (*Sequoia gigantea*) is Nature's forest masterpiece, and, so far as I know, the greatest of living things.

*Our National Parks*

Chapter IX (p. 268)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Resolute, consummate, determined in form, always beheld with wondering admiration, the Big Tree always seems unfamiliar, standing alone, unrelated, with peculiar physiognomy, awfully solemn and earnest.

*Our National Parks*

Chapter IX (p. 272)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...Sequoias, kings of their race, growing close together like grass in a meadow, poised their brave domes and spires in the sky, three hundred feet above the ferns and lilies that enameled the ground; towering serene through the long centuries, preaching God's forestry fresh from heaven.

*Our National Parks*

Chapter IX (p. 334)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...they never lose their god-like composure, never toss their arms or bow or wave like the pines, but only slowly, solemnly nod and sway, standing erect, making no sign of strife, none of rest, neither in alliance nor at war with the winds, too calmly unconsciously noble and strong to strive with or bid defiance to anything.

*Our National Parks*

Chapter IX (pp. 283–284)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

[The Sugar Pine is] the largest, noblest, and most beautiful of all the seventy or eighty species of pine trees in the world. ...

*Our National Parks*

Chapter IV (p. 109)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

The mighty trees getting their food are seen to be wide awake, every needle thrilling in the welcome nourishing storms, chanting and bowing low in glorious harmony, while every raindrop and snowflake is seen as a beneficent messenger from the sky.

*Our National Parks*

Chapter I (p. 26)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

I never saw a discontented tree. They grip the ground as though they liked it; and though fast rooted, they travel about as far as we do.

In Linnie Marsh Wolfe (ed.)

*John of the Mountains*

Chapter VII, Section 2, June-July 1890 (p. 313)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1938

...many of nature's five hundred kinds of wild trees had to make way for orchards and cornfields.

*Our National Parks*

Chapter IX (p. 335)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

As far as man is concerned [trees] are the same yesterday, today, and forever, emblems of permanence.

*Our National Parks*

Chapter IX (p. 269)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

...God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, leveling tempests and floods; but he cannot save them from fools, only Uncle Sam can do that.

*Our National Parks*

Chapter X (p. 365)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist and author

A Tree in its old age is like a bent but mellowed and wise old man; it inspires our respect and tender admiration; it is too noble to need our pity.

*An Almanac for Moderns*

October Twenty-Seventh (p. 241)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Pope, Alexander** 1688–1744

English poet

A spring there is, whose silver waters show  
Clear as a glass the shining sands below:

A flowering lotos spreads its arms above,  
Shades all the banks, and seems itself a grove.

*The Complete Poetical Works*

Sappho to Phaon, l. 177

Houghton Mifflin Company. New York, New York, USA. 1903

**Pownall, Thomas** 1722–1805

English statesman and soldier

The individual Trees of those Woods grow up, have their Youth, their old Age, and a Period to their Life, and die as we Men do. You will see many a Sapling growing up, many an old Tree tottering to its Fall, and many fallen and rotting away, while they are succeeded by others of their Kind, just as the Race of Man is: By this Succession of Vegetation this Wilderness is kept cloathed with Woods just as the human Species keeps the Earth peopled by its continuing Succession of Generations.

*A Topographical Description of the Dominions of the United States*

Section I, On the Face of the Country (p. 24)

University of Pittsburgh Press. Pittsburgh, Pennsylvania, USA. 1949

**Proust, Marcel** 1871–1922

French novelist

We have nothing to fear and a great deal to learn from trees, that vigorous and pacific tribe which without stint produces strengthening essences for us, soothing balms, and in whose gracious company we spend so many cool, silent and intimate hours.

Translated by Louise Varèse

*Pleasures and Regrets*

Regrets, Reveries, Changing Skies, Chapter XXVI (p. 165)

Crown Publishers. New York, New York, USA. 1948

**Shelley, Mary** 1797–1851

English Romantic writer

But I am a blasted tree; the bolt has entered my soul; and I felt then that I should survive to exhibit what I shall soon cease to be — a miserable spectacle of wrecked humanity, pitiable to others and intolerable to myself.

*Frankenstein*

Chapter 19 (p. 114)

Running Press. Philadelphia, Pennsylvania, USA. 1990

**Spenser, Edmund** 1552–99

English poet

Like to an almond tree mounted hye  
On top of greene Selinis all alone,  
With blossoms brave bedecked daintily;  
Whose tender locks do tremble every one,  
At everie little breath, that under heaven is blowne.

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book I, Canto VII, Stanza 32

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**St. Bernard of Clairvaux** 1091–1153

French monk

Believe me who have tried. Thou wilt find something more in woods than in books. Trees and rocks will teach what thou canst not hear from a master.

*Epistle 106*

Source undetermined

**Steinbeck, John** 1902–68

American novelist

The redwoods once seen, leave a mark or create a vision that stays with you always. ... It's not only their unbelievable stature, nor the color which seems to shift and vary under your eyes, no, they are not just like any trees we know, they are ambassadors from another time.

*Travels with Charley: In Search of America*

Part Three (p. 168)

The Viking Press. New York, New York, USA. 1962

**Sterling, John** 1808–44

Irish-born writer and clergyman

The Spice Tree lives in the garden green,  
Beside it the fountain flows;  
And a fair Bird sits the boughs between,  
And sings his melodious woes.

*Poems*

The Spice Tree, Stanza 1

Edward Moxon. London, England. 1839

**Taylor, Bayard** 1825–78

American journalist and author

Ancient Pines,

Ye bear no record of the years of man.  
Spring is your sole historian...

*The Poetical Works of Bayard Taylor*

The Pine Forest of Monterey, Stanza 4

Houghton, Osgood. Boston, Massachusetts, USA. 1880

**Tennyson, Alfred (Lord)** 1809–92

English poet

In crystal vapour everywhere  
Blue isles of heaven laugh'd between,  
And far, in forest-deeps unseen,  
The topmost elm-tree gather'd green  
From draughts of balmy air.

*Alfred Tennyson's Poetical Works*

Sir Lancelot and Queen Guinevere, Stanza I

Oxford University Press, Inc. London, England. 1953

**Thackeray, William Makepeace** 1811–63

English writer

Know ye the willow-tree,  
Whose grey leaves quiver,  
Whispering gloomily  
To yon pale river?

*The Complete Poems of W.M. Thackeray*

The Willow-Tree

White, Stokes & Allen. New York, New York, USA. 1884

Christmas is here;

Winds whistle shrill,  
Icy and chill,  
Little care we;  
Little we fear  
Weather without,  
Sheltered about  
The Mahogany-Tree.

*The Complete Poems of W.M. Thackeray*

The Mahogany-Tree

White, Stokes & Allen. New York, New York, USA. 1884

## The Bible

I shall plant cedar in the wilderness, acacias, myrtle, and wild olives; I shall grow pines on the barren heath side by side with fir the box tree...

*The Revised English Bible*

Isaiah 41:19

Oxford University Press, Inc. Oxford, England. 1989

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

It is remarkable how closely the history of the apple tree is connected with that of man.

*The Writings of Henry David Thoreau* (Volume 9)

Wild Apples (p. 356)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Twain, Mark (Samuel Langhorne**

**Clemens)** 1835–1910

American author and humorist

I once heard a grouty Northern invalid say that a coconut tree might be poetical, possibly it was; but it looked like a feather-duster struck by lightning.

*Roughing It* (Volume 2)

Chapter XVIII (p. 215)

Harper & Brothers. New York, New York, USA. 1899

**Wordsworth, William** 1770–1850

English poet

Of vast circumference and gloom profound  
This solitary Tree! a living thing  
Produced too slowly ever to decay;  
Of form and aspect too magnificent  
To be destroyed.

*The Complete Poetical Works of William Wordsworth*

Yew-Trees

Crowell. New York, New York, USA. 1888

## TREE OF LIFE

**Mason, Frances**

No biographical data available

Evolution does not move in a straight course, symbolized by the links in a chain; the tree is the symbol of nature's plan of creation. The trunk represents the main course of

life through the ages; the branches are the great groups of plants and animals that have appeared during the growth of the tree; the plants and animals now living are the green twigs at the tips of the branches. In the evolution of forms there are no offshoots leading from one branch to another; the branches start from below and diverge as they grow, each branch maintaining its own course.

In Frances Mason

*Creation by Evolution*

Frontispiece (p. ii)

The Macmillan Company. New York, New York, USA. 1928

## TREE RINGS

**Burroughs, John** 1837–1921

American naturalist and writer

An old tree, unlike an old person, as long as it lives at all, always has a young streak, or rather ring, in it. It wears a girdle of perpetual youth.

*Studies in Nature and Literature*

Bird Life in an Old Apple Tree (p. 38)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Leopold, Aldo** 1886–1948

American naturalist

We sensed that these two piles of sawdust were something more than wood: that they were the integrated transect of a century; that our saw was biting its way, stroke by stroke, decade by decade, into the chronology of a lifetime, written in concentric annual rings of oak.

*A Sand County Almanac, with Essays on Conservation from Round River*

Part I, February (p. 10)

Sierra Club. San Francisco, California, USA. 1970

## TRIAL AND ERROR

**Born, Max** 1882–1970

German-born English physicist

...I believe that there is no philosophical highroad in science, with epistemological signposts. No, we are in a jungle and find our way by trial and error, building our road behind us as we proceed. We do not find signposts at crossroads, but our own scouts erect them, to help the rest.

*Experiment and Theory in Physics* (p. 44)

Cambridge University Press. Cambridge, England. 1944

## TRIANGLE

**Beckett, Samuel** 1906–89

Irish playwright

...do not despair. Remember there is no triangle, however obtuse, but the circumference of some circle passes through its wretched vertices.

*The Collected Works of Samuel Beckett*  
Murphy  
Chapter 10 (p. 213)  
Grover Press, Inc., New York, New York, USA. 1970

### **Creele, August** 1780–1856

German civil engineer and mathematician

It is indeed wonderful that so simple a figure as the triangle is so inexhaustible in properties. How many as yet unknown properties of other figures may there not be?

School Science and Mathematics (p. 672)  
School Science and Mathematical Association, 1905

## TRIGONOMETRY

### **Chesterton, G. K. (Gilbert Keith)** 1874–1936

English author

A straight liner is straight  
And a square mile is flat:

But you learn in trigonometrics a trick worth two of that.

*The Collected Poems of G.K. Chesterton*  
Songs of Education, V, The Higher Mathematics (p. 97)

### **Howell, Scott** 1959–

American conservative political consultant

As long as schools continue to teach trigonometry and algebra, there will always be a moment of silence, and indeed prayer, in our public schools.

On why he sees no need to formalize a moment of silence in Utah schools

### **Philips, J. D.**

No biographical data available

The notion that anyone other than a scientist will ever use even the most elementary trigonometry or algebra is laughable. Imagine the absurdity of being in a car or on a plane when suddenly the need arises to solve a quadratic equation or to graph a trigonometric function. But this is precisely the scenario that the traditional defense has coerced us into accepting as realistic. Clearly this is absurd. And so is our complicity.

Mathematics as an Aesthetic Discipline  
*Humanistic Mathematics Network Journal*, Number 12, October 1995

## TRILOBITE

### **Conrad, Timothy** 1803–77

American geologist and malacologist

The race of man shall perish, but the eyes  
Of trilobites eternal be in stone,  
And seem to stare about in mild surprise  
At changes greater than they have yet known.

*A Geological Vision and Other Poems*  
Murphy & Bechtel. Trenton, New Jersey, USA. 1871

### **Howell, G. K.**

No biographical data available

Thou man of hammer and the disreputable trilobite I have some what to say unto thee. The hammer is an honest instrument that advertises what it does when it smashes — but for the trilobite ah what shall I say? I say that an animal that used 20 000 eyes must have been essentially a sneak! — not the one to meet a foe squarely but one that would be peeking around in all directions out of some if its headlights to be ready to run at the first sign of an adversary.

In Ellis L. Yochelson

*Charles Doolittle Walcott, Paleontologist*  
Letter to Walcott, October 31, 1879 (p. 118)  
The Kent State University Press. Kent, Ohio, USA. 1998

And then you never know how to class [a trilobite] — he wasn't a mollusk or a fish, and he wasn't a bird nor again an honest square reptile like the gay alligator. And he wasn't an Englishman — well perhaps you don't have Pinafore out among the Utes and the prairie dogs.

In Ellis L. Yochelson

*Charles Doolittle Walcott, Paleontologist*  
Letter to Walcott, October 31, 1879 (p. 118)  
The Kent State University Press. Kent, Ohio, USA. 1998

### **Levi-Setti, Riccardo**

No biographical data available

Trilobites tell me of ancient marine shores teeming with budding life, when silence was only broken by the wind, the breaking of the waves, or by the thunder of storms and volcanoes. The struggle for survival already had its toll in the seas, but only natural laws and events determined the fate of evolving life forms. No footprints were to be found on those shores, as life had not yet conquered land. Genocide had not been invented as yet, and the threat to life on Earth resided only with the comets and asteroids.

*Trilobites*

Preface (p. vii)  
The University of Chicago Press. Chicago, Illinois, USA. 1993

All fossils are, in a way, time capsules that can transport our imagination to unseen shores, lost in the sea of eons that preceded us. The time of trilobites is unimaginably far away, and yet, with relatively little effort, we can dig out these messengers of our past and hold them in our hand. And, if we learn the language, we can read the message.

*Trilobites*

Preface (p. vii)  
The University of Chicago Press. Chicago, Illinois, USA. 1993

### **Newman, Joseph S.** 1892–1960

American poet

A million years ago, or six...perhaps as much as seven,  
When rhizopods were spewing forth the chalky cliffs of  
Devon,

Upon a cool and mossy rock, beneath a bed of sedum,  
A trilobite named Annie lived in trilobitish freedom.

*Poems for Penguins and Other Lyrical Lapses*

The Trilobite

Greenburg. New York, New York, USA. 1941

## TRUTH

**Abbey, Edward** 1927–89

American environmentalist and nature writer

...I am sometimes forced to the conclusion that the whole  
truth is not always represented in certain of the orthodox  
attitudes. The intuitions of a lover are not always to be  
trusted; but neither are those of the loveless.

In Joseph Wood Krutch

*The Great Chain of Life*

Prologue (p. xi)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1957

**Adams, George** 1750–95

English instrument maker

Truth, though destined to be the guide of man, is not be-  
stowed with an unconditional profusion; but is hidden in  
darkness, and involved in difficulties; intended, like all  
the other gifts of heaven, to be fought and cultivated by  
all the different powers and exertions of human reason.

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 62)

Printed by R. Hindmarsh. London, England. 1794

You should, therefore, set out in the search of truth as of  
a stranger, not in search of arguments to support as of a  
stranger, not in search of arguments to support your own  
opinions, and endeavor to maintain your mind in a state  
of equilibrium, an indifference for everything but known  
and well attested truth, totally regardless of the place  
from whence it comes, or that to which it tends...

*Lectures on Natural and Experimental Philosophy* (Volume 1)

Lecture II (p. 28)

Printed by R. Hindmarsh. London, England. 1794

**Aristotle** 384 BCE–322 BCE

Greek philosopher

The investigation of the truth is in one way hard, in  
another easy. An indication of this is found in the fact that  
no one is able to attain the truth adequately, while, on the  
other hand, we do not collectively fail, but every one says  
something true about the nature of things, and while indi-  
vidually we contribute little or nothing to the truth, by the  
union of all a considerable amount is amassed. Therefore,  
since the truth seems to be like the proverbial door, which  
no one can fail to hit, in this respect it must be easy, but  
the fact that we can have a whole truth and not the particu-

lar part we aim at shows the difficulty of it.

In *Great Books of the Western World* (Volume 8)

*Metaphysics*

Book II, Chapter I (p. 511)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Aronowitz, Stanley** 1933–

American sociologist, labor/union advocate, and writer

The power of science consists, in the first place, in its  
conflation of knowledge and truth. Devising a method of  
proving the validity of propositions about objects taken  
as external to the knower has become identical with what  
we mean by truth.

*Science as Power: Discourse and Ideology in Modern Society*

Preface (p. vii)

University of Minnesota Press. Minneapolis, Minnesota, USA. 1988

**Avedon, Richard** 1923–2004

American photographer

The moment an emotion or fact is transformed into a  
photograph it is no longer fact but an opinion. There is  
no such thing as inaccuracy in a photograph. All photo-  
graphs are accurate. None of them is the truth.

*The Chronicle of Higher Education*, July 10, 1991, (p. B2)

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

The human understanding resembles not a dry light, but  
admits a tincture of the will and passions, which generate  
their own system accordingly; for man always believes  
more readily that which he prefers.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 49 (p. 111)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Balfour, Arthur James** 1848–1930

British prime minister

It is not by mere accumulation of material, nor even by a  
plant-like development, that our beliefs grow less inad-  
equate to the truths which they strive to represent. Rather  
we are like one who is perpetually engaged in altering  
some ancient dwelling in order to satisfy new-born needs.  
The ground-plan of it is being perpetually modified. We  
build here; we pull down there. One part is kept in repair,  
another part is suffered to decay. And even those portions  
of the structure which may in themselves appear quite  
unchanged, stand in such new relations to the rest, and  
are put to such different uses, that they would scarce be  
recognized by their original designer.

*The Foundations of Belief*

Appendix, Section I (p. 350)

Longmans, Green & Company. London, England. 1912

**Barfield, Owen** 1898–1997

British philosopher, critic, and anthroposophist

It was not simply a new theory of the nature of the celestial movements that was feared, but a new theory of the nature of theory; namely, that, if a hypothesis saves all the appearances, it is identical with truth.

*Saving the Appearances: A Study in Idolatry*  
Chapter VII (pp. 50–51)  
Faber & Faber Ltd. London, England. 1957

**Beaumont, William** 1785–1853  
American army surgeon

Truth, like beauty, when “unadorned, is adorned the most”; and in prosecuting these experiments and inquiries, I believe I have been guided by its light.

In William Osler  
*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*  
The Army Surgeon (p. 113)  
The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

**Becker, Ernest** 1925–74  
Canadian anthropologist

The man of knowledge in our time is bowed under a burden he never imagined he would ever have: the overproduction of truth that cannot be consumed. For centuries man lived in the belief that truth was slim and elusive and that once he found it the troubles of mankind would be over. And here we are in the closing of the 20<sup>th</sup> century, choking on truth.

*The Denial of Death*  
Preface (p. x)  
The Free Press. New York, New York, USA. 1973

**Bernard, Claude** 1813–78  
French physiologist

It seems, indeed, a necessary weakness of our mind to be able to reach truth only across a multitude of errors and obstacles.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter I, Section ii (p. 170)  
Henry Schuman, Inc. New York, New York, USA. 1927

Men of science, then, do not seek for the pleasure of seeking; they seek the truth to possess it, and they possess it already within the limits in the present state of the sciences. But men of science must not halt on the road; they must climb ever higher and strive toward perfection; they must always seek, as long as they see anything to be found.

Translated by Henry Copley Greene  
*An Introduction to the Study of Experimental Medicine*  
Part Three, Chapter III, Section iv (p. 222)  
Henry Schuman, Inc. New York, New York, USA. 1927

**Bohr, Niels Henrik David** 1886–1962  
Danish physicist

Truth lies in the abyss.

In Gerald Holton  
*Scientific Optimism and Societal Concerns*  
A Note of the Psychology of Scientists (p. 83)  
Publisher undetermined

The opposite of a correct statement is a false statement. But the opposite of a profound truth may well be another profound truth.

In Werner Heisenberg  
*Physics and Beyond: Encounters and Conversations*  
Chapter 8 (p. 102)  
Harper & Row, Publishers. New York, New York, USA. 1971

**Born, Max** 1882–1970  
German-born English physicist

Truth is what the scientist aims at. He finds nothing at rest, nothing enduring, in the universe. Not everything is knowable, still less is predictable. But the mind of man is capable of grasping and understanding at least a part of Creation; amid the flight of phenomena stands the immutable pole of law.

*The Restless Universe*  
Chapter V (p. 278)  
Dover Publications, Inc. New York, New York, USA. 1951

My optimistic enthusiasm about the disinterested search for truth has been severely shaken. . . .

*The Restless Universe*  
Postscript (p. 279)  
Dover Publications, Inc. New York, New York, USA. 1951

**Bronowski, Jacob** 1908–74  
Polish-born British mathematician and polymath

Truth in science is like Everest, an ordering of the facts.

*Science and Human Values*  
The Sense of Human Dignity (p. 52)  
Harper & Row, Publishers. New York, New York, USA. 1965

We cannot define truth in science until we move from fact to law. And within the body of laws in turn, what impresses us as truth is the orderly coherence of the pieces. They fit together like the characters of a great novel, or like the words of a poem. Indeed, we should keep that last analogy by us always, for science is a language, and like a language it defines its parts by the way they make up a meaning. Every word in a sentence has some uncertainty of definition, and yet the sentence defines its own meaning and that of its words conclusively. It is the internal unity and coherence of science which gives it truth, and which makes it a better system of prediction than any less orderly language.

*The Common Sense of Science*  
Chapter VIII, Section 5 (p. 131)  
Harvard University Press. Cambridge, Massachusetts, USA. 1953

**Brown, John** 1810–82  
Scottish physician and author



You may come to the chest of knowledge. It is shut, it is bolted, but...you have the key; put it in steadily and home. But what is the key? It is the love of truth; neither more or less; no other key opens it; no false one, however cunning can pick that lock; no assault of hammer, however stout, can force it open; but with its own key, a little child may open it; often does open it.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (p. 28)

Macmillan & Company Ltd. London, England. 1918

### **Bush, Vannevar** 1890–1974

American electrical engineer and physicist

It is a great truth of science that every ending is a beginning, that each question answered leads to new problems to solve, that each opportunity grasped and utilized engenders fresh and greater opportunities.

In Helen Wright

*Palomar: The World's Largest Telescope*

Dedication of the Hale Telescope (p. 183)

The Macmillan Company. New York, New York, USA. 1952

### **Calvin, Melvin** 1911–97

American biochemist

The true student will seek evidence to establish fact rather than confirm his own concept of truth, for truth exists whether it is discovered or not.

*Chemical Evolution*

Chapter 11 (p. 252)

Oregon State System of Higher Education. Eugene, Oregon, USA. 1961

### **Carmichael, Robert Daniel** 1879–1967

American mathematician

He who discovers a fact or makes known a new law or adds a novel beauty to truth in any way makes every one of us his debtor. How beautiful upon the highway are the feet of him who comes bringing in his hands the gift of a new truth to mankind.

*The Logic of Discovery*

Chapter IX (p. 273)

The Open Court Publishing. Chicago, Illinois, USA. 1930

### **Chandler, Raymond Thornton** 1888–1959

American novelist

There are two kinds of truth: the truth that lights the way and the truth that warms the heart. The first of these is science, and the second is art. ... With art science would be as useless as a pair of high forceps in the hands of a plumber. Without science art would become a crude mess of folklore and emotional quackery.

*The Notebooks of Raymond Chandler*

Great Thought (p. 7)

Ecco Press. New York, New York, USA. 1976

### **Chargaff, Erwin** 1905–2002

Austrian biochemist

...I prefer the search for the truth to its possession.

*Serious Questions*

Knowledge Industry (p. 111)

Birkhäuser. Boston, Massachusetts, USA. 1986

### **Charlie Chan**

Fictional character

Truth, like football, receive many kicks before reaching goal.

*Charlie Chan at the Olympics*

Film (1937)

### **Clarke, Arthur C.** 1917–

English science and science fiction writer

Faiths come and go, but Truth abides. Out there among the stars lie such truths as we may understand, whether we learn them by our own efforts, or from the strange teachers who are waiting for us along the infinite road on which our feet are now irrevocably set.

*The Challenge of the Spaceship*

Of Space and the Spirit (p. 212)

Harper & Brothers. New York, New York, USA. 1959

### **Cole, William** 1530–1600

English man of letters

Whoever attempts to erect a building, should take care that the foundation be securely laid; so also in our inquiries after truth, all our proceedings should be founded upon just and incontrovertible grounds.

*Philosophical Remarks on the Theory of Comets, a Dissertation on the Nature and Properties of Light*

Introduction (p. xi)

B.J. Holdsworth. London, England. 1823

### **Compton, Arthur H.** 1892–1962

American physicist

The truths that science teaches are of common interest the world over. The language of science is universal, and is a powerful force in bringing the peoples of the world closer together. We are all acquainted with the sharp divisions which religions draw between men. In science there are no such divisions: all peoples worship at the shrine of truth.

*Les Prix Nobel. The Nobel Prizes in 1927*

Nobel banquet speech for award received in 1927

Nobel Foundation. Stockholm, Sweden. 1928

### **Cornforth, John W.** 1917–2004

English organic chemist

...truth is so seldom the sudden light that shows new order and beauty; more often, truth is the uncharted rock that sinks [a] ship in the dark.

*Nobel Banquet Chemistry 1975*

Speech

### **D'Alembert, Jean Le Rond** 1717–83

French mathematician

Geometrical truths are in a way asymptotes to physical truths, that is to say, the latter approach the former indefinitely near without ever reaching them exactly.

In Alphonse Rebière

*Mathematiques et Mathématiciens: Pensées et Curiosités* (p. 10)

**Darwin, Charles Robert** 1809–82

English naturalist

The truth will not penetrate a preoccupied mind.

In Francis Darwin (ed.)

*More Letters of Charles Darwin* (Volume 1)

Letter 222, Darwin to Hooker, July 28, 1868 (p. 305)

D. Appleton & Company. New York, New York, USA. 1903

**Davy, Sir Humphry** 1778–1829

English chemist

To explain nature and the laws instituted by the Author of nature and to apply the phenomena presented in the external world to useful purposes are the great ends of physical investigation, and these ends can only be obtained by the exertion of all the faculties of the mind. And the imagination, the memory, and the reason are perhaps equally essential to the development of great and important truths.

*Humphry Davy on Geology: The 1805 Lectures for the General Audience*

Lecture Four (p. 58)

The University of Wisconsin Press. Madison, Wisconsin, USA. 1980

**de Fontenelle, Bernard le Bovier** 1657–1757

French author

Truth enters so naturally into the mind, that when we learn any thing for the first time, it appears as if we only remembered the thing learned, or exerted the faculty of our memory.

*Conversations on the Plurality of Worlds*

The Second Evening (p. 70)

Printed for Peter Wilson. Dublin, Ireland. 1761

**Descartes, René** 1596–1650

French philosopher, scientist, and mathematician

...we must believe that all the sciences are so interconnected, that it is much easier to study them all together than to isolate one from all the others. If, therefore, anyone wishes to search out the truth of things in serious earnest, he ought not to select one special science; for all the sciences are cojoined with each other and interdependent....

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule 1 (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Dewey, John** 1859–1952

American philosopher and educator

There is but one sure road of access to truth — the road of cooperative inquiry operating by means of observation, experiment, record, and controlled reflection.

*Common Faith*

Chapter II (p. 32)

Yale University Press. New Haven, Connecticut, USA. 1934

**Drake, Daniel** 1785–1852

American physician

The love of pleasure and the love of science may coexist, but cannot be indulged at the same time; though in fact they are seldom united. A student should draw his pleasures from the discovery of truth, and find his amusements in the beauties and wonders of nature. He should seek for recreation not debauchery

*Physician to the West* (p. 298)

University Press of Kentucky. Lexington, Kentucky, USA. 1970

**Dumas, Jean Baptiste-Andre** 1800–84

French biochemist

Truth is so beautiful that it deserves every effort a man can bestow to attain it; it is so fruitful that it carries along with it its own recompense. By keeping the end in view, without occupying ourselves with particulars, we find the ordinary details of prosperity and riches fall into their proper places.

In Faraday Lectures

*Lectures Delivered Before the Chemical Society*

The First Faraday Lecture (p. 3)

The Chemical Society. London, England. 1928

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

An addition to knowledge is won at the expense of an addition to ignorance. It is hard to empty the well of Truth with a leaky bucket.

*The Nature of the Physical World*

Chapter X (p. 229)

The Macmillan Company. New York, New York, USA. 1930

In science as in religion the truth shines ahead as a beacon showing us the path; we do not ask to attain it; it is better far that we be permitted to seek.

*Science and the Unseen World*

Chapter II (p. 23)

The Macmillan Company. New York, New York, USA. 1929

Accidental truth of a conclusion is no compensation for erroneous deduction.

*Space, Time and Gravitation: An Outline of the General Relativity Theory*

Chapter I (p. 29)

At The University Press. Cambridge, England. 1921

**Einstein, Albert** 1879–1955

German-born physicist

Truth is what stands the test of experience.

In Philipp Frank

*Relativity — A Richer Truth*

The Laws of Science and the Laws of Ethics (p. 10)

Jonathan Cape. London, England. 1951

The search for truth is more precious than its possession.  
*The American Mathematical Monthly*, Volume 100, Number 3, March 1993 (p. 254)

As for the search for truth, I know from my own painful searching, with its many blind alleys, how hard it is to take a reliable step, be it ever so small, towards the understanding of that which is truly significant.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side: New Glimpses from His Archives*  
Letter dated 13 February 1934 (p. 18)  
Princeton University Press. Princeton, New Jersey, USA. 1979

It is the most beautiful reward for one who has striven his whole life to grasp some little bit of truth if he sees that other men have real understanding of and pleasure with his work.

In Helen Dukas and Banesh Hoffman  
*Albert Einstein: The Human Side: New Glimpses from His Archives*  
Letter dated 9 December, 1952 (p. 29)  
Princeton University Press. Princeton, New Jersey, USA. 1979

But the years of searching in the dark for a truth that one feels, but cannot express; the intense desire and the alternations of confidence and misgiving, until one breaks through to clarity and understanding, are only known to him who has himself experienced them.

In Ronald W. Clark  
*Einstein: The Life and Times*  
Part Five, Chapter 21 (p. 590)  
The World Publishing Company. New York, New York, USA. 1971

I want to know how God created this world. I am not interested in this or that phenomenon, in the spectrum of this or that element. I want to know His thoughts, the rest are details.

In Ronald W. Clark  
*Einstein: The Life and Times*  
The World Publishing Company. New York, New York, USA. 1971

**Eliot, George (Mary Ann Evans Cross)** 1819–80  
English novelist

Approximate truth is the only truth attainable, but at least one must strive for that, and not wade off into arbitrary falsehood.

*The George Eliot Letters* (Volume 4) (p. 43)  
Yale University Press. New Haven, Connecticut, USA. 1954–1978

**Errera, Leo** 1858–1905  
Belgian botanist

Truth is on a curve whose asymptote our spirit follows eternally.

In J.A. Thomson  
*Introduction to Science*  
Chapter V (p. 125)  
Williams & Norgate Ltd. London, England. 1916

**Esquivel, Laura** 1951?–  
Mexican novelist

Anything could be true or false, depending on whether one believed it.

*Like Water for Chocolate*  
July (p. 127)  
Doubleday & Company, Inc. New York, New York, USA. 1989

**Everett, Edward** 1794–1865  
American statesman, educator, and orator

In the pure mathematics we contemplate absolute truths, which existed in the Divine Mind before the morning stars sang together, and which will continue to exist there, when the last of their radiant host shall have fallen from heaven.

In E.T. Bell  
*Mathematics: Queen and Servant of Science*  
Mathematical Truth (p. 21)  
McGraw-Hill Book Company, Inc. New York, New York, USA. 1951

**Feynman, Richard P.** 1918–88  
American theoretical physicist

We've learned from experience that the truth will come out. Other experimenters will repeat your experiment and find out whether you were wrong or right. Nature's phenomena will agree or they'll disagree with your theory. And, although you may gain some temporary fame and excitement, you will not gain a good reputation as a scientist if you haven't tried to be very careful in this kind of work. And it's this type of integrity, this kind of care not to fool yourself, that is missing to a large extent in much of the research in cargo cult science.

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character* (Caltech commencement address, 1974) Cargo Cult Science (p. 342)  
W.W. Norton & Company, Inc. New York, New York, USA. 1985

It is possible to know when you are right way ahead of checking all the consequences. You can recognize truth by its beauty and simplicity.

*The Character of Physical Law*  
Chapter 7 (p. 171)  
BBC. London, England. 1965

**Fourcroy, Antoine-François** 1755–1809  
French chemist

The general truths in any science are continually multiplied, as its perfection advances, and its means of investigation are improved. Such has been the fortune of chemistry.

Translated by R. Heron  
*Elements of Chemistry and Natural History* (Volume 1)  
Advertisement (p. 1)  
Printed for G. Mudie & Son. Edinburgh, Scotland. 1796

**Frederick the Great** 1712–86  
German king

The greatest and noblest pleasure which men can have in this world is to discover new truths; and the next is to shake off old prejudices.

In Lloyd William Taylor  
*Physics: The Pioneer Science* (Volume 2)  
 Chapter 47 (p. 729)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Galilei, Galileo** 1564–1642  
 Italian physicist and astronomer

Two truths cannot contradict one another.  
 Translated by Stillman Drake  
*Discoveries and Opinions of Galileo*  
 Letter to Madame Christina of Lorraine (p. 186)  
 Doubleday & Company, Inc. New York, New York, USA. 1957

**Galilei, Vincenzo** 1520–1591  
 Father of Galileo Galilei

It appears to me that they who in proof of any assertion rely simply on the weight of authority, without adducing any argument in support of it, act very absurdly. I, on the contrary, wish to be allowed freely to question and freely to answer you without any sort of adulation, as well becomes those who are in search of truth.

In John Joseph Fahie  
*Galileo*  
 Chapter I (p. 3)  
 John Murray. London, England. 1903

**Gauss, Johann Carl Friedrich** 1777–1855  
 German mathematician, physicist, and astronomer

In the Theory of Numbers it happens rather frequently that, by some unexpected luck, the most elegant new truths spring up by induction.

In G. Polya  
*Induction and Analogy in Mathematics* (Volume 1)  
 Chapter IV (p. 59)  
 Princeton University Press. Princeton, New Jersey, USA. 1954

**Gore, George** 1826–1909  
 English electrochemist

The deepest truths require still deeper truths to explain them.

*The Art of Scientific Discovery*  
 Chapter III (p. 26)  
 Longmans, Green & Company. London, England. 1878

**Gray, George W.**  
 American free lance science writer

No truth is sacrosanct. No belief is too generally accepted, too well established by experiment, to escape the challenge of doubt. And no doubt is too radical to receive a hearing if it is seriously proposed.

The Riddle of Our Reddening Skies  
*Harper's Monthly Magazine*, July 1937 (p. 169)

**Gregory, Sir Richard Arman** 1864–1952  
 British science writer and journalist

In the pursuit of truth the man of science spends his days; and for the defense of truth he is prepared to stand against the world.

*Discovery; or, The Spirit and Service of Science*  
 Chapter II (p. 24)  
 Macmillan & Company Ltd. London, England. 1918

A truthful mind is necessary for the discovery of truth in Nature.

*Discovery; or, The Spirit and Service of Science*  
 Chapter II (p. 25)  
 Macmillan & Company Ltd. London, England. 1918

**Halmos, Paul R.** 1916–2006  
 Hungarian-born American mathematician

The joy of suddenly learning a former secret and the joy of suddenly discovering a hitherto unknown truth are the same to me — both have the flash of enlightenment, the almost incredibly enhanced vision, and the ecstasy and euphoria of released tension.

*I Want to Be a Mathematician*  
 Chapter 1 (p. 3)  
 Springer-Verlag. New York, New York, USA. 1985

**Heaviside, Oliver** 1850–1925  
 English electrical engineer, mathematician, and physicist

We do not dwell in the Palace of Truth. But, as was mentioned to me not long since, “There is a time coming when all things shall be found out.” I am not so sanguine myself, believing that the well in which Truth is said to reside is really a bottomless pit.

*Electromagnetic Theory*  
 Chapter I, Volume 1 (p. 1)  
 “The Electrician” printing & publishing company. London, England. 1894–1912

**Heinlein, Robert A.** 1907–88  
 American science fiction writer

The hardest part about gaining any new idea is sweeping out the false idea occupying that niche. As long as that niche is occupied, evidence and proof and logical demonstration get nowhere. But once the niche is emptied of the wrong idea that has been filling it — once you can honestly say, “I don’t know,” then it becomes possible to get at the truth.

*The Cat Who Walks Through Walls: A Comedy of Manners*  
 Chapter XVIII (p. 230)  
 G.P. Putnam’s Sons. New York, New York, USA. 1985

**Herschel, Sir John Frederick William** 1792–1871  
 English astronomer and chemist

It is only when we are wandering and lost in the mazes of particulars, or entangled in fruitless attempts to work our way downwards in the thorny paths of applications, to which our reasoning powers are incompetent, that nature appears complicated: — the moment we contemplate it as

it is, and attain a position from which we can take a commanding view, though but of a small part of its plan, we never fail to recognise that sublime simplicity on which the mind rests satisfied that it has attained the truth.

*The Cabinet of Natural Philosophy*

Part III, Chapter VI, Section 393 (pp. 360–361)

Longman, Rees, Orme, Brown & Green. London, England. 1831

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

Every probability — and most of our common, working beliefs are probabilities — is provided with buffers at both ends, which break the force of opposite opinions clashing against it; but scientific certainty has no spring in it, no courtesy, no possibility of yielding. All this must react on the minds which handle these forms of truth.

*The Autocrat of the Breakfast-Table*

Chapter III (p. 56)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1891

### **Huxley, Aldous** 1894–1963

English writer and critic

Science is the only way we have of shoving truth down the reluctant throat.

*Literature and Science*

Chapter 27 (p. 79)

Harper & Row, Publishers. New York, New York, USA. 1963

### **Huxley, Thomas Henry** 1825–95

English biologist

Ecclesiasticism in science is only unfaithfulness to truth.

*Collected Essays* (Volume 2)

*Darwiniana*

Mr. Darwin's Critics (p. 149)

Macmillan & Company Ltd. London, England. 1904

The scientific spirit is of more value than its products, and irrationally held truths may be more harmful than reasoned errors.

*Collected Essays* (Volume 2)

*Darwiniana*

The Coming of Age of "The Origin of Species" (p. 229)

Macmillan & Company Ltd. London, England. 1904

History warns us, however, that it is the customary fate of new truths to begin as heresies and to end as superstitions. . . .

*Collected Essays* (Volume 2)

*Darwiniana*

The Coming of Age of "The Origin of Species" (p. 229)

Macmillan & Company Ltd. London, England. 1904

Science has fulfilled her function when she has ascertained and enunciated truth. . . .

*Collected Essays* (Volume 7)

Man's Place in Nature, On the Relations of Man to the Lower Animals (p. 151)

Macmillan & Company Ltd. London, England. 1904

*Magna est veritas et praevaleret!* Truth is great, certainly, but, considering her greatness, it is curious what a long time she is apt to take about prevailing.

*Man's Place in Nature and Other Anthropological Essays*

Preface (pp. ix–x)

D. Appleton & Company. New York, New York, USA. 1896

But to those whose life is spent, to use Newton's noble words, in picking up here a pebble and there a pebble on the shores of the great ocean of truth — who watch, day by day, the slow but sure advance of that mighty tide, bearing on its bosom the thousand treasures wherewith man ennobles and beautifies life: — it would be laughable, if it were not so sad, to see the little Canutes of the hour enthroned in solemn state, bidding that great wave to stay, and threatening to check it beneficent progress.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 2)

Chapter II (p. 77)

D. Appleton & Company. New York, New York, USA. 1896

### **Inge, William Ralph** 1860–1954

English religious leader and writer

Every truth is a shadow, except the last; but every truth is a substance in its own place, though it be but a shadow in another place; and the shadow is a true shadow, as the substance is a true substance.

*Proceedings of the Aristotelian Society*, 1918–1919 (p. 272)

### **Jeffers, Robinson** 1887–1962

American poet

The mathematicians and physics men  
Have their mythology; they work alongside the truth,  
Never touching it; their equations are false  
But the things work. Or, when gross error appears,  
They invent new ones; they drop the theory of waves  
In universal ether and imagine curved space.

*The Beginning and the End and Other Poems*

The Great Wound (p. 11)

Random House, Inc. New York, New York, USA. 1963

### **Jones, Raymond F.** 1915–94

American writer

...in the statistical world you can multiply ignorance by a constant and get truth.

*The Non-Statistical Man* (p. 58)

Belmont Books, New York, New York, USA. 1964

### **Jonson, Ben** 1573?–1637

English dramatist and poet

If in some things I dissent from others, whose wit, industry, diligence, and judgment I look up at and admire, let me not therefore hear presently of ingratitude and rashness. For I thank those that have taught me, and ever will; but yet dare not think the scope of their labour and inquiry

was to envy their posterity what they also could add and find out... If I err, pardon me...

*Timber; or Discoveries Made upon Man and Matter Explorata; or, Discoveries* (p. 7)  
Ginn & Company. Boston, Massachusetts, USA. 1892

**Kepler, Johannes** 1571–1630  
German astronomer

The very truth, and the nature of things, though repudiated and ordered into exile, sneaked in again through the back door, to be received by me under an unwonted guise.

Translated by William H. Donahue  
*New Astronomy*  
Part IV, 58 (p. 575)  
At The University Press. Cambridge, England. 1992

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829  
French biologist

Man is condemned to exhaust all possible errors when he examines any set of facts before he recognises the truth.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter V (p. 57)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

...both individual and public reason, when they find themselves exposed to any alteration, usually set up so great an obstacle to it, that it is often harder to secure the recognition of a truth than it is to discover it.

Translated by Hugh Elliot  
*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*  
Chapter VIII (p. 404)  
The University of Chicago Press. Chicago, Illinois, USA. 1984

**Laplace, Pierre Simon** 1749–1827  
French mathematician, astronomer, and physicist

Induction, analogy, hypotheses founded upon facts and rectified continually by new observations, a happy tact given by nature and strengthened by numerous comparisons of its indications with experience, such are the principal means for arriving at truth.

*A Philosophical Essay on Probabilities*  
Chapter XVII (p. 176)  
Dover Publications, Inc. New York, New York, USA. 1951

**Lawson, Alfred William** 1869–1954  
American baseball player, popular philosopher and economist

Education is the science of knowing TRUTH.  
Miseducation is the art of absorbing FALSITY.  
TRUTH is that which is, not that which ain't.  
FALSITY is that which ain't, not that which is.

In Martin Gardner  
*Fads and Fallacies in the Name of Science*  
Chapter 6 (p. 76)  
Dover Publications, Inc., New York, New York, USA. 1957

**Le Bon, Gustave** 1841–1931  
French social psychologist, author, and amateur physicist

Science has promised us truth — an understanding of such relationships as our minds can grasp; it has never promised us either peace or happiness.

*La Psychologie des Foules*  
Introduction

**Levy, Hyman** 1889–1975  
British mathematician and social activist

Truth is a dangerous word to incorporate within the vocabulary of science. It drags with it, in its train, ideas of permanence and immutability that are foreign to the spirit of a study that is essentially an historically changing movement, and that relies so much on practical examination within restricted circumstances....

*The Universe of Science*  
Chapter V (p. 206)  
The Century Company. New York, New York, USA. 1933

Truth is an absolute notion that science, which is not concerned with any such permanency, had better leave alone.

*The Universe of Science*  
Chapter V (p. 207)  
The Century Company. New York, New York, USA. 1933

**Lewis, Gilbert Newton** 1875–1946  
American chemist

The theory that there is an ultimate truth, although very generally held by mankind, does not seem useful to science except in the sense of a horizon toward which we may proceed, rather than a point which may be reached.

*The Anatomy of Science*  
Chapter I (p. 7)  
Yale University Press. New Haven, Connecticut, USA. 1926

**Lodge, Sir Oliver** 1851–1940  
English physicist

The direct aim of Science is Truth, and the temptation of its devotees is to concentrate too narrowly on this one aim and lose sight of the wealth of existence which gives all the meaning and value to bare fact, thus gaining but a purblind view of the universe, in spite of a large accumulation of knowledge which is accurate as far as it goes, but so incomplete as regards the totality of things as to be liable to mislead.

In J. Arthur Thomson  
*The Outline of Science* (Volume 4)  
Chapter XXIV (p. 1077)  
G.P. Putnam's Sons. New York, New York, USA. 1937

**Mach, Ernst** 1838–1916  
Austrian physicist and philosopher

Truth suffers herself to be won. She flirts at times disgracefully. Above all, she is determined to be merited,

and has naught but contempt for the man who will win her too quickly.

*Popular Scientific Lectures*

On the Causes of Harmony (p. 45)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

The inquirer seeks the truth. I do not know if the truth seeks the inquirer. But were that so, then the history of science would vividly remind us of that classical rendezvous, so often immortalized by painters and poets. A high garden wall. At the right a youth, at the left a maiden. The youth sighs, the maiden sighs! Both wait. Neither dreams how near the other is.

*Popular Scientific Lectures*

On the Causes of Harmony (p. 45)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

Only when Truth is in exceptionally good spirits does she bestow upon her wooer a glance of encouragement. For, thinks Truth, if I do not do something, in the end the fellow will not seek me at all.

*Popular Scientific Lectures*

On the Causes of Harmony (pp. 45–46)

The Open Court Publishing Company. Chicago, Illinois, USA. 1898

### **Medawar, Sir Peter Brian** 1915–87

Brazilian-born English zoologist

The truth is not in nature waiting to declare itself, and we cannot know a priori which observations are relevant and which are not; every discovery, every enlargement of the understanding begins as an imaginative preconception of what the truth might be. This imaginative preconception — a “hypothesis” — arises by a process as easy or as difficult to understand as any other creative act of mind; it is a brainwave, an inspired guess, the product of a blaze of insight. It comes, anyway, from within and cannot be arrived at by the exercise of any known calculus of discovery.

*Advice to a Young Scientist*

Chapter 11 (p. 84)

Basic Books, Inc. New York, New York, USA. 1979

### **Millikan, Robert Andrews** 1868–1953

American physicist

...in science, truth once discovered always remains truth.

*Science and the New Civilization*

Chapter III (p. 76)

Charles Scribner's Sons. New York, New York, USA. 1930

### **Moulton, Forest Ray** 1872–1952

American astronomer

Many a chemist, physicist, biologist, psychologist, and historian, as well as monk, has had as his first and only love The Truth, and as it his greatest reward the approval of his own conscience.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 2)

The University of Chicago Press. Chicago, Illinois, USA. 1927

Science does not bow down before precedent nor custom nor dogma; it exalts the truth and honestly seeks it.

In H.H. Newman (ed.)

*The Nature of the World and of Man*

Astronomy (p. 4)

The University of Chicago Press. Chicago, Illinois, USA. 1927

### **Newton, Sir Isaac** 1642–1727

English physicist and mathematician

Truth is the offspring of silence and unbroken meditation.

Attributed to Newton

Source unknown

I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

In David Brewster

*Memoirs of the Life, Writings and Discoveries of Sir Isaac Newton* (Volume 2)

Chapter 27 (p. 407)

Hamilton, Adams & Company. London, England. 1855

### **Orlans, Harold** 1912–

American education researcher

A profession which seeks the truth must consider whether silence about motives and restraint in expression serve, on balance, to enhance or suppress it.

Neutrality and Advocacy in Policy Research

*Policy Sciences*, Volume 6, 1975

### **Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

Truth has been well called the daughter of Time, and even in anatomy, which is a science in a state of fact, the point of view changes with successive generations.

*Aequanimitas, with Other Addresses to Medical Students, Nurses, and Practitioners of Medicine*

The Leaven of Science (p. 84)

The Blakiston Company. Philadelphia, Pennsylvania, USA. 1932

The truth is the best you can get with your best endeavor, the best that the best men accept — with this you must learn to be satisfied, retaining at the same time with due humility an earnest desire for an ever larger portion.

*Selected Writings of Sir William Osler*

Chapter 11 (p. 172)

Oress. London, England. 1951

### **Pagels, Heinz R.** 1939–88

American physicist and science writer

The only touchstone for empirical truth is experiment and observation.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part Four, Chapter 1 (p. 355)  
Simon & Schuster. New York, New York, USA. 1985

**Pascal, Blaise** 1623–62  
French mathematician and physicist

We may have three main objects in the study of truth: first, to find it when we are seeking it; second, to demonstrate it after we have found it; third, to distinguish it from error by examining it.

In *Great Books of the Western World* (Volume 33)  
*Scientific Treatises*

On Geometrical Demonstration (p. 430)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95  
French chemist

Truth, Sir, is a great coquette. She will not be won by too much passion. Indifference is often more successful with her. She escapes when apparently caught, but she yields readily if patiently waited for. She reveals herself when one is about to abandon the hope of possessing her; but she is inexorable when one affirms her, that is when loves her with too much fervor.

In Rene Dubos

*Louis Pasteur: Free Lance of Science*

Chapter XIV (p. 389)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Peirce, Charles Sanders** 1839–1914  
American scientist, logician, and philosopher

...truths, on the average, have a greater tendency to get believed than falsities have. Were it otherwise, considering that there are myriads of false hypotheses to account for any given phenomenon, against one sole true one (or if you will have it so, against every true one), the first step towards genuine knowledge must have been next door to a miracle.

*The Collected Works of Charles Sanders Peirce* (Volume 5)

Pragmatism and Pragmaticism (p. 431)

**Penrose, Roger** 1931–  
English mathematical physicist

Scientists do not invent truth — they discover it.

In John Horgan

Quantum Consciousness

*Scientific American*, Volume 261, Number 5, November 1989 (p. 32)

**Planck, Max** 1858–1947  
German physicist

Conscientiousness and truth are as necessary in research in pure science as in practical life.

*A Survey of Physical Theory*

Dynamical Laws and Statistical Laws

Methuen & Company Ltd. London, England. 1925

If we seek a foundation for the edifice of exact science which is capable of withstanding every criticism, we must first of all tone down our demands considerably. We must not expect to succeed at a stroke, by one single lucky idea, in hitting on an axiom of universal validity, to permit us to develop, with exact methods, a complete scientific structure. We must be satisfied initially to discover some form of truth which no skepticism can attack. In other words, we must set our sights not on what we would like to know, but first on what we do not know with certainty.

*Scientific Autobiography and Other Papers*

The Meaning and Limits of Exact Science, Part I (p. 84)

Philosophical Library. New York, New York, USA. 1949

It is not the possession of truth, but the success which attends the seeking after it, that enriches the seeker and brings happiness to him.

In H.A. Ross

*Elihu Root Lectures of Carnegie Institution of Washington on the Influence of Science and Research on Current Thought*

The Nature of Progress in Science (p. 14)

Washington, D.C. 1945

...“to believe” means “to recognize as a truth,” and the knowledge of nature, continually advancing on incontrovertibly safe tracks, has made it utterly impossible for a person possessing some training in natural science to recognize as founded on truth the many reports of extraordinary occurrences contradicting the laws of nature, of miracles which are still commonly regarded as essential supports and confirmations of religious doctrines, and which formerly used to be accepted as facts pure and simple, without doubt or criticism.

*Scientific Autobiography and Other Papers*

Religion and Natural Science, Part I (p. 154)

Philosophical Library. New York, New York, USA. 1949

...the whole strenuous intellectual work of an industrious research worker would appear, after all, in vain and hopeless, if he were not occasionally through some striking facts to find that he had, at the end of his all criss-cross journeys, at last accomplished at least one step which was conclusively nearer the truth.

*Nobel Lectures, Physics 1901–1921*

Nobel lecture for award received in 1918 (p. 407)

Elsevier Publishing Company. Amsterdam, Netherlands. 1967

**Poe, Edgar Allan** 1809–49  
American short story writer

Truth is not always in a well. In fact, as regards the more important knowledge, I do believe that she is invariably superficial. The depth lies in the valleys where we seek her, and not upon the mountain-tops where she is found.

*Complete Tales and Poems of Edgar Allan Poe*

The Murders in the Rue Morgue (p. 153)

The Modern Library. New York, New York, USA. 1965



**Priestley, Joseph** 1733–1804  
English theologian and scientist

When I...compare my last discoveries relating to the constitution of the atmosphere with the first, I see the closest and easiest connexion in the world between them, so as to wonder that I should not have been led immediately from the one to the other. That this was not the case, I attribute to the force of prejudice, which unknown to ourselves, biases not only our judgments, properly so called, but even the perception of our senses: for we may take a maxim so strongly for granted, that the plainest evidence of sense will not entirely change, and often hardly modify, our persuasions; and the more ingenious a man is, the more effectually he is entangled in his errors; ...his ingenuity only helping him to deceive himself, by evading the force of truth.

In F.W. Gibbs

*Joseph Priestley: Adventurer in Science and Champion of Truth*  
Chapter 9 (p. 119)  
Thomas Nelson & Sons Ltd. London, England. 1965

**Reichenbach, Hans** 1891–1953  
German philosopher of science

He who searches for truth must not appease his urge by giving himself up to the narcotic of belief.

In Ruth Renya

*The Philosophy of Matter in the Atomic Era: A New Approach to the Philosophy of Science* (p. 16)  
Asia Publishing House. Bombay, India. 1962

**Renan, Ernest** 1823–92  
French philosopher and Orientalist

Science has no enemies save those who consider truth as useless and making no difference, and those who granting to truth its priceless value profess to get at it by other roads than those of criticism and rational investigation.

*The Future of Science*

Chapter IV (p. 68)

Roberts Brothers. Boston, Massachusetts, USA. 1893

The simplest schoolboy is now familiar with truths for which Archimedes would have sacrificed his life.

In L.I. Ponomarev

*The Quantum Dice* (p. 34)

Institute of Physics Publishing. Bristol, England. 1993

**Richet, Charles** 1850–1935  
French physiologist

Truth, the goddess, the sovereign, the all-powerful, who will freeze with terror those who jeer at her!

Translated by Sir Oliver Lodge

*The Natural History of a Savant*

Chapter II (p. 25)

J.M. Dent & Sons Ltd. London, England. 1927

...if you would discover a new truth, do not seek to know what use will be made of it.

*The Natural History of a Savant*

Chapter XII (p. 133)

J.M. Dent & Sons Ltd. London, England. 1927

**Romanoff, Alexis Lawrence** 1892–1980  
Russian soldier and scientist

Science speaks the language of universal truth.

*Encyclopedia of Thoughts*

Aphorisms 961

Ithaca Heritage Books. Ithaca, New York, USA. 1975

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

When a man tells you that he knows the exact truth about anything, you are safe in inferring that he is an inexact man.

*The Scientific Outlook*

Characteristics of Scientific Method (p. 65)

George Allen & Unwin Ltd. London, England. 1931

Science thus encourages abandonment of the search for absolute truth, and the substitution of what may be called “technical” truth, which belongs to any theory that can be successfully employed in inventions or in predicting the future. “Technical” truth is a matter of degree: a theory from which more successful inventions and predictions spring is truer than one which gives rise to fewer.

*Religion and Science*

Grounds of Conflict (p. 15)

Henry Holt & Company. New York, New York, USA. 1935

**Sagan, Carl** 1934–96

American astronomer and science writer

The truth may be puzzling. It may take some work to grapple with. It may be counterintuitive. It may contradict deeply held prejudices. It may not be consonant with what we desperately want to be true. But our preferences do not determine what’s true.

Wonder and Skepticism

*Skeptical Inquirer*, Volume 19, Issue 1, January–February 1995

We have a method, and that method helps us to reach not absolute truth, only asymptotic approaches to the truth — never there, just closer and closer, always finding vast new oceans of undiscovered possibilities.

Wonder and Skepticism

*Skeptical Inquirer*, Volume 19, Issue 1, January–February 1995

**Sattler, R.**

No biographical data available

Modern philosophy of science has gone far beyond the naive belief that science reveals the truth. Even if it could, we would have no means of proving it. Certainty seems unattainable. All scientific statements remain open to doubt.... We cannot reach the absolute at least as far as science is concerned; we have to content ourselves with the relative.

*Biophilosophy*

Chapter 1 (p. 41)

Springer-Verlag, Berlin, Germany. 1986

**Sendivogius, Michael** 1566–1636

Polish alchemist and inventor

There is abundance of knowledge, yet but little Truth known. The generality of our knowledge is as Castles in the Air, or groundless Fancies.

*A New Light of Alchymy*

To the Reader

Printed by A. Clark. London, England. 1674

**Shaw, George Bernard** 1856–1950

Irish comic dramatist and literary critic

RIDGEON: The buried truth germinates and breaks through to the light.

*The Doctor's Dilemma*

Act V (p. 114)

Brentano's. New York, New York, USA. 1920

**Shepherd, Linda Jean**

American biochemist

...the "truth" has many faces, depending upon the perspective of the observer.

*Lifting the Veil: The Feminine Face of Science*

Chapter 6 (p. 153)

Shambhala. Boston, Massachusetts, USA. 1993

**Smuts, Jan Christian** 1870–1950

South African statesman, military leader, and holistic philosopher

Truth is a whole, and the truth of physics will be found to link on and to be but part of that larger truth which is the nature and the character of the universe.

Contributions to a British Association Discussion on the Evolution of the Universe

*Nature*, Supplement, October 24, 1931 (p. 718)**Spencer-Brown, George** 1923–

English mathematician and polymath

To arrive at the simplest truth, as Newton knew and practiced, requires years of contemplation. Not activity. Not reasoning. Not calculating. Not busy behavior of any kind. Not reading. Not talking. Not making an effort. Not thinking. Simply bearing in mind what it is one needs to know. And yet those with the courage to tread this path to real discovery are not only offered practically no guidance on how to do so, they are actively discouraged and have to set about it in secret, pretending meanwhile to be diligently engaged in the frantic diversions and to conform with the deadening personal opinions which are continually being thrust upon them.

*Laws of Form*

Appendix I (p. 110)

George Allen &amp; Unwin Ltd. London, England. 1969

**Teilhard de Chardin, Pierre** 1881–1955

French Jesuit, paleontologist, and biologist

We are given to boasting of our age being an age of science.... Yet though we may exalt research and derive enormous benefits from it, with what pettiness of spirit, poverty of means and general haphazardness do we pursue truth in the world today! [W]e leave it to grow as best it can, hardly tending it, like those wild plants whose fruits are plucked by primitive peoples in their forests.

*The Phenomenon of Man*

Book Four, Chapter III, Section 2 (p. 278, 278, 279)

Harper &amp; Brothers. New York, New York, USA. 1959

**Thomson, Sir George** 1892–1975

English physicist

Science is essentially a search for truth.

*The Inspiration of Science*

Introduction (p. 1)

Oxford University Press, Inc. London, England. 1961

**Tolstoy, Leo** 1828–1910

Russian writer

Some mathematician, I believe, has said that true pleasure lies not in the discovery of truth, but in the search for it.

*Anna Karenina*

Part II, Chapter XIV (p. 192)

Barnes &amp; Noble Books. New York, New York, USA. 2003

**Toynbee, Arnold J.** 1852–83

English historian

The Truth apprehended by the Subconscious Psyche finds natural expression in Poetry; The Truth apprehended by the Intellect finds natural expression in science....

In Theodosius Dobzhansky

*The Biology of Ultimate Concern*

Chapter 6 (p. 115)

The New American Library, Inc. New York, New York, USA. 1967

**Trollope, Anthony** 1815–82

English novelist

There are certain statements which, though they are false as hell, must be treated as though they were true gospel.

*The Eustace Diamond* (Volume 2)

Chapter LXXVIII (p. 353)

Oxford University Press, Inc. London, England. 1973

**Uzor**

Fictional character

Truth will flourish in fantasy only to wither and die in what you call reality.

*The Mummy's Curse*

Film (1944)

**Vaihinger, Hans** 1852–1933

German philosopher

We have repeatedly insisted...that the boundary between truth and error is not a rigid one, and we were able ultimately to demonstrate that what we generally call truth, namely a conceptual world coinciding with the external world, is merely the most expedient error.

*The Philosophy of "As If"*

Part I, Chapter XXIV (p. 108)

Harcourt, Brace & Company, Inc. New York, New York, USA. 1925

**van Leeuwenhoek, Antony** 1632–1723

Dutch biology researcher and microscope developer

As I aim at nothing but Truth, and so far as in me lieth, to point out Mistakes that may have crept into certain Matters; I hope that in so doing those I chance to censure will not take it ill: and if they would expose any Errors in my own Discoveries, I'd esteem it an Encouragement toward the Attaining of a nicer Accuracy.

*Antony van Leeuwenhoek and His "Little Animals"*

Envoy: Leeuwenhoek's Place in Protozoology and Bacteriology (p. 387)

John Bale, Sons & Danielsson Ltd. London, England. 1932

**Wallace, Alfred Russel** 1823–1913

English humanist, naturalist, and geographer

Truth is born into this world only with pangs and tribulations, and every fresh truth is received unwillingly. To expect the world to receive a new truth, or even an old truth, without challenging it, is to look for one of those miracles which do not occur.

In an interview/obituary by W.B. Northrop

*The Outlook* (New York), Volume 105, 1913 (p. 622)

**Wegener, Alfred** 1880–1930

German climatologist and geophysicist

Scientists still do not appear to understand sufficiently that all earth sciences must contribute evidence toward unveiling the state of our planet in earlier times, and that the truth of the matter can only be reached by combing all this evidence.... It is only by combing the information furnished by all the earth sciences that we can hope to determine "truth" here, that is to say, to find the picture that sets out all the known facts in the best arrangement and that therefore has the highest degree of probability.

Translated by John Biram

*The Origin of Continents and Oceans* (4th edition)

Foreword (p. vii)

Dover Publications, Inc. New York, New York, USA. 1966

**Weil, Simone** 1909–43

French philosopher and mystic

Truth is a radiant manifestation of reality.

Translated by Arthur Wills

*The Need for Roots: Prelude to a Declaration of Duties Toward Mankind*

Part Three (p. 253)

The Beacon Press. Boston, Massachusetts, USA. 1952

**Weinberg, Steven** 1933–

American nuclear physicist

We search for universal truths about nature and when we find them, we show that they can be deduced from deeper truths.

*Dreams of a Final Theory: The Scientist's Search for the Ultimate Laws of Nature*

Prologue (p. 6)

Pantheon Books. New York, New York, USA. 1992

**Weyl, Hermann** 1885–1955

German mathematician

We are not very pleased when we are forced to accept a mathematical truth by virtue of a complicated chain of formal conclusions and computations, which we traverse blindly, link by link, feeling our way by touch. We want first an overview of the aim and of the road; we want to understand the idea of the proof, the deeper context.

In Abe Shenitzer

Part II. Topology and Abstract Algebra as Two Roads of Mathematical Comprehension

*The American Mathematical Monthly*, Volume 102, Number 7, August–September 1995 (p. 646)

**Whewell, William** 1794–1866

English philosopher and historian

Experience must always consist of a limited number of observations; and however numerous these may be, they can show nothing with regard to the infinite number of cases in which the experiment has not been made....

[T]ruths can only be known to be general, not universal, if they depend upon experience alone. Experience cannot bestow that universality which she herself cannot have, nor that necessity of which she has no comprehension.

*The Philosophy of the Inductive Sciences Founded upon Their History* (Volume 1)

Part I, Book I, Chapter V, Article 1, Article 2 (pp. 63, 64)

John W. Parker. London, England. 1847

**Whipple, George H.** 1878–1976

American pathologist

Any investigator is indeed fortunate who can contribute a tiny stone to the great edifice which we call scientific truth.

*Les Prix Nobel. The Nobel Prizes in 1934*

Nobel banquet speech for award received in 1934

Nobel Foundation. Stockholm, Sweden. 1935

**Wilde, Oscar** 1854–1900

Irish wit, poet, and dramatist

JACK: ...That, my dear Algy, is the whole truth, pure and simple.

ALGERNON — The truth is rarely pure and never simple.

*The Importance of Being Earnest*

Act I (p. 13)

Walter H. Baker Company. Boston, Massachusetts, USA. 19 —

It is a terrible thing for a man to find out suddenly that all his life he has been speaking nothing but the truth.

In John D. Barrow

*The World Within the World* (p. 260)

Clarendon Press, Oxford, England, 1988

**Wilkins, John** 1614–72

English writer

That the strangeness of this opinion is no sufficient reason why it should be rejected, because other certain truths have been formerly esteemed ridiculous, and great absurdities entertained by common consent.

*The Discovery of a World in the Moone* (p. 1)

**Wilson, Edward O.** 1929–

American biologist and author

...if history and science have taught us anything, it is that passion and desire are not the same as truth. The human mind evolved to believe in the gods. It did not evolve to believe in biology. Acceptance of the supernatural conveyed a great advantage throughout prehistory, when the brain was evolving. Thus it is in sharp contrast to biology, which was developed as a product of the modern age and is not underwritten by genetic algorithms. The uncomfortable truth is that the two beliefs are not factually compatible. As a result those who hunger for both intellectual and religious truth will never acquire both in full measure.

*Consilience: The Unity of Knowledge*

Chapter 11 (p. 262)

Alfred A. Knopf, New York, New York, USA, 1998

**Wright, Chauncey** 1830–75

American philosopher of science

We receive the truths of science by compulsion. Nothing but ignorance is able to resist them.

In Edward H. Madden (ed.)

*The Philosophical Writings of Chauncey Wright*

The Philosophy of Herbert Spencer (p. 23)

The Liberal Arts Press, New York, New York, USA, 1958

## TUNNELING

**Drinker, Henry** 1850–1937

A barbarous people may, perhaps, develop a high degree of perfection in the mere art of open-air building, where stone can be piled on stone, and rafter fitted to rafter, in the light of day; but it takes the energy, knowledge, experience, and skill of an educated and trained class of men to cope with the unknown dangers of the dark depths that are to be invaded by the tunnel-man.

In Henry Drinker

*Tunneling, Explosive Compounds, and Rock Drilling* (p. 32)

John Wiley & Sons, Inc. New York, New York, USA, 1878

## TURBULENCE

**Feynman, Richard P.** 1918–88

American theoretical physicist

**Leighton, Robert B.** 1919–97

American physicist

**Sands, Matthew L.** 1919–

American physicist

The next great era of awakening of human intellect may well produce a method of understanding the qualitative content of equations. Today we cannot. Today we cannot see that the water flow equations contain such things as the barber pole structure of turbulence that one sees between rotating cylinders. Today we cannot see whether Schrödinger's equation contains frogs, musical composers, or morality — or whether it does not.

*The Feynman Lectures on Physics* (Volume 2)

Chapter 41 (p. 41–12)

Addison-Wesley Publishing Company, Reading, Massachusetts, USA, 1983

**Lamb, Sir Horace** 1848–1934

English applied mathematician

It remains to call attention to the chief outstanding difficulty of our subject [turbulent motion].

*Hydrodynamics*

Chapter VI, section 365 (p. 663)

Dover Publications, Inc. Mineola, New York, USA, 1945

**Saffman, P. G.**

No biographical data available

...we should not altogether neglect the possibility that there is no such thing as “turbulence.” That is to say, it is not meaningful to talk of the properties of a turbulent flow independently of the physical situation in which it arises. In searching for a theory of turbulence, we are perhaps looking for a chimera.

In H. Fiedler (ed.)

*Structure and Mechanisms of Turbulence* (Volume 2)

Problems and Progress in the Theory of Turbulence (p. 276)

Springer-Verlag, Berlin, Germany, 1978

## TYPHUS

**Butler, Samuel** 1612–80

English novelist, essayist, and critic

They made a clean sweep of all machinery that had not been in use for more than two hundred and seventy-one years (which period was arrived at after a series of compromises), and strictly forbade all further improvements and inventions under pain of being considered in the eye of the law to be labouring under typhus fever, which they regard as one of the worst of all crimes.

*Erewhon and Erewhon Revisited*

Chapter IX (pp. 81–82)

The Modern Library. New York, New York, USA. 1955

**Nicolle, Charles** 1866–1936

French bacteriologist

And this is the ultimate lesson that our knowledge of the mode of transmission of typhus has taught us: Man carries on his skin a parasite, the louse. Civilization rids him of it. Should man regress, should he allow himself to resemble a primitive beast, the louse begins to multiply again and treats man as he deserves, as a brute beast.

*Nobel Lectures, Physiology or Medicine 1922–1941*

Nobel lecture for award received in 1928

Investigations on Typhus (p. 187)

Elsevier Publishing Company. Amsterdam, Netherlands. 1965

## TYPOLGY

**Bordes, Francois** 1919–81

French scientist, geologist, and archaeologist

One has to see a great number of implements, classify them, see them again several times, before one acquires a “typological eye.”

On Old and New Concepts of Typology

*Current Anthropology*, Volume 13, Number 1 (p. 141)

**Brögger, A. W.**

No biographical data available

The proud edifice of chronology built on a foundation of typology is a dangerous mirage.

*Kulturgeschichte des Norwegischen Altertums* (p. 14)

**Hawksworth, D. L.**

No biographical data available

The Purpose of typification is to fix permanently the application of names of all ranks governed by the Code so as to preclude the possibility of the same name being used in different senses; i.e., for different plants.

*Mycologist's Handbook: An Introduction to the Principles of Taxonomy and Nomenclature in the Fungi and Lichens* (p. 127)

Commonwealth Mycological Institute. Kew, England. 1974

**Krieger, A.**

In speaking of “types” did the author follow any philosophy of typology, or — as is so common — did he merely devise still another “typology” for his own convenience.

Epistemology and Archaeological Theory, Comment on Lowtherm

*Current Anthropology*, Volume 3, 1963 (p. 506)

**Malmer, Mats P.**

No biographical data available

Archaeology is directed at the general, it aims to depict the important features of existence for groups of people in prehistoric times. It is clear, therefore, that typology is the central method in archaeology: the study of types and their associations. This central archaeological concept is the type. If typology were not the central and unifying factor, all other methods and subsidiary sciences would fall hopelessly apart, and archaeology as a science would cease to exist.... There can be no typology without types, no archaeology without typology.

*Acta Archaeologica Lundensis*

*Jungneolithische Studien*, Number 2 (pp. 880–881)

**Reed, T. D.**

No biographical data available

Towards the end of the last century those strange new gods Typology and Chronology, Athanasian in their relationship, arose and the archaeologists bowed down and worshipped them.... The younger archaeologist of today is a sad, wise, disillusioned, and almost human being.

*The Battle for Britain in the 5<sup>th</sup> Century: An Essay in Dark Age History* (pp. 5–6)

**Taylor, Walter W.** 1913–97

American archaeologist

It is possible to type automobiles on the basis of the length of the scratches in their paint, to classify sand tempered potsherds on the number of sand grains in each, or to group together all chipped stone points which have side notches. It would be possible, but the pertinent question is “So what?”

*A Study of Archeology*

Part II, Chapter 5 (p. 127)

Southern Illinois University Press. Carbondale, Illinois, USA. 1967

## U

### UFO

#### **Bramley, William**

American author

An in-depth study of the UFO phenomenon reveals that it does not offer a happy little romp through the titillating unknown. The UFO appears more and more to be one of the grimmest realities ever confronted by the human race.

*The Gods of Eden*

Avon Books. New York, New York, USA. 1989

#### **Sagan, Carl** 1934–96

American astronomer and science writer

UFOs: The reliable cases are uninteresting and the interesting cases are unreliable.

*Other Worlds* (p. 114)

Bantam Books. New York, New York, USA. 1975

After I give lectures — on almost any subject — I am often asked, “Do you believe in UFOs?.” I’m always struck by how the question is phrased, the suggestion that this is a matter of belief and not evidence. I’m almost never asked, “How good is the evidence that UFOs are alien spaceships?”

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 3 (p. 82)

Random House, Inc. New York, New York, USA. 1995

### UNCERTAINTY

#### **Buffalo Springfield** 1966–67

American folk rock group

There’s something happening here,  
What it is ain’t exactly clear.

*The Best of Buffalo Springfield*

For What It’s Worth

Electra CD. 1969

#### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

In fact, our ordinary description of nature, and the idea of exact laws, rests on the assumption that it is possible to observe the phenomena without appreciably influencing them.

*The Physical Principles of the Quantum Theory*

Translated by Carl Eckhart and Frank C. Hoyt. (p. 62)

The University of Chicago Press. Chicago, Illinois, USA. 1930

#### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

If matters still seem very uncertain it must always be

remembered that clearly sign-posted roads are not to be expected at a pioneering frontier.

*Frontiers of Astronomy*

Chapter Nineteen (p. 341)

Harper & Row, Publishers. New York, New York, USA. 1955

#### **Pagels, Heinz R.** 1939–88

American physicist and science writer

Space looks empty only because this great creation and destruction of all the quanta takes place over such short times and distances.

*The Cosmic Code: Quantum Physics as the Language of Nature*

Part II, Chapter 8 (p. 274)

Simon & Schuster. New York, New York, USA. 1982

#### **Professor Hubert J. Farnsworth**

Fictional character

Announcer [on loudspeaker]: And it’s a dead heat! They’re checking the electron microscope. And the winner is...[A man holds up a “3” in a window.]...number 3, in a quantum finish.

Farnsworth: No fair! You changed the outcome by measuring it.

*Futurama*

Luck of the Fryrish

Aired 11 March 2001

#### **Vincenti, Walter G.** 1917–

American aeronautical engineer

In the end, decreasing uncertainty in the growth of knowledge in a technology comes, I suggest, mainly from the increase in scope and precision (that is, the decrease in unsureness) in the vicarious means of selection. Just as expanding scope tends, as we saw, to widen the field that can be overtly searched, so also the increase in both scope and precision sharpens the ability to weed out variations that won’t work in the real environment. Blindness in the variations may by the same token even increase — engineers have freedom to be increasingly blind in their trial variations as their means of vicarious selection become more reliable. One sees engineers today, for example, using computer models to explore a much wider field of possibilities than they were able to select from just a decade ago.

*What Engineers Know and How They Know It: Analytical Studies from Aeronautical History*

Chapter 8 (p. 250)

The Johns Hopkins University Press. Baltimore, Maryland, USA. 1990

#### **Ziman, John M.** 1925–

British physicist

Many philosophers have now sadly come to the conclusion that there is no ultimate procedure which will wring the last drops of uncertainty from what scientists call their knowledge.

*Public Knowledge: An Essay Concerning the Social Dimension of Science*

Chapter 1 (p. 5)

Cambridge University Press. Cambridge, England. 1968

## UNCERTAINTY PRINCIPLE

**Stoppard, Tom** 1937–

Czech-born English playwright

An electron can be here or there at the same moment. You can choose. It can go from here to there without going in between; it can pass through two doors at the same time, or from one door to another by a path which is there for all to see until someone looks, and then the act of looking has made it take a different path.

[An electron's] movements cannot be anticipated because it has no reasons. It defeats surveillance because when you know what it's doing you can't be certain where it is, and when you know where it is you can't be certain what it's doing: Heisenberg's uncertainty principle; and this is not because you're not looking carefully enough, it is because there is no such thing as an electron with a definite position and a definite momentum; you fix one, you lose the other, and it's all done without tricks, it's the real world, it is awake.

*Tom Stoppard: Plays*

Hapgood, Act I, Scene 5 (p. 544)

Faber & Faber. London, England. 1999

## UNDERSTANDING

**Arnott, Neil** 1788–1874

Scottish physician

...no man can understand a subject of which he does not carry a distinct outline in his mind...

*Elements of Physics, or, Natural Philosophy, General and Medical Synopsis* (p. 4)

Printed for Thomas & George Underwood. London, England. 1827

**Atiyah, Sir Michael** 1929–

English mathematician

...it is hard to communicate understanding because that is something you get by living with a problem for a long time. You study it, perhaps for years, you get the feel of it and it is in your bones. You can't convey that to anybody else. Having studied the problem for five years you may be able to present it in such a way that it would take somebody else less time to get to that point than it took you, but if they haven't struggled with the problem and seen all the pitfalls, then they haven't really understood it.

An Interview with Michael Atiya

*The Mathematical Intelligencer*, Volume 6, Number 1, 1984 (p. 17)

## Author undetermined

The rabbi spoke three times. The first talk was brilliant; clear and simple. I understood every word. The second was even better; deep and subtle. I didn't understand much, but the rabbi understood all of it. The third was by far the finest; a great and unforgettable experience. I understood nothing, and the rabbi himself didn't understand much either.

In Aage Petersen

*The Philosophy of Niels Bohr*

*Bulletin of the Atomic Scientists*, Volume 19, Number 7, September

1963 (p. 8)

I understand the material. I just can't do the problems.

*The Physics Teacher*, Volume 6, Number 9, December

1968

**Bacon, Sir Francis** 1561–1626

English lawyer, statesman, and essayist

The eye of the understanding is like the eye of the sense: for as you may see great objects through small crannies or levels; so you may see great axioms of nature through small and contemptible instances.

*The Works of Francis Bacon* (Volume 1)

*Sylva Sylvarum*

Century I, 91 (p. 278)

Printed for C. & J. Rivington. London, England. 1826

The human understanding is like a false mirror, which, receiving rays irregularly, distorts and discolors the nature of things by mingling its own nature with it.

In *Great Books of the Western World* (Volume 30)

*Novum Organum*

First Book, Aphorism 48 (p. 110)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Barbour, Julian** 1937–

English physicist

...the higher we climb, the more comprehensive the view. Each new vantage point yields a better understanding of the interconnection of things. What is more, gradual accumulation of understanding is punctuated by sudden and startling enlargements of the horizon, as when we reach the brow of a hill and see things never conceived of in the ascent. Once we have found our bearings in the new landscape, our path to the most recently attained summit is laid bare and takes its honourable place in the new world.

*The End of Time: The Next Revolution in Physics*

Part 1, Chapter 1 (p. 13)

Weidenfield & Nicolson. London, England. 1999

**Becker, Carl L.** 1873–1945

American historian

We really haven't time to stand amazed, either at the stary firmament above or the Freudian complexes within

us. The multiplicity of things to manipulate and make use of so fully engage our attention that we have neither the leisure nor the inclination to seek a rational explanation of the force that makes them function so efficiently.

*The Heavenly City of the Eighteenth Century Philosophers*

Chapter I (pp. 23–24)

Yale University Press. New Haven, Connecticut, USA. 1932

### **Bergaust, Erik**

No biographical data available

Some day in the very, very distant future earthlings may learn to understand the universe...

*Wernher von Braun*

Are Flying Saucers Real? (p. 547)

National Space Institute. Washington, D.C. 1976

### **Bergman, Torbern Olaf** 1735–84

Swedish chemist and naturalist

A scientist strives to understand the work of Nature. But with our insufficient talents as scientists, we do not hit upon the truth all at once. We must content ourselves with tracking it down, enveloped in considerable darkness, which leads us to make new mistakes and errors. By diligent examination, we may at length little by little peel off the thickest layers, but we seldom get the core quite free, so that finally we have to be satisfied with a little incomplete knowledge.

In J.A. Schuffe

*Chymia*

Torbern Bergman, *Earth Scientist*, Volume 12, 1967

Lecture to the Royal Swedish Academy of Science

May 23, 1764 (p. 78)

University of Pennsylvania Press. Philadelphia, Pennsylvania, USA.

1948–1967

### **Berkeley, George** 1685–1753

Irish prelate and metaphysical philosopher

PHILONOUS: I am not for imposing any sense on your words: you are at liberty to explain them as you please. Only, I beseech you, make me understand something by them.

*Three Dialogues Between Hylas and Philonous*

First Dialogue (p. 40)

The Bobbs-Merrill Company, Inc. Indianapolis, Indiana, USA. 1954

### **Bush, Vannevar** 1890–1974

American electrical engineer and physicist

The enthusiasm, the exuberance, that properly accompanies the great achievements of science, the thrill of at last beginning to understand nature and the universe about us, in all their awesome magnificence, continues to lead many men all over the world, especially young men, on to this new materialism.

*Science Is Not Enough*

Chapter II (pp. 19–20)

William Morrow & Company, Inc. New York, New York, USA. 1967

### **Chu, Steven** 1948–

American physicist

You want to try to put something that you learn in your own language, so that it's no longer something that's merely memorized but something you transfer from your head to your gut — you simplify it and put it in your own language to the point where it seems almost obvious and intuitive. It's only when you understand your science in this very obvious, intuitive way that you have a chance of thinking of something new.

Interview

*American Scientist*, Volume 86, January–February 1998 (p. 25)

### **Cole, K. C.** 1946–

American science writer

...the need to go to the moon or smash atoms is on a par with the need to have natural history museums: Science provides a handle on who we are and how we fit into the scheme of things. Understanding our place in the sun requires an understanding of the sun's place in the solar system, the cycles of the sky, the nature of the elements, and the improbabilities of life. If what we learn leaves us a little stunned by our limitations and potentials, so be it. Science gives us a sense of scale and a sense of limits, an appreciation for perspective and a tolerance for ambiguity.

*First You Build a Cloud and Other Reflections on Physics as a Way of Life*

Introduction (p. 11)

Harcourt Brace & Company. New York, New York, USA. 1999

### **Conrad, Joseph** 1857–1924

Polish-born English novelist

Things and men have always a certain sense, a certain side by which they must be got hold of if one wants to obtain a solid grasp and a perfect command.

*Under Western Eyes*

Section 10 (p. 304)

Harper & Brothers Publishers. New York, New York, USA. 1911

### **Cortázar, Julio** 1914–84

Argentinian novelist and short story writer

It had been some time since Gregorovius had given up the illusion of understanding things, but at any rate, he still wanted misunderstanding to have some sort of order, some reason about them.

Translated by Gregory Rabassa

*Hopscotch*

Chapter 31 (p. 179)

Pantheon Books. New York, New York, USA. 1966

### **Dahlberg, Edward** 1900–77

American novelist and essayist

It takes a long time to understand nothing.

*Reasons of the Heart*



On Wisdom and Folly  
Horizon Press, Inc. New York, New York, USA. 1965

**Eco, Umberto** 1932–  
Italian novelist, essayist, and scholar

ADSO: “But how does it happen,” I said with admiration, “that you were able to solve the mystery of the library looking at it from the outside, and you were unable to solve it when you were inside?”

WILLIAM OF BASKERVILLE: “Thus God knows the world, because He conceived it in His mind, as if from the outside, before it was created, and we do not know its rule, because we live inside it, having found it already made.”

Translated by William Weaver  
*The Name of the Rose*  
Vespers (p. 218)  
Harcourt Brace Jovonovich. San Diego, California, USA. 1983

**Einstein, Albert** 1879–1955  
German-born physicist

The hardest thing to understand is why we understand anything at all.  
In Morton Wagman  
*Cognitive Science and Concepts of Mind* (p. 103)  
Praeger. New York, New York, USA. 1991

**Einstein, Albert** 1879–1955  
German-born physicist

**Infeld, Leopold** 1898–1968  
Polish physicist

With the help of physical theories we try to find our way through the maze of observed facts, to order and understand the world of our sense impressions.  
*The Evolution of Physics*  
Physics and Reality (p. 296)  
Simon & Schuster. New York, New York, USA. 1961

The scientist reading the book of nature...must find the solution for himself, for he cannot, as impatient readers of other stories often do, turn to the end of the book. In our case the reader is also the investigator, seeking to explain, at least in part, the relation of events to their rich context. To obtain even a partial solution the scientist must collect the unordered facts available and make them coherent and understandable by creative thought.  
*The Evolution of Physics*  
The Great Mystery (pp. 4–5)  
Simon & Schuster. New York, New York, USA. 1961

**Ferguson, Marilyn** 1938–  
American writer

Real progress in understanding nature is rarely incremental. All important advances are sudden intuitions, new principles, new ways of seeing. We have not fully

recognized this process of leaping ahead, however, in part because textbooks tend to tame revolutions, whether cultural or scientific. They describe the advances as if they had been logical in their day, not at all shocking.  
*The Aquarian Conspiracy: Personal and Social Transformation in the 1980s*  
Chapter 1 (p. 28)  
J.P. Tarcher, Inc. Los Angeles, California, USA. 1980

**Ferris, Timothy** 1944–  
American science writer

We might eventually obtain some sort of bedrock understanding of cosmic structure, but we will never understand the universe in detail; it is just too big and varied for that. If we possessed an atlas of our galaxy that devoted but a single page to each star system in the Milky Way (so that the sun and all its planets were crammed in on one page), that atlas would run to more than ten million volumes of ten thousand pages each. It would take a library the size of Harvard's to house the atlas, and merely to flip through it, at the rate of a page per second, would require over ten thousand years.  
*Coming of Age in the Milky Way*  
Chapter 20 (p. 383)  
William Morrow & Company, Inc. New York, New York, USA. 1988

**Feynman, Richard P.** 1918–88  
American theoretical physicist

What I cannot create I do not understand.  
In James Gleick  
*Genius: The Life and Science of Richard Feynman*  
Epilogue (p. 437)  
Pantheon Books. New York, New York, USA. 1992

I would like to be rather more special, and I would like to be understood in an honest way rather than in a vague way.  
*The Character of Physical Law*  
Chapter 1 (p. 13)  
BBC. London, England. 1965

One does not, by knowing all the physical laws as we know them today, immediately obtain an understanding of anything much.  
*The Character of Physical Law*  
Chapter 5 (p. 122)  
BBC. London, England. 1965

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

We proceed in step-by-step discussion from inference to inference, whereas He conceives through mere intuition. Thus in order to gain insight into some of the properties of the circle, of which it possesses infinitely many, we begin with one of the simplest; we take it for a definition and proceed from it by means of inference to a second property, from this to a third, and hence a fourth, and

so on. The divine intellect, on the other hand, grasps the essence of a circle *senza temporaneo discorso* and thus apprehends the infinite array of the properties.

*Opere* (VII)

Dialogo (p. 129)

SAGREDO: My brain already reels. My mind, like a cloud momentarily illuminated by a lightning-flash, is for an instant filled with an unusual light, which now beckons to me and which now suddenly mingles and obscures strange, crude ideas.

In *Great Books of the Western World* (Volume 28)

*Dialogues Concerning the Two New Sciences*

First Day (p. 132)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

The vain presumption of understanding everything can have no other basis than never understanding anything. For anyone who had experienced just once the perfect understanding of one single thing, and had truly tasted how knowledge is accomplished, would recognize that infinity of other truths of which he understands nothing.

Translated by Stillman Drake

*The Two Chief World Systems*

First Day (p. 101)

University of California Press. Berkeley, California, USA. 1953

### **Hawking, Stephen William** 1942–

English theoretical physicist

...there may be no ultimate theory, and even if there is, we may not find it. But it is surely better to strive for a complete understanding than to despair of the human mind.

*Black Holes and Baby Universes and Other Essays*

Preface (p. ix)

Bantam Books. New York, New York, USA. 1993

### **Hazlitt, William Carew** 1834–1913

English bibliographer

...in what we really understand, we reason but little.

*The Collected Works of William Hazlitt*

On the Conduct of Life (p. 430)

McClure, Phillips & Company. New York, New York, USA. 1904

### **Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Whenever we proceed from the known into the unknown we may hope to understand, but we may have to learn at the same time a new meaning of the word “understanding.”

*Physics and Philosophy*

Chapter XI (p. 201)

Harper & Row, Publishers. New York, New York, USA. 1962

The exact sciences also start from the assumption that in the end it will always be possible to understand nature, even in every new field of experience, but that we may make no a priori assumptions about the meaning of the word understand.

In Heinrich O. Proskauer

*The Rediscovery of Color: Goethe Versus Newton Today*

Preface (p. ix)

Anthroposophic Press. Spring Valley, New York, USA. 1986

Even for a physicist the description in plain language will be a criterion of the degree of understanding that has been reached.

*Physics and Philosophy: The Revolution in Modern Science*

Chapter X (p. 168)

Harper & Row, Publishers. New York, New York, USA. 1958

...as facts and knowledge accumulate, the claim of the scientist to an understanding of the world in a certain sense diminishes.

*Wandlungen in der Grundlagen der Naturwissenschaft*

Zur Geschichte der physikalischen NaturerklSrung (p. 28)

### **Hoffman, Roald** 1937–

Polish-born applied theoretical chemist and writer

In principle one could go ahead and calculate each molecule. ... [H]owever...even if the results were in excellent agreement with experiment, the resultant predictability would not necessarily imply understanding. True understanding implies a knowledge of the various physical factors, the mix of different physical mechanisms, that go into making an observable.

*Interaction of Orbitals Through Space and Through Bonds*

*Accounts of Chemical Research*, Volume 4, Number 1, 1971 (p. 1)

### **Holmes, Oliver Wendell** 1809–94

American physician, poet, and humorist

A moment's insight is sometimes worth a life's experience.

*The Professor at the Breakfast-Table*

Chapter X (p. 301)

Ticknor & Fields. Boston, Massachusetts, USA. 1860

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

The man who voyages strange seas must of necessity be a little unsure of himself. It is the man with the flashy air of knowing everything, who is always on the ball, always with it, that we should beware of.

*Of Men and Galaxies*

Motives and Aims of the Scientist (pp. 24–25)

University of Washington Press. Seattle, Washington, USA. 1964

### **Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

...a man may be a fine genius, and yet understand nothing of an art which he has not studied.

*Notre-Dame de Paris*

Book III, Chapter 2 (p. 126)

J.M. Dent & Sons Ltd. London, England. 1910

### **Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

If any one is resolved to find fault with it, let him first be sure he understands it.

*The Celestial Worlds Discover'd, or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*  
Book the First, Arguments for the Truth of It (p. 13)  
Printed for T. Childe. London, England. 1698

**Juster, Norton** 1929–

American architect and author

Milo tried very hard to understand all the things he'd been told, and all the things he'd seen, and, as he spoke, one curious thing still bothered him. "Why is it, " he said quietly, "that quite often even the things which are correct just don't seem to be right?"

*The Phantom Tollbooth*  
Chapter 16 (p. 198)  
Alfred A. Knopf. New York, New York, USA. 1989

**Kaufmann, William J., III** 1942–94

American astronomer

We shall speak of things we cannot understand. We shall discuss concepts we cannot grasp. We shall examine processes we cannot comprehend.

*Stars and Nebulas*  
Chapter I (p. 4)  
W.H. Freeman & Company. San Francisco, California, USA. 1978

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Some people say they cannot understand a million million. Those people cannot understand that twice two makes four. That is the way I put it to people who talk to me about the incomprehensibility of such large numbers. I say finitude is incomprehensible, the infinite in the universe is comprehensible.

Wave Theory of Light  
*Journal of the Franklin Institute*, Volume 118, November 1884

**Le Guin, Ursula K.** 1929–

American writer of science fiction and fantasy

If the human creatures will not understand Relativity, very well; but they must understand Relatedness.

*The Wind's Twelve Quarters*  
Direction of the Road (p. 223)  
Harper & Rowe, Publishers, New York, New York, USA; 1975

**Lec, Stanislaw** 1909–66

Polish poet and aphorist

Some like to understand what they believe in. Others like to believe in what they understand.

*Unkempt Thoughts* (p. 159)  
St. Martin's Press. New York, New York, USA. 1962

**Oppenheimer, Frank** 1912–85

American physicist

Understanding is a lot like sex. It's got a practical purpose, but that's not why people do it normally.

In K.C. Cole  
*The Universe and the Teacup: The Mathematics of Truth and Beauty*  
Chapter 1 (p. 5)  
Harcourt Brace & Company. New York, New York, USA. 1998

**Ortega y Gasset, José** 1883–1955

Spanish philosopher

To be surprised, to wonder, is to begin to understand.

*The Revolt of the Masses*  
Chapter I (p. 12)  
W.W. Norton & Company, Inc. New York, New York, USA. 1960

**Osler, Sir William** 1849–1919

Canadian physician and professor of medicine

To understand the old writers one must see as they saw. Feel as they felt, believe as they believed — and this is hard, indeed impossible! We may get near them by asking the Spirit of the Age in which they lived to enter in and dwell with us, but it does not always come.... Each generation has its own problems to face, look at truth from a special focus, and does not see quite the same outlines as any other.

*The Evolution of Medicine*  
Chapter VI (p. 218)  
Yale University Press. New Haven, Connecticut, USA. 1922

**Pagels, Heinz R.** 1939–88

American physicist and science writer

The attempt to understand the origin of the universe is the greatest challenge confronting the physical sciences. Armed with the new concepts, scientists are rising to meet that challenge, although they know that success may be far away. Yet when the origin of the universe is understood, it will open a new vision that is beautiful, wonderful and filled with the mystery of existence. It will be our intellectual gift to our progeny and our tribute to the scientific heroes who began this great adventure of the human mind, never to see it completed.

*Perfect Symmetry: The Search for the Beginning of Time*  
Part One, Chapter 7 (p. 156)  
Simon & Schuster. New York, New York, USA. 1985

**Palade, George E.** 1912–?

Russian-born American cell biologist

For a scientist, it is a unique experience to live through a period in which his field of endeavor comes to bloom — to be witness to those rare moments when the dawn of understanding finally descends upon what appeared to be confusion only a while ago — to listen to the sound of darkness crumbling.

*Les Prix Nobel. The Nobel Prizes in 1974*  
Nobel banquet speech for award received in 1974  
Nobel Foundation. Stockholm, Sweden. 1975

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

We have a solid tangible object before us... But we do not know what it is. Then let a team of physicists and chemists inspect the object. Let them be equipped with all the physics and chemistry ever to be known, but let their technological outlook be that of the stone age. Or, if we cannot disregard the practical incompatibility of these two assumptions, let us agree that in their investigations they shall not refer to any operational principles. They will describe the clock precisely in every particular, and in addition, they will predict all its possible future configurations. Yet they will never be able to tell us that it is a clock. The complete knowledge of a machine as an object tells us nothing about it as a machine.

*Personal Knowledge*

Chapter 11, Section 2 (p. 330)

Harper & Row, Publishers. New York, New York, USA. 1962

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

Only a man who understands science (that is scientific problems) can understand its history... [O]nly a man who has some real understanding of its history (the history of its problem situations) can understand science.

*Objective Knowledge*

On the Theory of the Objective Mind

Oxford University Press, Inc. Oxford, England. 1972

Bohr...thought of understanding in terms of pictures and models — in terms of a kind of visualization. This was too narrow, I felt; and in time I developed an entirely different view. According to this view what matters is the understanding not of pictures but of the logical force of a theory: its explanatory power, its relation to the relevant problems and to other theories.

*Unended Quest: An Intellectual Autobiography*

Chapter 18 (p. 93)

Open Court Publishing Company. La Salle, Illinois, USA. 1976

...the activity of understanding is, essentially, the same as that of all problem solving.

*Objective Knowledge: An Evolutionary Approach*

Chapter 4 (p. 166)

Clarendon Press. Oxford, England. 1972

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

Scientific understanding...is an essential step to our finding a home for ourselves in the universe. Through understanding the universe, we become at home in it. In a certain sense we have made this universe out of human concepts and human discoveries. It ceases to be a lonely place, because we can to some extent actually navigate in it.

In A.A. Warner, Dean Morse and T.E. Cooney (eds.)

*The Environment of Change*

The Revolution in Science (p. 49)

Columbia University Press. New York, New York, USA. 1969

**Ramsay, Sir William** 1852–1916

English chemist

I trust we have not wearied you in giving some account of our attempts to see the invisible, touch the intangible, and weigh the imponderable.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1912*

Measurements of Infinitesimal Quantities of Substances (p. 229)

Government Printing Office. Washington, D.C. 1913

**Recorde, Robert** 1510?–58

English mathematician and writer

I see in the heaven marvelous motions; and in the reste of the worlde straunge transmutations, and therefore desire muche to know what the worlde is, and what are the principall partes of it, and also how all these strange sightes doo come.

*The Castle of Knowledge*

The First Treatise (p. 3)

Imprinted by R. Wolfe. London, England. 1556

**Sagan, Carl** 1934–96

American astronomer and science writer

We go about our daily lives understanding almost nothing of the world. We give little thought to the machinery that generates the sunlight that makes life possible, to the gravity that glues us to an Earth that would otherwise send us spinning off into space, or to the atoms of which we are made and on whose stability we fundamentally depend. Except for children (who don't know enough not to ask the important questions), few of us spend much time wondering why nature is the way it is; where the cosmos came from, or whether it was always here; if time will one day flow backward and effects precede causes; or whether there are ultimate limits to what humans can know.

In Stephen W. Hawking

*A Brief History of Time: From the Big Bang to Black Holes*

Introduction (p. ix)

Bantam Books. Toronto, Ontario, Canada. 1988

If you know something only qualitatively, you know it no more than vaguely. If you know it quantitatively — grasping some numerical measure that distinguishes it from an infinite number of other possibilities — you are beginning to know it deeply.

*Billions & Billions: Thoughts on Life and Death at the Brink of the Millennium*

Chapter 2 (p. 21)

Random House, Inc. New York, New York, USA. 1997

**Stewart, Ian** 1945–

English mathematician and science writer

A person who insists on understanding every tiny step before going on to the next is liable to concentrate so much on looking at his feet that he fails to realize he is walking in the wrong direction.

*Concepts of Modern Mathematics*

Chapter 20 (p. 286)

Dover Publications, Inc. New York, New York, USA. 1995

**Swift, Jonathan** 1667–1745

Irish-born English writer

...where I am not understood, it shall be concluded, that something very useful and profound is couched underneath...

*Gulliver's Travels, the Tale of a Tub, Battle of the Books, Etc.*

Tale of a Tub, the Preface (p. 403)

Oxford University Press, Inc. London, England. 1929

**Teller, Edward** 1908–2003

Hungarian-born American nuclear physicist

What is called understanding is often no more than a state where one has become familiar with what one does not understand.

*Better a Shield than a Sword: Perspectives in Defense and Technology*

Chapter 30 (p. 218)

The Free Press. New York, New York, USA. 1987

**Walker, Kenneth** 1882–1966

Physician

It may be said that all understanding of the universe comes from the combined action of two faculties in us, the power to register impressions and the capacity to reason and reflect on them.

*Meaning and Purpose*

Chapter II (p. 18)

Jonathan Cape. London, England. 1944

**Welch, Lew** 1926–71?

American Beat poet

Step out onto the Planet. Draw a circle a hundred feet round. Inside the circle are 300 things nobody understands, and maybe nobody's ever really seen. How many can you find?

*Hermit Poems*

Step Out Onto the Planet

Four Seasons Foundation. San Francisco, California, USA. 1965

**Wittgenstein, Ludwig Josef Johann** 1889–1951

Austrian-born English philosopher

Telling someone something he does not understand is pointless, even if you add that he will not be able to understand it.

Translated by Peter Winch

*Culture and Value* (p. 7e)

The University of Chicago Press. Chicago, Illinois, USA. 1980

**Woodbridge, Frederick James Eugene** 1867–1940

American philosopher

We understand a thing when we have discovered what it can do in relation to other things. In different relations it acts differently, but in every case with a definiteness in accord with its property. Its operation in specific cases is a specific operation which nonetheless illustrates its proper action.

*Nature and Mind: Selected Essays of Frederick J.E. Woodbridge*

(p. 257)

Columbia University Press. New York, New York, USA. 1937

## UNEXPECTED

**Heraclitus** 540 BCE–480 BCE

Greek philosopher

If one does not expect the unexpected one will not find it out, since it is not to be searched out, and difficult to compass.

In G.S. Kirk and J.E. Raven

*The Pre-Socratic Philosophers: A Critical History with a Selection of Texts*

Fragment 213 (p. 195)

At the University Press. Cambridge, England. 1963

**Raymo, Chet** 1936–

American physicist and science writer

Delight in the unexpected is part of the lifeblood of science. Almost alone among belief systems, science welcomes the disturbingly new.

*The Virgin and the Mousetrap: Essays in Search of the Soul of Science*

Chapter 15 (p. 138)

The Viking Press. New York, New York, USA. 1991

**Selye, Hans** 1907–82

Austrian endocrinologist

...“peripheral vision”: the ability not only to look straight at what you want to see, but also to watch continually, through the corner of your eye, for the unexpected. I believe this to be one of the greatest gifts a scientist can have. Usually we concentrate so much upon what we intend to examine that other things cannot reach our consciousness, even if they are far more important. This is particularly true of things so different from the commonplace that they seem improbable. Yet, only the improbable is really worthy of attention! If the unexpected is nevertheless found to be true, the observation usually represents a great step forward.

*From Dream to Discovery: On Being a Scientist*

McGraw-Hill Book Company, Inc. New York, New York, USA. 1950

## UNIFIED FIELD THEORY

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Ranged against GUTs, however, is the fact that there is no unique theory, and the unification scale is so remote there

is no prospect whatever that it will become accessible to direct experimentation. How, then, are we to discriminate between rival theories? If the GUTs describe a world so small and so energetic that we can never observe it, has not physics degenerated to pure philosophy? Are we not in the same position as Democritus and the other Greek philosophers who mused endlessly about the shapes and properties of atoms without any hope of ever observing them?

*Superforce: The Search for a Grand Unified Theory of Nature*  
Chapter 8 (p. 135)  
Simon & Schuster. New York, New York, USA. 1984

**Hawking, Stephen William** 1942–  
English theoretical physicist

The discovery of a complete unified theory, therefore, may not aid the survival of our species. It may not even affect our life-style. But ever since the dawn of civilization, people have not been content to see events as unconnected and inexplicable. They have craved an understanding of the underlying order in the world. Today we still yearn to know why we are here and where we came from. Humanity's deepest desire for knowledge is justification enough for our continuing quest. And our goal is nothing less than a complete description of the universe we live in.

*A Brief History of Time: From The Big Bang to Black Holes*  
Chapter 2 (p. 13)  
Bantam Books. Toronto, Ontario, Canada. 1988

**Kaku, Michio** 1947–  
Japanese-American theoretical physicist

**Thompson, Jennifer**  
American author

To a physicist, finally discovering the unified field theory is like being a child left in the middle of a toy store. Far from the end, it is only a beginning.

*Beyond Einstein : The Cosmic Quest for the Theory of the Universe*  
Chapter 11 (p. 204)  
Bantam Books. Toronto, Ontario, Canada. 1987

## UNIFORMITARIANISM

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

Is uniformitarianism necessary?  
Is Uniformitarianism Necessary?  
*Journal of Science*, Volume 263, 1965 (p. 223)

**Lapworth, Charles** 1842–1920  
English geologist

Uniformity and Evolution are one.  
*Report of the British Association for the Advancement of Science*  
(1892)  
Presidential Address to the Geology Section (p. 707)

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

...what is surprising in physics is not the existence of general laws, but their extreme simplicity. It is not the uniformity of nature that should surprise us, for, by sufficient analytic ingenuity any conceivable course of nature might be shown to exhibit uniformity. What should surprise us is the fact that the uniformity is simple enough for us to be able to discover it. But it is just this characteristic of simplicity which it would be fallacious to generalize, for it is obvious that simplicity has been a part of cause of their discovery, and can, therefore, give not ground for the supposition that other undiscovered laws are equally simple.

*Scientific Method in Philosophy*  
Section I (p. 8)  
At The Clarendon Press. Oxford, England. 1914

## UNIQUENESS

**Doyle, Sir Arthur Conan** 1859–1930  
Scottish writer

As a rule, when I have heard some slight indication of the course of events, I am able to guide myself by the thousands of other similar cases which occur to my memory. In the present instance I am forced to admit that the facts are, to the best of my belief, unique.

In William S. Baring-Gould (ed.)  
*The Annotated Sherlock Holmes* (Volume 1)  
The Red-Headed League (p. 419)  
Wings Books. New York, New York, USA. 1967

**Simon, Herbert Alexander** 1916–2001  
American social scientist

The definition of man's uniqueness has always formed the kernel of his cosmological and ethical systems. With Copernicus and Galileo, he ceased to be the species located at the centre of the universe, attended by sun and stars. With Darwin, he ceased to be the species created and specially endowed by God with soul and reason. With Freud he ceased to be the species whose behavior was — potentially — governable by rational mind. As we begin to produce mechanisms that think and learn, he has ceased to be the species uniquely capable of complex, intelligent manipulation of his environment.

What Computers Mean for Man and Society  
*Science*, Volume 195, Number 4283, March 18, 1977 (p. 190)

## UNITS

**Lodge, Sir Oliver** 1851–1940  
English physicist

Changing the units does not affect the velocity of light. Whether you say light travels at 186,000 miles a second

or whether you say it is so many inches an hour makes no difference to the velocity. An algebraic symbol ought to represent the thing itself, not a mere number of units. Altering the numerical specifications — which is what you do by altering units — means no difference to the thing itself.

Royal Astronomical Society

*Monthly Notices*, Volume 80, 1919 (p. 107)

## UNIVERSE

**Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

For a long period of time there was much speculation and controversy about where the so-called “missing matter” of the Universe had got to. All over the Galaxy the science departments of all the major universities were acquiring more and elaborate equipment to probe and search the hearts of distant galaxies, and then the very center and the very edges of the whole Universe, but when eventually it was tracked down it turned out in fact to be all the stuff which the equipment had been packed in.

*The Ultimate Hitchhiker's Guide to the Galaxy*

Mostly Harmless

Chapter 17 (p. 756)

Ballantine Books. New York, New York, USA. 2002

The Universe, as has been observed before, is an unsettlingly big place, a fact which for the sake of a quiet life most people tend to ignore.

*The Ultimate Hitchhiker's Guide to the Galaxy*

The Restaurant at the End of the Universe

Chapter 10 (p. 194)

Ballantine Books. New York, New York, USA. 2002

If the Universe came to an end every time there was some uncertainty about what happened in it, it would never have got beyond the first picosecond. And many of course don't. It's like the human body, you see. A few cuts and bruises here and there don't hurt it. Not even major surgery if it's done properly. Paradoxes are just the scar tissue. Time and space heal themselves up around them and people remember a version of events which makes as much sense as they require it to make.

*Dirk Gently's Holistic Detective Agency*

Chapter 32 (p. 283)

Simon & Schuster. New York, New York, USA. 1988

**Alfven, Hannes** 1908–95

Swedish physicist

I have never thought that you can get the extremely clumpy, heterogeneous universe we have today from a smooth and homogenous one dominated by gravitation.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 42)

Random House, Inc. New York, New York, USA. 1991

**Amaldi, Ginestra Giovane**

Italian physicist

Our imagination has roamed far and wide through distant reaches of the Universe. Understandably, we may have become dazed by the immense dimensions of space and the enormous sizes of some of its occupants.

*Our World and the Universe Around Us* (Volume 1)

First Steps into Space (p. 124)

Abradale Press. New York, New York, USA. 1966

**Apfel, Necia H.** 1930–

**Hynek, J. Allen** 1910–?

No biographical data available

It is hard for us today to assimilate all the new ideas that are being suggested in response to the new information we have. We must remember that our picture of the universe is based not only on our scientific knowledge but also on our culture and our philosophy. What new discoveries lie ahead no one can say. There may well be civilizations in other parts of our galaxy or in other galaxies that have already accomplished much of what lies ahead for mankind. Others may just be beginning. The universe clearly presents an unending challenge.

*Architecture of the Universe*

Chapter 21 (p. 453)

The Benjamin/Cummings Publishing Company, Inc. Menlo Park, California, USA. 1979

**Atkins, Peter William** 1940–

English physical chemist and writer

My aim is to argue that the universe can come into existence without intervention, and that there is no need to invoke the idea of a Supreme Being in one of its numerous manifestations.

*The Creation*

Preface

W.H. Freeman. San Francisco, California, USA. 1981

**Aurelius Antoninus, Marcus** 121–180

Roman emperor

Either it is a well-arranged universe or a chaos huddled together, but still a universe. But can a certain order subsist in thee, and disorder in the All?

In *Great Books of the Western World* (Volume 12)

*The Meditations of Marcus Aurelius*

Book IV, #27 (p. 266)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bacon, Leonard** 1887–1954

American poet and critic

Eddington's universe goes phut.

Richard Tolman's can open and shut.

Eddington's bursts without grace or tact,

But Tolman's swells and perhaps may contract.

*Rhyme and Punishment*

Richard Tolman's Universe  
Farrar & Rinehart, Inc. New York, New York, USA. 1936

**Bacon, Sir Francis** 1561–1626  
English lawyer, statesman, and essayist

For the fabric of this universe is like a labyrinth to the contemplative mind, where doubtful paths, deceitful imitations of things and their signs, winding and intricate folds and knots of nature everywhere present themselves, and a way must constantly be made through the forests of experience and particular natures, with the aid of the uncertain light of the senses, shining and disappearing by fits.

In Basil Montague  
*The Works of Francis Bacon* (Volume 3)  
The Great Instauration, Preface (p. 336)  
Parry & McMillan. Philadelphia, Pennsylvania, USA. 1859

**Bagehot, Walter** 1826–77  
English journalist

We are startled to find a universe we did not expect.  
*Literary Studies* (Volume 2) (p. 403)  
J.M. Dent & Sons Limited. London, England. 1951

Taken as a whole, the universe is absurd. There seems an unalterable contradiction between the human mind and its employments.

*Literary Studies* (Volume 1) (p. 36)  
J.M. Dent & Sons Limited. London, England. 1951

**Barbellion, Wilhelm Nero Pilate** 1889–1919  
English author

This great bully of a universe overwhelms me. The stars make me cower. I am intimidated by the immensity surrounding my own littleness.

*The Journal of a Disappointed Man*  
March 2, 1917 (p. 283)  
George H. Doran Company. New York, New York, USA. 1919

**Barth, John** 1930–  
American writer

All the scientists hope to do is describe the universe mathematically, predict it, and maybe control it. The philosopher, by contrast, seems unbecomingly ambitious: He wants to understand the universe; to get behind phenomena and operation and solve the logically prior riddles of being, knowledge, and value. But the artist, and in particular the novelist, in his essence wishes neither to explain nor to control nor to understand the universe. He wants to make one of his own, and may even aspire to make it more orderly, meaningful, beautiful, and interesting than the one God turned out. What's more, in the opinion of many readers of literature, he sometimes succeeds.

*The Friday Book: Essays and Other Nonfiction*  
How to Make a Universe (p. 17)  
G.P. Putnam's Sons. New York, New York, USA. 1984

**Bergson, Henri** 1859–1941  
French philosopher

The universe is not made, but is being made continually. It is growing, perhaps indefinitely....

Translated by Arthur Mitchell  
*Creative Evolution*  
Chapter III (p. 255)  
The Modern Library. New York, New York, USA. 1944

**Bloch, Arthur** 1948–  
American humorist

The universe is simmering down, like a giant stew left to cook for four billion years. Sooner or later we won't be able to tell the carrots from the onions.

In John D. Barrow  
*The World Within the World* (p. 221)  
Clarendon Press. Oxford, England. 1988

**Blount, Sir Thomas Pope** 1649–97  
English author

Whoever surveys the curious fabric of the universe can never imagine, that so noble a structure should be fram'd for no other use, than barely for mankind to live and breathe in. It was certainly the design of the great Architect, that his creatures should afford not only necessities and accommodations to our animal part, but also instructions to our intellectual.

*A Natural History*  
Preface  
Printed for R. Bentley. London, England. 1693

**Born, Max** 1882–1970  
German-born English physicist

We have sought for firm ground and found none. The deeper we penetrate, the more restless becomes the universe; all is rushing about and vibrating in a wild dance.

*The Restless Universe*  
Chapter V (p. 277)  
Dover Publications, Inc. New York, New York, USA. 1951

**Bove, Ben**  
No biographical data available

The universe lies before us. What we know about it today is merely the steppingstone to a greater, deeper understanding.

*The Milky Way Galaxy*  
Chapter 10 (p. 201)  
Holt, Rinehart & Winston. New York, New York, USA. 1961

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

...man is the only animal who can face with a thought, a dream, and a smile the mystery and the madness and the terrible beauty of the universe.



*Autobiography of Earth*

Chapter XII, Section III (p. 347)

Coward-McCann, Inc. New York, New York, USA. 1935

### **Browne, J. Stark**

No biographical data available

And we, listening to this wonderful music of the spheres, are filled with emotions of the deepest humility and awe, but at the same time with a great pride in the achievements of the mind of man in wrestling from the dark universe about us some of its long-hidden secrets.

*The Rationalist Annual*

The Number and Distances of the Stars, 1931 (p. 66)

### **Bruno, Giordano** 1548–1600

Italian philosopher and pantheist

The center of the universe is everywhere, and the circumference nowhere.

In Joseph Silk

*The Big Bang* (p. 84)

W.H. Freeman & Company. San Francisco, California, USA. 1980

The universe is then one, infinite, immobile.... It is not capable of comprehension and therefore is endless and limitless, and to that extent infinite and indeterminable, and consequently immobile.

Translated by Jack Lindsay

*Cause, Principle, and Unity*

Fifth Dialogue (p. 135)

International Publishers. New York, New York, USA. 1962

### **Burritt, Elijah H.** 1794–1838

American astronomer

Beyond these are other suns, giving light and life to other systems, not a thousand, or two thousand merely, but multiplied without end, and ranged all around us, at immense distances from each other, attended by ten thousand times ten thousand worlds, all in rapid motion; yet calm, regular and harmonious — all space seems to be illuminated, and every particle of light a world.... And yet all this vast assemblages of suns and worlds may bear no greater proportion to what lies beyond the utmost boundaries of human vision, than a drop of water to the ocean.

*The Geography of the Heavens*

Chapter XVI (p. 153)

Huntington & Savage, Mason & Law. New York, New York, USA. 1850

### **Burroughs, William S.** 1914–97

American writer

This is a war universe. War all the time. That is its nature. There may be other universes based on all sorts of other principles, but ours seems to be based on war and games.

The War Universe

*Grand Street 37*, Volume Ten, Number 1, 1991 (p. 95)

### **Bush, Vannevar** 1890–1974

American electrical engineer and physicist

In no other discipline...do men confront mystery and challenge of the order of that which looms down on the astronomers in the long watches of the night. The astronomer knows at first hand...how slight is our earth, how slight and fleeting are mankind.... But more than that, he senses...the majesty which resides in the mind of man because that mind seeks in all its slightness to see, to learn, to understand at least some part of the mysterious majesty of the universe.

In James Mullaney

Some Noted Dreamers Tell of the Skies' Spell

*Science Digest*, June 1978 (p. 41)

### **Calder, Alexander** 1898–1976

American kinetic sculptor

The universe is real but you can't see it. You have to imagine it.

In Katharine Kuh

*The Artist's Voice: Talks with Seventeen Artists*

Josef Albers (p. 14)

Da Capo Press Edition. Cambridge, Massachusetts, USA. 2000

### **Camus, Albert** 1913–60

French novelist, essayist, and playwright

...I laid my heart open to the benign indifference of the universe.

*The Outsider*

Part II, Chapter V (p. 127)

H. Hamilton. London, England. 1946

### **Card, Orson Scott** 1951–

Science fiction writer

Give the universe a push, and you don't know which dominoes will fall. There are always a few you never thought were connected.

*Ender's Shadow*

Chapter 22 (p. 342)

TOR. New York, New York, USA. 1999

### **Carlyle, Thomas** 1795–1881

English historian and essayist

Margaret Fuller: I accept the Universe.

Thomas Carlyle: Gad! she'd better!

In D.A. Wilson

*Carlyle on Cromwell and Others*

Looking Round, Margaret Fuller Has to Listen (pp. 349–350)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1925

I don't pretend to understand the Universe — it's a great deal bigger than I am.

In D.A. Wilson and D.W. MacArthur

*Carlyle in Old Age (1865–1881)* (p. 177)

Kegan Paul, Trench, Trubner & Company Ltd. London, England. 1934

### **Chekhov, Anton Pavlovich** 1860–1904

Russian author and playwright

But perhaps the universe is suspended on the tooth of some monster.

*Note-Book of Anton Chekhov* (p. 20)

B.W. Huebsch, Inc. New York, New York, USA. 1921

**Clarke, Arthur C.** 1917–

English science and science fiction writer

There is no reason to assume that the universe has the slightest interest in intelligence — or even in life. Both may be random accidental by-products of its operations like the beautiful patterns on a butterfly's wings. The insect would fly just as well without them....

*The Lost Worlds of 2001*

Chapter 16 (p. 109)

New American Library. New York, New York, USA. 1972

Every thoughtful man has often asked himself: Is our race the only intelligence in the universe, or are there other, perhaps far higher, forms of life elsewhere? There can be few questions more important than this, for upon its outcome may depend all philosophy — yes, and all religion, too.

Lecture

St Martin's Technical School on Charing Cross Road, October 5, 1946

The universe: a device contrived for the perpetual astonishment of astronomers.

In Clifford A. Pickover

*Keys to Infinity*

Chapter 5 (p. 41)

John Wiley & Sons, Inc. New York, New York, USA. 1995

Many and strange are the universes that drift like bubbles in the foam of the river of time.

*The Collected Stories of Arthur C. Clarke*

The Wall of Darkness (p. 104)

Tom Doherty Associates. New York, New York, USA. 2001

...the universe has no purpose and no plan...

*The Collected Stories of Arthur C. Clarke*

The Star (p. 521)

Tom Doherty Associates. New York, New York, USA. 2001

...the universes...drift like bubbles in the foam upon the River of Time.

The Wall of Darkness

*Super Science Stories*, July 1949

**Coleridge, Samuel Taylor** 1772–1834

English lyrical poet, critic, and philosopher

It surely is not impossible that to some infinitely superior being the whole universe may be as one plain, the distance between planet and planet being only as the pores in a grain of sand, and the spaces between system and system no greater than the intervals between one grain and the grain adjacent.

*The Table Talk and Omniana of Samuel Taylor Coleridge*

Omniana

The Universe (p. 415)

George Bell & Sons. London, England. 1884

**Conger, George Perrigo** 1884–1960

American philosopher

The universe as revealed in modern days and ways is so overwhelming that mind needs some other title than that of self-appointed legislator for it. Mind must register before it can regulate.

*A World of Epitomizations: A Study in the Philosophy of the Sciences*

Introduction to Division Two (pp. 345–346)

Princeton University Press. Princeton, New Jersey, USA. 1931

**Cook, Peter** 1937–95

English comedian

I am very interested in the Universe — I am specializing in the Universe and all that surrounds it.

*Beyond the Fringe*

Disc 2, Sitting on the Bench

EMI International. 1996

**Copernicus, Nicolaus** 1473–1543

Polish astronomer

But they say that beyond the heavens there isn't any body or place or void or anything at all; and accordingly it is not possible for the heavens to move outward: in that case it is rather surprising that something can be held together by nothing. But if the heavens were infinite and were finite only with respect to a hollow space inside, then it will be said with more truth that there is nothing of heaven, since anything which occupied any space would be in them, but the heavens will remain immobile. For movement is the most powerful reason wherewith they try to conclude that the universe is finite.

In *Great Books of the Western World* (Volume 16)

*On the Revolutions of the Heavenly Spheres*

Book One, Chapter 8 (p. 519)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Crane, Stephen** 1871–1900

American writer

A man said to the universe:

“Sir I exist!”

“However,” replied the universe,

“The fact has not created in me

A sense of obligation.”

*The Collected Poems of Stephen Crane*

War Is Kind (p. 101)

Alfred A. Knopf. New York, New York, USA. 1965

**Croswell, Ken**

American astronomer and author

Is it mere coincidence that the universe happens to possess just those properties which allow part of it to be alive? Some people say yes; it was simply good luck that the universe was born with the particular characteristics that it has. Others say no; our universe is only one of many universes.... Still others, of a more spiritual persuasion,

see the universe's remarkable offspring as a sign that an intelligent creator wrote a tremendous symphony whose melodies the stars, galaxies, and planets now play with beauty and precision.... Whatever the case, and vast and complex though the universe is, its most astonishing features are two of the simplest: it exists, and so do we.

*Planet Quest: The Epic Discovery of Alien Solar Systems*

Chapter 12 (p. 247)

Oxford University Press, Inc. Oxford, England. 1997

### **Crowley, Aleister** 1875–1947

British occultist and writer

It sometimes strikes me that the whole of science is a piece of impudence; that nature can afford to ignore our impertinent interference. If our monkey mischief should ever reach the point of blowing up the earth by decomposing an atom, and even annihilated the sun himself, I cannot really suppose that the universe would turn a hair.

*The Confessions of Aleister Crowley: An Autohagiography*

Part One, Chapter 14 (p. 128)

Arkana. London, England. 1989

I have never grown out of the infantile belief that the universe was made for me to suck.

*The Confessions of Aleister Crowley: An Autobiography*

Part Three, Chapter 54 (p. 460)

Arkana. London, England. 1989

### **D'Alembert, Jean Le Rond** 1717–83

French mathematician

To some one who could grasp the universe from a unified standpoint, the entire creation would appear as a unique truth and necessity.

In Charles W. Misner et al.

*Gravitation*

Part X, Chapter 44 (p. 1218)

W.H. Freeman & Company. San Francisco, California, USA. 1973

### **Darling, David** 1953–

British astronomer and science writer

In giving birth to us, the universe has performed its most astonishing creative act. Out of a hot, dense melee of subatomic particles...it has fashioned intelligence and consciousness.... Somehow the anarchy of genesis has given way to exquisite, intricate order, so that now there are portions of the universe that can reflect upon themselves....

*Equations of Eternity: Speculations on Consciousness, Meaning, and the Mathematical Rules that Orchestrate the Cosmos*

Introduction (p. xiii)

Hyperion. New York, New York, USA. 1993

### **Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Mathematics and beauty are the foundation stones of the universe. No one who has studied the forces of nature

can doubt that the world about us is a manifestation of something very, very clever indeed.

*The Forces of Nature* (2<sup>nd</sup> edition)

Conclusion (p. 167)

Cambridge University Press. Cambridge, England. 1983

If there is a purpose to the universe, and it achieves that purpose, then the universe must end, for its continued existence would be gratuitous and pointless. Conversely, if the universe endures forever, it is hard to imagine that there is any ultimate purpose to the universe at all.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*

Chapter 11 (p. 155)

Basic Books, Inc. New York, New York, USA. 1994

### **Dawkins, Richard** 1941–

British ethologist, evolutionary biologist, and popular science writer

I believe that an orderly universe, one indifferent to human preoccupations, in which everything has an explanation even if we still have a long way to go before we find it, is a more beautiful, more wonderful place than a universe tricked out with capricious, ad hoc magic.

*Unweaving the Rainbow: Science, Delusion and The Appetite for Wonder*

Preface (p. xi)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

### **Day, Clarence** 1874–1935

American writer

Is it possible that our race may be an accident, in a meaningless universe, living its brief life uncared for, on this dark, cooling star: but so — and all the more — what marvelous creatures we are! What fairy story, what tale from the Arabian Nights of the Jinns, is a hundredth part as wonderful as this story of simians! It is so much more heartening, too, than the tales we invent. A universe capable of giving birth to so many accidents is — blind or not — a good world to live in, a promising universe.

*This Simian World*

Chapter XIX (p. 91)

Alfred A. Knopf. New York, New York, USA. 1941

### **de Fontenelle, Bernard le Bovier** 1657–1757

French author

How vast then! And beyond all reckoning, and beyond all mensuration must the spaces of the universe be!

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 151, fn)

Printed for Peter Wilson. Dublin, Ireland. 1761

...I see the universe so large...that I know not where I am, or what will become of me.

*Conversations on the Plurality of Worlds*

The Fifth Evening (p. 151)

Printed for Peter Wilson. Dublin, Ireland. 1761

...the universe is but a watch on a larger scale; all its motions depending on determined laws and mutual relation of its parts.

*Conversations on the Plurality of Worlds*

The First Evening (p. 10)

Printed for Peter Wilson. Dublin, Ireland. 1761

...when the heavens appeared to me as a little blue vault, stuck with stars, methought the universe was too straight and close, I was almost stifled for want of air; but now, it is enlarged in height and breadth, and a thousand and a thousand vortexes taken in, I begin to breathe with more freedom, and think the universe to be incomparably more magnificent than it was before.

*Conversations on the Plurality of Worlds*

The Fifth Evening (pp. 151–152)

Printed for Peter Wilson. Dublin, Ireland. 1761

**de Sitter, Willem** 1872–1934

Dutch mathematician, physicist and astronomer

Our conception of the structure of the Universe bears all the marks of a transitory structure. Our theories are decidedly in a state of continuous and just now very rapid evolution.

In J.H.F. Umbgrove

*The Pulse of the Earth*

Chapter I (p. 1)

Martinus Nijhoff. The Hague, Netherlands. 1947

**de Vries, Peter** 1910–93

American editor and novelist

The universe is like a safe to which there is a combination but the combination is locked up in the safe.

*Let Me Count the Ways*

Chapter Twenty-Two (p. 307)

Little, Brown & Company. Boston, Massachusetts, USA. 1965

**Dee, John** 1527–1609

English mathematician and occultist

The entire universe is like a lyre tuned by some excellent artificer, whose strings are separate species of the universal whole.

Translated by Wayne Schumaker

*John Dee on Astronomy*

XI (p. 127)

University of California Press. Berkeley, California, USA. 1978

**DeLillo, Don** 1936–

American novelist

It's the size of things that worries people. No reason for the universe to be so large.

*Ratner's Star*

Vintage Contemporaries. Toronto, Ontario, Canada. 1976

**Deutsch, Karl W.** 1912–92

Czech-born American international political scientist

Any universe uneven enough to sustain the life of a flat-worm should perhaps be uneven enough to be eventually known by man.

Mechanism, Organism, and Society: Some Models in Natural and Social Science

*Philosophy of Science*, Volume 18, Number 3, July 1951 (p. 231)

**Dillard, Annie** 1945–

American poet, essayist, novelist, and writing teacher

The universe was not made in jest but in solemn incomprehensible earnest.

*Pilgrim at Tinker Creek*

Chapter 15 (p. 270)

Harper's Magazine Press. New York, New York, USA. 1974

**du Prel, Karl** 1839–99

German hypnosis researcher

The universe as a totality is without cause, without origin, without end.

In Ludwig Buchner

*Force and Matter* (p. 11)

Truth Seeker. New York, New York, USA. 1950

**Dyson, Freeman J.** 1923–

American physicist and educator

The hypothesis is that the universe is constructed according to a principle of maximum diversity. The principle of maximum diversity operates both at the physical and at the mental level. It says that the laws of nature and the initial conditions are such as to make the universe as interesting as possible. As a result, life is possible but not too easy. Always when things are dull, something new turns up to challenge us and to stop us from settling into a rut. Examples of things which make life difficult are all around us: comet impacts, ice ages, weapons, plagues, nuclear fission, computers, sex, sin and death. Not all challenges can be overcome, and so we have tragedy. Maximum diversity often leads to maximum stress. In the end we survive, but only by the skin of our teeth.

*Infinite in All Directions*

Part Two, Chapter Seventeen (p. 298)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

As a working hypothesis to explain the riddle of our existence, I propose that our universe is the most interesting of all possible universes, and our fate as human beings is to make it so.

*Infinite in All Directions*

Preface (p. vii)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

As we look out into the Universe and identify the many accidents of physics and astronomy that have worked together to our benefit, it almost seems as if the Universe must in some sense have known that we were coming.

In John D. Barrow and Frank J. Tipler

*The Anthropic Cosmological Principle*  
Chapter 5.5 (p. 318)  
Clarendon Press. Oxford, England. 1986

I have found a universe growing without limit in richness and complexity, a universe of life surviving forever and making itself known to its neighbors across unimaginable gulfs of space and time. Whether the details of my calculations turn out to be correct or not, there are good scientific reasons for taking seriously the possibility that life and intelligence can succeed in molding this universe of ours to their own purposes.

*Infinite in All Directions*  
Part One, Chapter Six (p. 117)  
Harper Collins Publisher, Inc. New York, New York, USA. 1988

I do not feel like an alien in this universe. The more I examine the universe and study the details of its architecture, the more evidence I find that the universe in some sense must have known that we were coming.

*Disturbing the Universe*  
Chapter 23 (p. 250)  
Basic Books, Inc. New York, New York, USA. 1979

**Eddington, Sir Arthur Stanley** 1882–1944  
English astronomer, physicist, and mathematician

The unanimity with which the galaxies are running away looks almost as though they had a pointed aversion to us. We wonder why we should be shunned as though our system were a plague spot in the universe.

*The Expanding Universe*  
Chapter I, Section III (p. 12)  
The University Press. Cambridge. 1933

Meanwhile the knowledge that has been attained shows only the more plainly how much there is to learn. The perplexities of today foreshadow the discoveries of the future. If we have still to leave the stellar universe a region of hidden mystery, yet it seems as though, in our exploration, we have been able to glimpse the outline of some vast combination which unites even the farthest stars into an organised system.

*Stellar Movements and the Structure of the Universe*  
Chapter XII (p. 261)  
Macmillan & Company Ltd. London, England. 1914

I would feel more content that the universe should accomplish some great scheme of evolution and, having achieved whatever may be achieved, lapse back into chaotic changelessness, than its purpose should be banalised by continual repetition. I am an Evolutionist, not a Multiplicationist. It seems rather stupid to keep doing the same thing over and over again.

*The Nature of the Physical World*  
Chapter IV (p. 86)  
The Macmillan Company. New York, New York, USA. 1930

## Editorial

It is obvious that we must regard the universe as extending infinitely, forever, in every direction; or that we must regard it as not so extending. Both possibilities go beyond us.

Einstein's Finite Universe  
*Scientific American*, Volume 124, Number 11, March 12, 1921 (p. 202)

**Ehrmann, Max** 1872–1945  
American lawyer and writer

You are a child of the universe, no less than the trees and the stars; you have a right to be here. And whether or not it is clear to you, no doubt the universe is unfolding as it should.

*Desiderata*  
Published by author. 1927

**Eliot, T. S. (Thomas Stearns)** 1888–1965  
American expatriate poet and playwright

Do I dare  
Disturb the universe?  
In a minute there is time

For decisions and revisions which a minute will reverse.  
*The Collected Poems and Plays 1909–1950*  
The Love Song of J. Alfred Prufrock (p. 5)  
Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Elliot, Hugh** 1752–1830  
British diplomat and adventurer

No sign of purpose can be detected in any part of the vast universe disclosed by our most powerful telescopes.  
*Modern Science and Materialism* (p. 39)  
Longmans, Green & Company. 1919

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

We are taught by great actions that the universe is the property of every individual in it.

*Ralph Waldo Emerson: Essays and Lectures*  
Nature: Addresses, and Lectures  
Beauty (p. 16)  
The Library of America. New York, New York, USA. 1983

Philosophically considered, the universe is composed of Nature and the Soul.

*Ralph Waldo Emerson: Essays and Lectures*  
Nature: Addresses, and Lectures  
Introduction (p. 8)  
The Library of America. New York, New York, USA. 1983

Everything in the universe goes by indirection. There are no straight lines.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)  
Society and Solitude  
Works and Days (p. 181)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

...the universe does not jest with us, but is in earnest...

*Letters and Social Aims*

Poetry and Imagination (p. 3)

James R. Osgood & Company. Boston, Massachusetts, USA. 1876

### Engard, Charles J.

American botanist

We accept the universe as far as we know it, but we do not attempt to explain why it exists. It is difficult enough to understand how!

In Johann Wolfgang von Goethe, Bertha Mueller, and Charles J. Engard

*Goethe's Botanical Writings*

Introduction (p. 14)

University of Hawaii Press. Honolulu, Hawaii, USA. 1952

### Estling, Ralph

No biographical data available

There is no question about there being design in the Universe. The question is whether this design is imposed from the Outside or whether it is inherent in the physical laws governing the Universe. The next question is, of course, who or what made these physical laws.

*The Skeptical Inquirer*, Spring 1993

I do not know what, if anything, the Universe has in its mind, but I am quite, quite sure that, whatever it has in its mind, it is not at all like what we have in ours. And, considering what most of us have in ours, it is just as well.

*The Skeptical Inquirer*, Spring 1993

### Euler, Leonhard 1707–83

Swiss mathematician and physicist

For since the fabric of the universe is most perfect and the work of a most wise Creator, nothing at all takes place in the universe in which some rule of maximum or minimum does not appear.

In Morris Kline

*Mathematical Thought from Ancient to Modern Times* (p. 573)

Oxford University Press, Inc. New York, New York, USA. 1972

### Ferris, Timothy 1944–

American science writer

There could be more life out there than we've ever imagined — for if the universe has taught us anything, it is that reality is richer and more resourceful than our wildest dreams.

*Life Beyond Earth*

The Ice Zone (p. 116)

Simon & Schuster. New York, New York, USA. 2000

We live in a changing universe, and few things are changing faster than our conception of it.

*The Whole Shebang: A State-of-the Universe's Report*

Preface (p. 11)

Simon & Schuster. New York, New York, USA. 1996

### Feynman, Richard P. 1918–88

American theoretical physicist

This universe has been described by many, but it just goes on, with its edge as unknown as the bottom of the bottomless sea of the other ideas — just as mysterious, just as awe-inspiring, and just as incomplete as the poetic pictures that came before.

*The Meaning of It All: Thoughts of a Citizen Scientist*

Chapter I (p. 10)

Perseus Books. Reading, Massachusetts, USA. 1998

Is no one inspired by our present picture of the universe? The value of science remains unsung by singers: you are reduced to sharing not a song or poem, but an evening lecture about it. This is not yet a scientific age.

*What Do You Care What Other People Think?*

The Value of Science (p. 244)

W.W. Norton & Company, Inc. New York, New York, USA. 1988

### Feynman, Richard P. 1918–88

American theoretical physicist

### Leighton, Robert B. 1919–97

American physicist

### Sands, Matthew L. 1919–

American physicist

A poet once said, "The whole universe is in a glass of wine." We will probably never know in what sense he meant that, for poets do not write to be understood... How vivid is the claret, pressing its existence into the consciousness that watches it! If our small minds, for some convenience, divide this glass of wine, this universe, into parts — physics, biology, geology, astronomy, psychology, and so on — remember that nature does not know it! So let us put it all back together, not forgetting ultimately what it is for. Let it give us one more final pleasure: drink it and forget it all!

*The Feynman Lectures on Physics* (Volume 1)

Chapter 3–7 (p. 3–10)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1983

### Field, Edward 1924–

American poet

Look, friend, at this universe  
With its spiral clusters of stars  
Flying out all over space

Like bedsprings suddenly bursting free;

*New and Selected Poems from the Book of My Life*

From Stand Up, Friend, with Me (1963) Prologue

### Flammarion, Camille 1842–1925

French astronomer and author

When the last human eyelid closes here below, and our globe — after having been for so long the abode of life with its passions, its labour, its pleasures and its pains, its loves and its hatred, its religious and political expectations and all its vain finalities — is enshrouded in the

winding-sheet of a profound night, when the extinct sun wakes no more; well, then — then, as to-day, the universe will be as complete, the stars will continue to shine in the sky, other suns will illuminate other worlds, other springs will bring round the bloom of flowers and the illusions of youth, other mornings and other evenings will follow in succession, and the universe will move on as at present; for creation is developed in infinity and eternity.

*Popular Astronomy: A General Description of the Heavens*  
Book II, Chapter VI (p. 164)  
Chatto & Windus. London, England. 1894

May we conclude, then, that in these successive endings the universe will one day become an immense and dark tomb. No: otherwise it would already have become so during a past eternity. There is in nature something else besides blind matter; an intellectual law of progress governs the whole creation; the forces which rule the universe cannot remain inactive. The stars will rise from their ashes. The collision of ancient wrecks causes new flames to burst forth, and the transformation of motion into heat creates nebulae and worlds. Universal death shall never reign.

*Popular Astronomy: A General Description of the Heavens*  
Book I, Chapter VII (p. 80)  
Chatto & Windus. London, England. 1894

**France, Anatole (Jean Jacques Brousson)** 1844–1924  
French writer

The universe which science reveals to us is a dispiriting monotony. All the suns are drops of fire and all the planets are drops of mud.

In Stanley L. Jacki

*Creator*

Chapter Two (p. 26)

Scottish Academic Press. Edinburgh, Scotland. 1980

If desire lends a grace to whatsoever be the object of it, then the desire of the unknown makes beautiful the Universe.

*My Friend's Book*

Chapter XI (p. 159)

Dodd, Mead & Company. New York, New York, USA. 1924

**Frayn, Michael** 1933–  
English dramatist

The complexity of the universe is beyond expression in any possible notation. Lift up your eyes. Not even what you see before you can ever be fully expressed. Close your eyes. Not even what you see now.

*Constructions*

No. 1

Wildwood House. London, England. 1974

**Fritzsich, Harald** 1943–  
German theoretical physicist

The universe is more than merely an accretion of electrons, quarks, and galaxies, more than space and time. The complex, interrelated world of the earth which created us is part of it. It is our duty not only to ourselves to preserve this world. The universe itself imposes this task on us.

*The Creation of Matter: The Universe from Beginning to End*

Chapter 17 (p. 282)

Basic Books, Inc. New York, New York, USA. 1984

**Frost, Robert** 1874–1963  
American poet

The Universe is but the Thing of Things  
The things but balls all going round in rings  
Some of them mighty huge, some mighty tiny  
All of them radiant and might shiny.

*Complete Poems of Robert Frost*

Accidentally on Purpose

Henry Holt & Company. New York, New York, USA. 1949

...all reasoning is in a circle. At least that's why the universe is round.

*Complete Poems of Robert Frost*

Build the Soil

Henry Holt & Company. New York, New York, USA. 1949

**Galilei, Galileo** 1564–1642  
Italian physicist and astronomer

No one will be able to read the great book of the Universe if he does not understand its language which is that of mathematics.

In A. Zee

*Fearful Symmetry*

Chapter 9 (p. 122)

Macmillan Publishing Company. New York, New York, USA. 1986

Philosophy is written in this grand book, the universe, which stands continually open to our gaze. But the book cannot be understood unless one first learns to comprehend the language and read the letters in which it is composed. It is written in the language of mathematics, and its characters are triangles, circles, and other geometric figures without which it is humanly impossible to understand a single word of it.

Translated by Stillman Drake

*Discoveries and Opinions of Galileo*

The Assayer (pp. 237–238)

Doubleday & Company, Inc. New York, New York, USA. 1957

I should think that anyone who considered it more reasonable for the whole universe to move in order to let the Earth remain fixed would be more irrational than one who should climb to the top of a cupola just to get a view of the city and its environs, and then demand that the whole countryside should revolve around him so that he would not have to take the trouble to turn his head.

*Dialogues Concerning the Two Chief World Systems*

**Giraudoux, Jean** 1882–1944  
French novelist, playwright, and essayist

COUNTESS: I know perfectly well that at this moment the whole universe is listening to us — and that every word we say echoes to the remotest star.

English adaptation by Maurice Valency  
*The Madwoman of Chaillot*  
Act Two (p. 94)  
Random House, Inc. New York, New York, USA. 1947

**Gleiser, Marcello** 1959–  
Brazilian-born physicist and astronomer

Our planet is not in a special place in the solar system, our Sun is not in a special place in our galaxy and our galaxy is not in a special place in the Universe.

*The Dancing Universe*  
Chapter 9 (p. 274)  
The Penguin Group. New York, New York, USA. 1997

**Guth, Alan** 1947–  
American physicist

The universe may be the ultimate free lunch.  
In P.C.W. Davies (ed.)  
*The New Physics*  
The Inflationary Universe (p. 54)  
Cambridge University Press. Cambridge, England. 1989

**Guth, Alan** 1947–  
American physicist

**Steinhardt, Paul**  
American physicist

The inflationary model of the universe provides a possible mechanism by which the observed universe could have evolved from an infinitesimal region. It is then tempting to go one step further and speculate that the entire universe evolved from literally nothing.

The Inflationary Universe  
*Scientific American*, Volume 250, Number 5, May 1984 (p. 128)

**Halacy, Jr., D. S.**  
No biographical data available

Our universe operates not at the whims of those who live in it, but by inexorable natural laws.

*They Gave Their Names to Science*  
Prologue (p. 9)  
G.P. Putnam's Sons. New York, New York, USA. 1967

**Haldane, John Burdon Sanderson** 1892–1964  
English biologist

...the universe is not only queerer than we suppose but it is queerer than we can suppose.

*Possible Worlds and Other Papers*  
Chapter XXXIV (p. 298)  
Harper & Brothers Publishers. New York, New York, USA. 1928

**Hale, George Ellery** 1868–1938  
American astronomer

It is a far cry from the facile imaginings of the philosopher to the rigorous demonstrations of exact science, and the true structure of the universe is not yet known.

*Beyond the Milky Way*  
Beyond the Milky Way (p. 100)  
Charles Scribner's Sons. New York, New York, USA. 1926

**Hardy, G. H. (Godfrey Harold)** 1877–1947  
English pure mathematician

“Imaginary” universes are so much more beautiful than this stupidly constructed “real” one; and most of the finest products of an applied mathematician's fancy must be rejected, as soon as they have been created, for the brutal but sufficient reason that they do not fit the facts.

*A Mathematician's Apology*  
Section 26 (p. 135)  
Cambridge University Press. Cambridge, England. 1967

**Harrison, Edward Robert**  
Cosmologist

What determines the design of a universe; is it the Universe, God, fortuity, or the human mind?

*Masks of the Universe*  
Chapter 1 (p. 5)  
Macmillan Publishing Company. New York, New York, USA. 1985

We cannot doubt the existence of an ultimate reality. It is the Universe forever masked. We are part of an aspect of it, and the masks figured by us are the Universe observing and understanding itself from a human point of view. When we doubt the Universe we doubt ourselves. The Universe thinks, therefore it is.

*Masks of the Universe*  
Chapter I (p. 14)  
Macmillan Publishing Company. New York, New York, USA. 1985

We do not know what sets limits to the Great Chain of hierarchical structures, nor do we know what unifies it. We are clueless as to why atoms exist and why the Universe is structured the way it is. Of course, if the Universe were structured in any other way, we would not be here asking these pertinent questions; or so we are told. But I am a heretic and inclined to think the other way: without us this Universe would not be here.

*A Twinkle in the Eye of the Universe*  
*Quarterly Journal of the Royal Astronomical Society*, Volume 25, Number 4, December 1984 (p. 428)

From the outset we must decide whether to use Universe or universe. This is not so trivial a matter as it might seem. We know of only one planet called Earth; similarly, we know of only one Universe. Surely then the proper word is Universe?

*Cosmology: The Science of the Universe*  
Chapter 1 (p. 10)  
Cambridge University Press. Cambridge, England. 1981



The universe consists only of atoms and the void: all else is opinion and illusion.

*Masks of the Universe*

Chapter 4 (p. 55)

Macmillan Publishing Company. New York, New York, USA. 1985

### **Haught, James A.**

No biographical data available

The universe is a vast, amazing, seething dynamo which has no discernable purpose except to keep on churning. From quarks to quasars, it's alive with incredible power. But it seems utterly indifferent to any moral laws. It destroys as blindly as it nurtures.

*2000 Years of Disbelief: Famous People with The Courage to Doubt*

Afterthought (p. 324)

Prometheus Books. Amherst, New York, USA. 1996

### **Hawking, Stephen William** 1942–

English theoretical physicist

There ought to be something very special about the boundary conditions of the universe and what can be more special than the condition that there is no boundary.

In John D. Barrow and Frank J. Tipler

*The Anthropic Cosmological Principle*

Chapter 6.15 (p. 444)

Clarendon Press. Oxford, England. 1986

We see the universe the way it is because we exist.

*A Brief History of Time: The Updated and Expanded Edition*

Chapter 8 (p. 128)

Bantam Books. Toronto, Ontario, Canada. 1988

Even if there is only one possible unified theory, it is just a set of rules and equations. What is it that breathes fire into the equations and makes a universe for them to describe? The usual approach of science of constructing a mathematical model cannot answer the questions of why there should be a universe for the model to describe. Why does the universe go to all the bother of existing?

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 11 (p. 174)

Bantam Books. Toronto, Ontario, Canada. 1988

I do not agree with the view that the universe is a mystery, something that one can have intuition about but never fully analyze or comprehend.

*Black Holes and Baby Universes and Other Essays*

Preface (p. viii)

Bantam Books. New York, New York, USA. 1993

I think the universe is completely self-contained. It doesn't have any beginning or end, it doesn't have any creation or destruction.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 89)

Routledge & Kegan Paul. London, England. 1986

...we do not know what is happening at the moment farther away in the universe: the light that we see from distant galaxies left them millions of years ago and in the case of the most distant object that we have seen, the light left some eight thousand million years ago. Thus, when we look at the universe, we are seeing it as it was in the past.

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 2 (p. 28)

Bantam Books. Toronto, Ontario, Canada. 1988

### **Hawkins, Michael** 1942–

British astrophysicist

The stars and galaxies that fill our view as we survey the depths of the Universe are really just a froth delineating the massive, dark unseen structures beneath.

*Hunting Down the Universe: The Missing Mass, Primordial Black Holes, and Other Dark Matters*

Chapter 13 (p. 183)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1997

### **Hayflick, Leonard** 1928–

American microbiologist

Everything in the universe ages, including the universe.

In Nancy Shute

*U.S. News and World Report*, 18/25 August 1997 (p. 57)

### **Haynes, Margaret**

No biographical data available

The universe is just a bowl of spaghetti.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 1 (p. 49)

Random House, Inc. New York, New York, USA. 1991

### **Heinlein, Robert A.** 1907–88

American science fiction writer

Tomorrow I will seven eagles see, a great comet will appear, and voices will speak from whirlwinds foretelling monstrous and fearful things — This Universe never did make sense; I suspect that it was built on government contract.

*The Number of the Beast*

Chapter II (p. 19)

Fawcett Columbine Books. New York, New York, USA. 1980

No storyteller has ever been able to dream up anything as fantastically unlikely as what really does happen in this mad universe.

*Time Enough for Love*

Prelude, Chapter II (p. 51)

G.P. Putnam's Sons. New York, New York, USA. 1973

A zygote is a gamete's way of producing more gametes. This may be the purpose of the universe.

*Time Enough for Love*

Intermission (p. 262)

G.P. Putnam's Sons. New York, New York, USA. 1973

**Henderson, Archibald** 1877–1933

American mathematician and writer

We are doomed to dwell within a finite universe a thousand million times greater than the region now accessible to astronomical observation. Our glances are confined for ever within this giant — this all too minute — monad.

The Size of the Universe

*Science*, Volume 58, Number 1497, 7 September, 1923 (p. 172)**Hinshelwood, Sir Cyril** 1897–1967

English chemist

To some men knowledge of the universe has been an end possessing in itself a value that is absolute: to others it has seemed a means of useful application.

*The Structure of Physical Chemistry*

Chapter I (p. 2)

Clarendon Press, Oxford, England, 1951

**Hogan, John**

No biographical data

...cosmologists — and the rest of us — may have to forego attempts at understanding the universe and simply marvel at its infinite complexity and strangeness.

Universal Truths

*Scientific American*, Volume 263, Number 4, October 1990 (p. 117)**Holmes, John Haynes** 1879–1964

American clergyman

The universe is not hostile, nor yet is it friendly. It is simply indifferent.

*A Sensible Man's View of Religion*

Is the Universe Friendly? (p. 39)

**Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

There is a coherent plan in the universe, though I don't know what it's a plan for.

*Wired*, 2/98 (p. 174)

Perhaps the most majestic feature of our whole existence is that while our intelligences are powerful enough to penetrate deeply into the evaluation of this quite incredible Universe, we still have not the smallest clue to our own fate.

*The Nature of the Universe*

Chapter 7 (p. 142)

The University Press, Cambridge, 1933

The Universe is everything; both living and inanimate things; both atoms and galaxies; and if the spiritual exists as well as the material, of spiritual things also; and if there is a Heaven and a Hell, of Heaven and Hell too; for by its very nature the Universe is the totality of all things.

*Frontiers of Astronomy*

Chapter Eighteen (p. 304)

Harper &amp; Row, Publishers, New York, New York, USA, 1955

...if there is one important result that comes out of our inquiry into the nature of the Universe it is this: when by patient inquiry we learn the answer to any problem, we always find, both as a whole and in detail, that the answer thus revealed is finer in concept and design than anything we could ever have arrived at by a random guess.

*The Nature of the Universe*

Chapter 7 (p. 140)

The University Press, Cambridge, 1933

**Hubble, Edwin Powell** 1889–1953

American astronomer

We find them smaller and fainter, in constantly increasing numbers, and we know that we are reaching out into space, further and ever further, until, with the faintest nebulae that can be detected with the greatest telescope, we arrive at the frontiers of the known universe.

In Joseph Silk

*The Big Bang* (p. 26)

W.H. Freeman &amp; Company, San Francisco, California, USA, 1980

...equipped with his five senses, man explores the universe around him and calls the adventure science.

*The Nature of Science and Other Lectures*

Part I, The Nature of Science (p. 6)

The Huntington Library, San Marino, California, USA, 1954

**Huygens, Christiaan** 1629–95

Dutch mathematician, astronomer, and physicist

What a wonderful and amazing Scheme have we here of the magnificent Vastness of the Universe! So many Suns, so many Earths...!

*The Celestial Worlds Discover'd; or, Conjectures Concerning the Planetary Worlds, Their Inhabitants and Productions*

Kosmotheoros (p. 222)

Printed for T. Childe, London, England, 1698

**Inge, William Ralph** 1860–1954

English religious leader and author

If the universe is running down like a clock, the clock must have been wound up at a date which we could name if we knew it. The world, if it is to have an end in time, must have had a beginning in time.

*God and the Astronomers*

Chapter 3 (p. 48)

W.W. Norton &amp; Company, Inc, New York, New York, USA, 1978

**Ionesco, Eugene** 1912–94

French playwright

...the universe seems to me infinitely strange and foreign. At such a moment I gaze upon it with a mixture of anguish and euphoria; separate from the universe, as though placed at a certain distance outside it; I look and I see pictures, creatures that move in a kind of timeless time and spaceless space, emitting sounds that are a kind of language I no longer understand or ever register.

*Notes and Counter Notes: Writing on the Theatre*  
Part II, Interviews, Brief Notes for Radio (p. 136)

**James, William** 1842–1910  
American philosopher and psychologist

Whatever universe a professor believes in must at any rate be a universe that lends itself to lengthy discourse. A universe definable in two sentences is something for which the professorial intellect has no use. No faith in anything of that cheap kind!

*Pragmatism: A New Name for Some Old Ways of Thinking*  
Lecture I (p. 4)  
Longmans, Green & Company. London, England. 1914

**Jastrow, Robert** 1925–  
American space scientist

Theologians generally are delighted with the proof that the Universe had a beginning, but astronomers are curiously upset. Their reactions provide an interesting demonstration of the response of the scientific mind — supposedly a very objective mind — when evidence uncovered by science itself leads to a conflict with the articles of faith in our profession. It turns out that the scientist behaves the way the rest of us do when our beliefs are in conflict with the evidence. We become irritated, we pretend the conflict does not exist, or we paper it over with meaningless phrases.

*God and the Astronomers*  
Epilogue (p. 117)  
W.W. Norton & Company, Inc. New York, New York, USA. 1978

Thus, the facts indicate that the Universe will expand forever. We still come across pieces of mass here and there in the Universe, and someday we may find the missing matter, but the consensus at the moment is that it will not be found. According to the available evidence, the end will come in darkness.

*God and the Astronomers*  
Epilogue (p. 123)  
W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Jeans, Sir James Hopwood** 1877–1946  
English physicist and mathematician

The universe can not go on forever as it now is, and neither can it have existed in its present condition from all eternity.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1926*  
The New Outlook in Cosmogony (p. 155)  
Government Printing Office. Washington, D.C. 1928

The Universe can be best pictured, although still very imperfectly and inadequately, as consisting of pure thought, the thought of what, for want of a wider word, we must describe as a mathematical thinker.

*The Mysterious Universe*  
Chapter V (p. 136)  
The Macmillan Company. New York, New York, USA. 1932

The universe begins to look more like a great thought than a machine.

In Jefferson Hane Weaver  
*The World of Physics* (Volume 2)  
Q.3 (p. 632)  
Simon & Schuster. New York, New York, USA. 1987

The physical universe never has any choice — it must inevitably move along a single road to a predestined end. Contributions to a British Association Discussion on the Evolution of the Universe  
*Nature*, Supplement, October 24, 1931 (p. 701)

The universe consists in the main not of stars but of desolate emptiness — inconceivably vast stretches of desert space in which the presence of a star is a rare and exceptional event. ... The stars move blindly through space, and the players in the stellar blind-man's-buff are so few and far between that the chance of encountering another star is almost negligible.

*The Universe Around Us*  
Chapter I (pp. 84–85)  
The Macmillan Company. New York, New York, USA. 1929

**Jeffers, Robinson** 1887–1962  
American poet

The learned astronomer  
Analyzing the light of most remote star-swirls  
Has found them — or a trick of distance deludes his prism — All at incredible speeds fleeing outward from ours.

I thought, no doubt they are fleeing the contagion  
Of consciousness that infects this corner of space.  
In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 2)  
Margrave (p. 161)  
Stanford University Press. Stanford, California. USA. 1988

The universe expands and contracts like a great heart.  
It is expanding, the farthest nebulae  
Rush with the speed of light into empty space.  
*The Beginning and the End and Other Poems*  
The Great Explosion (p. 3)  
Random House, Inc. New York, New York, USA. 1963

It seemed to Barclay the cloud broke and he saw the stars,  
Those of this swarm were many, but beyond them  
universe past universe  
Flared to infinity, no end conceivable. Alien, alien, alien universes.

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 1)  
The Women at Point Sur (p. 312)  
Stanford University Press. Stanford, California. USA. 1988

**Jennings, Herbert Spencer** 1868–1947  
American zoologist

...the universe is not “a mere clockwork mechanical wonder swinging in a vast vacuum,” but is a system that, in the course of time, comes to life.

*The Universe and Life*

Chapter II (p. 33)

Yale University Press. New Haven, Connecticut, USA. 1941

**Joad, Cyril Edwin Mitchinson** 1891–1953

English philosopher and broadcasting personality

When the scientist leaves his laboratory and speculates about the universe as a whole, the resultant conclusions are apt to tell us more about the scientist than about the universe.

*Philosophical Aspects of Modern Science*

Chapter XI (p. 339)

George Allen & Unwin Ltd. London, England. 1939

**Kaku, Michio** 1947–

Japanese-American theoretical physicist

The fact that our universe, like Appleworld, is curved in an unseen dimension beyond our spatial comprehension has been experimentally verified. These experiments, performed on the path of light beams, shows that starlight is bent as it moves across the universe.

*Hyperspace : A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10<sup>th</sup> Dimension*

Chapter 1 (p. 17)

Oxford University Press, Inc. New York, New York, USA. 1995

**Kepler, Johannes** 1571–1630

German astronomer

This very cogitation carries with it I don't know what secret, hidden horror; indeed one finds oneself wandering in this immensity to which are denied limits and centre and therefore also all determinate places.

In Alexander Koyre

*From the Closed World to the Infinite Universe*

Chapter III (p. 61)

The Johns Hopkins Press. Baltimore, Maryland, USA. 1968

The diversity of the phenomena of Nature is so great, and the treasures hidden in the heavens so rich, precisely in order that the human mind shall never be lacking in fresh nourishment.

*Mysterium Cosmographicum*

Original Dedication (p. 55)

**Keyser, Cassius Jackson** 1862–1947

American mathematician

Depend upon it, the universe will never really be understood unless it may be sometime resolved into an ordered multiplicity and made to own itself an everlasting drama of the calculus.

*The Human Worth of Rigorous Thinking: Essays and Addresses*

Mathematical Emancipations: Dimensionality and Hyperspace (p. 101)

Columbia University Press. New York, New York, USA. 1925

**Kirshner, Robert P.**

American astronomer

Although the Universe is under no obligation to make sense, students in pursuit of the Ph.D. are.

Exploding Stars and the Expanding Universe

*Quarterly Journal of the Royal Astronomical Society*, Volume 32, Number 3, September 1991 (p. 240)

If Copernicus taught us the lesson that we are not at the center of things, our present picture of the universe rubs it in.

In John Noble Wilford

From Distant Galaxies, News of a "Stop-and-Go Universe"

*New York Times*, June 3, 2003

**Koestler, Arthur** 1905–83

Hungarian-born English writer

There are no longer any absolute directions in space. The universe has lost its core. It no longer has a heart, but a thousand hearts.

*The Sleepwalkers*

Part Three, Chapter II, Section 6 (p. 217)

The Macmillan Company. New York, New York, USA. 1966

In my youth I regarded the universe as an open book, printed in the language of physical equations, whereas now it appears to me as a text written in invisible ink, of which in our rare moments of grace we are able to decipher a small fragment.

*Bricks to Babel*

Epilogue (pp. 682–683)

Random House, Inc. New York, New York, USA. 1980

**Kolb, Edward W. (Rocky)** 1951–

American cosmologist

There are many beautiful and wondrous things to see in the universe, and to discover them we simply have to gaze into the dark night sky.

*Blind Watchers of the Sky*

Chapter One (p. 1)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

Whether our cosmological view of the universe is right or wrong, or just incomplete, we were brave enough to confront our ignorance and look. We looked with all our might, and with boldness and imagination managed to see a little bit farther than our predecessors. We were not proud of our blindness, but neither were we ashamed of it or intimidated by it, for we chose to look for the light of truth fully cognizant of our blindness.

*Blind Watchers of the Sky*

Chapter Ten (p. 282)

Addison-Wesley Publishing Company. Reading, Massachusetts, USA. 1996

**Krauss, Lawrence M.** 1954–

American theoretical physicist

There is a maxim about the universe which I always tell my students: That which is not explicitly forbidden is

guaranteed to occur. Or, as Data said in the episode “Parallels,” referring to the laws of quantum mechanics, “All things which can occur, do occur.”

*The Physics of Star Trek*

Chapter Two (p. 16)

Harp Perennial Publishers. New York, New York, USA. 1995

**Kunitz, Stanley** 1905–2006

American poet

I see lines of your spectrum shifting red,  
The Universe expanding, thinning out,  
Our worlds flying, oh flying, fast apart.

*The Collected Poems*

The Science of the Night (p. 88)

W.W. Norton & Company, Inc. New York, New York, USA. 2000

**Kunz, F. L.**

No biographical data available

The whole universe is one mathematical and harmonic expression, made up of finite representations of the infinite.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 139)

Routledge & Kegan Paul. London, England. 1986

**Lambert, Johann Heinrich** 1728–77

Swiss-German mathematician and astronomer

...the firmament must be more enduring than things on our earth and the empires of the world.

Translated by Stanley Jaki

*Cosmological Letters on the Arrangement of the World-Edifice*

Twentieth Letter (p. 193)

Science History Publications. New York, New York, USA. 1976

**Lao Tzu** fl. 6<sup>th</sup> century BCE

Chinese philosopher and father of Taoism

Something mysteriously formed,  
Born before heaven and earth.

In the silence and the void,  
Standing alone and unchanging,  
Ever present and in motion.

Translated by Gia-Fu Feng and Jane English

*Tao Te Ching*

Twenty-five

Alfred A. Knopf. New York, New York, USA. 1974

**Lederman, Leon** 1922–

American high-energy physicist

We hope to explain the entire universe in a single, simple formula that you can wear on your T-shirt.

In Richard Wolkomir article

Quark City

*OMNI Magazine*, February 1984 (p. 41)

**Lemaître, Abbé Georges** 1894–1966

Belgian astronomer and cosmologist

Our universe bears the marks of youth and we can hope to reconstruct its story. The documents at our disposal

are not buried in the piles of bricks carved by the Babylonians; our library does not risk being destroyed by fire; it is in space, admirably empty, where light waves are preserved better than sound is conserved on the wax of phonograph discs.

*The Primeval Atom*

Chapter II (p. 75)

D. Van Nostrand Company, Inc. New York, New York, USA. 1950

**Lloyd, Seth** 1950–

American engineer

I wanted to get a handle on why the universe is so complex.... Or at any rate why there seems to be so much information processing going on. You can look at life and almost all the things — well, all the things — that we see going on around us in terms of information processing. You could say that life is an example of information being processed in the service of getting a free lunch out of your environment. A typical event in evolution, for example, is some organism suddenly, by a mutation, being able to produce an enzyme that allows it to digest something it couldn't get at before. The free lunch is there, but in order to get it, you've got to be able to process information.

In Tim Folger

*Discover Magazine*

The Best Computer in All Possible Worlds, October 1995

**Longfellow, Henry Wadsworth** 1807–82

American poet

The Universe as an immeasurable wheel  
Turning for evermore

In the rapid and rushing river of Time.

*The Poetical Works of Henry Wadsworth Longfellow*

Rain in Summer

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

...the existing universe is bounded in none of its dimensions; for then it must have an outside.

In *Great Books of the Western World* (Volume 12)

*Lucretius: on the Nature of Things*

Book One, l. 958 (p. 12)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

The universe is like a machine in which the motion of certain parts is determined by that of others, only nothing is determined about the motion of the whole machine.

*History and Root of the Principle of the Conservation of Energy*

Chapter IV (p. 62)

The Open Court Publishing Company. Chicago, Illinois, USA. 1911

**Marquis, Don** 1878–1937

American newspaperman, poet, and playwright

you write so many things  
 about me that are not true  
 complained the universe  
 there are so many things  
 about you which you seem to be  
 unconscious of yourself said archy  
 contain a number of things  
 which i am trying to forget  
 rejoined the universe  
 such as what asked archy  
 such as cockroaches and poets  
 replied the universe

*the lives and times of archy & mehitablel*  
 poets (p. 289)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

do not tell me said warty bliggens that there is not a  
 purpose in the universe

the thought is blasphemy

*the lives and times of archy & mehitablel*

warty bliggens, the toad (p. 56)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

the men of science are talking about the size and shape  
 of the universe

again i thought i had settled that for them years ago

it is as big as you think it is and it is spherical in shape

*the lives and times of archy & mehitablel*

why the earth is round (p. 284)

Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

### Masson, David

No biographical data available

Erst, space was nebulous.

It whirled and in the whirl, the nebulous milk

Broke into rifts and curdled into orbs —

Whirled and still curdled, till the azure rifts

Severed and shored vast systems, all of orbs.

In Alexander Winchell

*World-Life or Comparative Geology*

Part II, Chapter I (p. 145)

S.C. Griggs & Company. Chicago, Illinois, USA. 1883

### McAleer, Neil 1942–

American science writer

If science ever knows for certain the fate of the Universe,  
 what will this tell us? It will tell us the ultimate fate  
 of the atoms that now make up our living bodies and  
 brains, the same atoms that allow us to exist and strug-  
 gle to give meaning to the Universe and to our brief  
 lives.

*The Mind-Boggling Universe*

Chapter 6 (p. 239)

Doubleday & Company, Inc. Garden City, New York, USA. 1957

### Melville, Herman 1819–91

American novelist

It's too late to make any improvements now. The universe  
 is finished; the copestone is set on, and the chips were  
 carted off a million years ago.

In *Great Books of the Western World* (Volume 48)

*Moby Dick*

Chapter 2 (p. 7)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

### Minto, Walter

No biographical data available

This immense, beautiful, and varied universe is a book  
 written by the finger of Omnipotence and raises the  
 admiration of every attentive beholder.

In John Archibald Wheeler

*At Home in the Universe*

The Spirit of Collegueship at Princeton (p. 89)

The American Institute of Physics. Woodbury, New York, USA. 1994

### Morris, Richard 1939–2003

American physicist and science writer

How is it that common elements such as carbon,  
 nitrogen, and oxygen happened to have just the right  
 kind of atomic structure that they needed to combine  
 to make the molecules upon which life depends? It is  
 almost as though the universe had been consciously  
 designed.

*The Fate of the Universe*

Chapter 8 (pp. 154–155)

Playboy Press. New York, New York, USA. 1982

### Muir, John 1838–1914

American naturalist

When we try to pick out anything by itself, we find it  
 hitched to everything else in the universe.

*My First Summer in the Sierra*

July 27 (p. 211)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1911

The clearest way into the Universe is through a forest  
 wilderness.

*The Wilderness World of John Muir*

The Philosophy of John Muir (p. 312)

Houghton, Mifflin & Company. Boston, Massachusetts, USA. 2001

How hard to realize that every camp of men or beast has  
 this glorious starry firmament for a roof! In such places  
 standing alone on the mountaintop it is easy to realize that  
 whatever special nests we make of leaves and moss like  
 marmots and birds, or tents or piled stone we all dwell in  
 a house of one room the world with the firmament for its  
 roof and are sailing the celestial spaces without leaving  
 any track.

*The Wilderness World of John Muir*

The Philosophy of John Muir (p. 312)

Houghton, Mifflin & Company. Boston, Massachusetts, USA. 2001

### Newton, Sir Isaac 1642–1727

English physicist and mathematician

The most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being.

A Heavenly Master governs all the world as Sovereign of the universe. We are astonished at Him by reason of His perfection, we honor Him and fall down before Him because of His unlimited power. From blind physical necessity, which is always and everywhere the same, no variety adhering to time and place could evolve, and all variety of created objects which represent order and life in the universe could happen only by the willful reasoning of its original Creator, Whom I call the Lord God.

*Principia*

General Scholium

...since Space is divisible in infinitum, and Matter is not necessarily in all places, it may be also allow'd that God is able to create Particles of Matter of several Sizes and Figures, and in several Proportions to Space, and perhaps of different Densities and Forces, and thereby to vary the Laws of Nature, and make Worlds of several sort in several Parts of the Universe.

In *Great Books of the Western World* (Volume 34)

*Optics*

Query 31

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Nietzsche, Friedrich** 1844–1900

German philosopher

If the universe may be conceived as a definite quantity of energy, as a definite number of centers of energy — and every other concept remains indefinite and therefore useless — it follows therefore that the universe must go through a calculable number of combinations in the great game of chance which constitutes its existence. In infinity, at some moment or other, every possible combination must once have been realized; not only this, but it must have been realized an infinite number of times.

*Complete Works*

Volume IX (p. 430)

Foulis, Edinburgh, Scotland. 1913

**Noyes, Alfred** 1880–1958

English poet

This universe exists, and by that one impossible fact Declares itself a miracle.

*The Torch Bearers: Watchers of The Sky*

Newton, VII (p. 226)

Frederick A. Stokes Company Publishers. New York, New York, USA. 1922

**Oates, Joyce Carol** 1938–

American writer

Nothing is accidental in the universe — this is one of my Laws of Physics — except the entire universe itself, which is Pure Accident, pure divinity.

*Do What You Will*

The Summing Up: Meredith Dawe

Random House, Inc. New York, New York, USA. 1982

**Pagels, Heinz R.** 1939–88

American physicist and science writer

...the universe contains the record of its past the way that sedimentary layers of rock contain the geological record of the earth's past.

*Perfect Symmetry: The Search for the Beginning of Time*

Part One, Chapter 2 (p. 24)

Simon & Schuster. New York, New York, USA. 1985

**Parker, Barry**

Canadian science writer

Looking into the dark night sky we feel a tingle of excitement as we are overcome by its grandeur and beauty. Each point of light we see is the image of a star, an image of light that may have left the star long before we were born. The universe is vast beyond imagination — almost terrifying in its intensity and complexity.

*Einstein's Dream: The Search for a Unified Theory of the Universe*

Chapter 1 (p. 1)

Plenum Press. New York, New York, USA. 1986

**Pascal, Blaise** 1623–62

French mathematician and physicist

The spaces of the universe enfold me and swallow me up like a speck; but I, by the power of thought, may comprehend the universe.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section VI, 348

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

[The Universe] is an infinite sphere, the centre of which is everywhere, the circumference nowhere.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section II, 72

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Pasteur, Louis** 1822–95

French chemist

The universe is asymmetrical; for, if the whole of the bodies which compose the solar system moving with their individual movements were placed before a glass, the image in the glass could not be superimposed upon the reality.

In René Dubos

*Louis Pasteur: Free Lance of Science*

Chapter IV (p. 111)

Little, Brown & Company. Boston, Massachusetts, USA. 1950

**Peattie, Donald Culrose** 1896–1964

American botanist, naturalist, and author

There is no certainty vouchsafed us in the vast testimony of Nature that the universe was designed for man, nor yet for any purpose, even the bleak purpose of symmetry. The courageous thinker must look the inimical aspects of his environment in the face, and accept the stern fact that the universe is hostile and deadly to him save for a very narrow zone where it permits him, for a few eons, to exist.

*An Almanac for Moderns*

March Twenty-Ninth (p. 11)

G.P. Putnam's Sons. New York, New York, USA. 1935

**Penzias, Arno** 1933–

German-American mathematical physicist

Either we've seen the birth of the universe, or we've seen a pile of pigeon shit.

In Roylston Roberts

*Serendipity: Accidental Discoveries in Science*

John Wiley & Sons, Inc. New York, New York, USA. 1989

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The universe ought to be presumed too vast to have any character.

*Chance, Love, and Logic: Philosophical Essays* (p. 127)

University of Nebraska Press. Lincoln, Nebraska, USA. 1998

**Plato** 428 BCE–347 BCE

Greek philosopher

Time and the heavens came into being at the same instant, in order that, if they were ever to dissolve, they might be dissolved together. Such was the mind and thought of God in the creation of time.

In James Jeans

*The Mysterious Universe*

Chapter V (p. 182)

The Macmillan Company. New York, New York, USA. 1932

...had we never seen the stars, and the sun, and the heaven, none of the words which we have spoken about the universe would ever have been uttered.

In *Great Books of the Western World* (Volume 7)

*Timaeus*

Section 47 (p. 455)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Poe, Edgar Allan** 1809–49

American short story writer

Telescopic observations, guided by the laws of perspective, enable us to understand that the perceptible Universe exists as a roughly spherical cluster of clusters irregularly disposed.

*Eureka*

Line 16 (p. 96)

Geo. P. Putnam. New York, New York, USA. 1848

The Universe is a plot of God.

*Eureka*

Line 7 (p. 120)

Geo. P. Putnam. New York, New York, USA. 1848

I design to speak of the Physical, Metaphysical and Mathematical — of the Material and Spiritual Universe: — of its Essence, its Origin, its Creation, its Present Condition and its Destiny.

*Eureka*

Line 9 (p. 7)

Geo. P. Putnam. New York, New York, USA. 1848

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

The universe is still dead, but it already has the capacity of coming to life.

In Freeman Dyson

*Personal Knowledge*

Chapter 13, Section 7 (p. 404)

Harper & Row, Publishers. New York, New York, USA. 1962

**Pope, Alexander** 1688–1744

English poet

Order is Heav'n's first law.

*The Complete Poetical Works* (Volume 2)

An Essay on Man, Epistle IV, l. 49

Houghton Mifflin Company. New York, New York, USA. 1903

**Prigogine, Ilya** 1917–2003

Russian-born Belgian physical chemist

I certainly think we are only living in the prehistory of the understanding of our universe.

In Renée Weber

*Dialogues with Scientists and Sages: The Search for Unity* (p. 199)

Routledge & Kegan Paul. London, England. 1986

**Rabi, Isidor Isaac** 1898–1988

Austrian-born American physicist

The scientist does not defy the universe. He accepts it. It is his dish to savor, his realm to explore; it is his adventure and never-ending delight. It is complaisant and elusive but never dull. It is wonderful both in the small and in the large. In short, its exploration is the highest occupation for a gentleman.

In Leon Lederman

*The God Particle: If the Universe Is the Answer, What Is the Question?*

Chapter 4 (p. 104)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1993

**Ramón y Cajal, Santiago** 1852–1934

Spanish histologist

As long as the brain is a mystery, the universe will also be a mystery.

In Victor Cohn

Charting the Soul's Frail Dwelling-House

*The Washington Post*, September 5, 1982, Final Edition (p. A1)

**Rand, Ayn**

Russian-born American novelist and philosopher



I know not if this earth on which I stand is the core of the universe or if it is but a speck of dust lost in eternity.

*Anthem*

Chapter XI (p. 95)

E.P. Dutton & Company. New York, New York, USA. 1995

**Raymo, Chet** 1936–

American physicist and science writer

Give me the ninety-two elements and I'll give you a universe. Ubiquitous hydrogen. Standoffish helium, Spooky boron. No-nonsense carbon. Promiscuous oxygen. Faithful iron. Mysterious phosphorous. Exotic xenon. Brash tin. Slippery mercury. Heavy-footed lead.

*The Soul of The Night*

Chapter 7 (p. 65)

Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA. 1985

**Reade, Winwood** 1838–75

English philosopher and historian

The universe is anonymous; it is published under secondary laws; these at least we are able to investigate, and in these perhaps we may find a partial solution of the great problem.

*The Martyrdom of Man*

Chapter IV (p. 465)

E.P. Dutton & Company. New York, New York, USA. 1926

**Reed, Ishmael** 1938–

American poet, essayist, and writer

The universe is a spiraling Big Band in a polka-dotted speak-easy, effectively generating new lights every one-night stand.

In A. Zee

*An Old Man's Toy: Gravity at Work and Play in Einstein's Universe*

Chapter 8 (p. 123)

The Macmillan Company. New York, New York, USA. 1989

**Reichenbach, Hans** 1891–1953

German philosopher of science

Instead of asking for a cause of the universe, the scientist can ask only for the cause of the present state of the universe; and his task will consist in pushing farther and farther back the date from which he is able to account for the universe in terms of laws of nature.

*The Rise of Scientific Philosophy*

Chapter 12 (p. 208)

University of California Press. Berkeley, California, USA. 1951

**Remsen, Ira** 1846–1927

American chemist

The universe is inexhaustible, and its mysteries are inexplicable. We may and must strive to learn all we can, but we can not hope to learn all. We are finite; the mysteries we are dealing with are infinite.

The Age of Science

*Science*, New Series, Volume 20, Number 407, July 15, 1904 (p. 73)

**Renard, Maurice** 1875–1939

French writer

Man, peeping at the Universe through only a few tiny windows — his senses — catches mere glimpses of the world around him. He would do well to brace himself against unexpected surprises from the vast unknown; from that immeasurable sector of reality that has remained a closed book.

In Charles Noël Martin

*The Role of Perception in Science* (p. 7)

Hutchinson of London. London, England. 1963

**Richards, Theodore William** 1868–1928

American chemist

The mystery that enshrouds the ultimate nature of the physical universe has always stimulated the curiosity to the thinking man.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1911* (Faraday Lecture) The Fundamental Properties of the Elements

(p. 100)

Government Printing Office. Washington, D.C. 1912

**Rindler, Wolfgang**

Physicist and author

Modern scientific man has largely lost his sense of awe in the Universe. He is confident that given sufficient intelligence, perseverance, time, and money, he can understand all there is beyond the stars.

In M. Taube

*Evolution of Matter and Energy*

Chapter 2 (p. 18)

Springer-Verlag. New York, New York, USA. 1985

**Rothman, Tony** 1953–

American cosmologist

When confronted with the order and beauty of the universe and the strange coincidences of nature, it's very tempting to take the leap of faith from science into religion. I am sure many physicists want to. I only wish they would admit it.

In J.L. Casti

*Paradigms Lost: Images of Man in the Mirror of Science*

Chapter 7 (pp. 482–483)

William Morrow & Company, Inc., New York, New York, USA. 1989

**Rubin, Vera** 1928–

American astronomer

The joy and fun of understanding the universe we bequeath to our grandchildren — and to their grandchildren. With over 90% of the matter in the universe still to play with, even the sky will not be the limit.

In Marcia Bartusiak

*The Woman Who Spins the Stars*

*Discover*, October 1990 (p. 94)

**Ruderman, M. A.**

No biographical data available

**Rosenfeld, A. H.**

No biographical data available

We are peeling an onion layer by layer, each layer uncovering in a sense another universe, unexpected, complicated, and — as we understand more — strangely beautiful.

An Explanatory Statement on Elementary Particle Physics  
*American Scientist*, Volume 48, June 1960, Number 2 (p. 210)

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

So far as scientific evidence goes, the universe has crawled by slow stages to a somewhat pitiful result on this earth, and is going to crawl by still more pitiful stages to a condition of universal death.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Has Religion Made Useful Contributions to Civilization (p. 32)  
Watts. London, England. 1927

The Universe may have a purpose, but nothing that we know suggests that, if so, this purpose has any similarity to ours.

*Why I Am Not a Christian: And Other Essays on Religion and Related Subjects*

Do We Survive Death? (p. 92)  
Watts. London, England. 1927

All the labors of the ages, all the devotion, all the inspiration, all the noonday brightness of human genius, are destined to extinction in the vast death of the solar system; and the whole temple of Man's achievement must inevitably be buried beneath the debris of a universe in ruins.

In George Smoot

*Wrinkles in Time*

Chapter 4 (p. 69)

William Morrow & Company, Inc. New York, New York, USA. 1993

**Sagan, Carl** 1934–96

American astronomer and science writer

We might have lived in a Universe in which nothing could be understood by a few simple laws, in which Nature was complex beyond our abilities to understand, in which laws that apply on Earth are invalid on Mars, or in a distant quasar. But the evidence — not the preconceptions, the evidence — proves otherwise. Luckily for us, we live in a Universe in which much can be “reduced” to a small number of comparatively simple laws of Nature. Otherwise we might have lacked the intellectual capacity and grasp to comprehend the world.

*The Demon-Haunted World: Science As a Candle in the Dark*

Chapter 15 (pp. 273–274)

Random House, Inc. New York, New York, USA. 1995

The universe is not required to be in perfect harmony with human ambition.

But the fact that some geniuses were laughed at does not imply that all who are laughed at are geniuses. They laughed at Columbus, they laughed at Fulton, they laughed at the Wright brothers. But they also laughed at Bozo the Clown.

*Cosmos*

Chapter II (p. 31)

Random House, Inc. New York, New York, USA. 1980

A universe in which everything is known would be static and dull, as boring as the heaven of some weak-minded theologians. A Universe that is unknowable is no fit place for a thinking being.

*Broca's Brain: Reflections on the Romance of Science*

Part I, Chapter 2 (p. 18)

Random House, Inc. New York, New York, USA. 1979

A religion old or new, that stressed the magnificence of the universe as revealed by modern science, might be able to draw forth reserves of reverence and awe hardly tapped by the conventional faiths. Sooner or later, such a religion will emerge.

*Pale Blue Dot: A Vision of the Human Future in Space*

Chapter 4 (p. 52)

Random House, Inc. New York, New York, USA. 1994

**Sagan, Carl** 1934–96

American astronomer and author

**Druyan, Ann** 1949–

American author and television producer

The Universe is lavish beyond imagining.

*Shadows of Forgotten Ancestors: A Search for Who We Are*

Chapter 1 (p. 13)

Random House, Inc. New York, New York, USA. 1992

**Sandage, Allan** 1926–

American astronomer

The present universe is something like the old professor nearing retirement with his brilliant future behind him.

In G. Borner

*The Early Universe*

Chapter 3 (p. 90)

Springer-Verlag, Berlin, Germany. 1988

**Santayana, George (Jorge Agustín Nicolás**

**Ruiz de Santillana)** 1863–1952

Spanish-born American philosopher

The universe, as far as we can observe it, is a wonderful and immense engine; its extent, its order, its beauty, its cruelty, make it alike impressive. If we dramatize its life and conceive its spirit, we are filled with wonder, terror, and amusement, so magnificent is that spirit, so prolific, inexorable, grammatical and dull.

In Logan Pearsall Smith

*Little Essays Drawn from the Writings of George Santayana*

Piety (p. 85)

Books for Libraries Press, Freeport, New York, USA. 1967

**Schiller, Ferdinand Canning Scott** 1759–1805

German poet, dramatist and philosopher

The universe is one of God's thoughts.

*Essays: Aesthetical and Philosophical*

Letter 4: Theosophy of Julius

**Shelley, Percy Bysshe** 1792–1822

English poet

The curtain of the Universe is rent and shattered,  
The splendor-winged worlds disperse like wild doves  
scattered.

Hellas, Leaves of Grass. A Lyrical Drama

Its easier to suppose that the universe has existed from  
all eternity than to conceive a Being beyond its limits  
capable of creating it.

*The Complete Poetical Works of Percy Bysshe Shelley*

Queen Mab

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

Below lay stretched the boundless universe!

*The Complete Poetical Works of Percy Bysshe Shelley*

The Daemon of the World Part I, The Daemon and the Spirit

1241

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Siegel, Eli** 1902–78

American philosopher, poet, critic, and founder of Aesthetic Realism

The universe is Why, How, and What, in any order, and  
all at once.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #69 (p. 28)

Definition Press. New York, New York, USA. 1972

The universe, being clever, has given scientists trouble.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #71 (p. 28)

Definition Press. New York, New York, USA. 1972

The weight of the universe is at one with all its space.

*Damned Welcome*

Aesthetic Realism, Maxims, Part One, #70 (p. 28)

Definition Press. New York, New York, USA. 1972

**Silk, Joseph** 1942–

American astronomer and physicist

The development of human awareness of the Universe  
evolved from the geocentric cosmology of the ancient  
world via the heliocentric cosmology of the Renaissance  
and the egocentric cosmology of the nineteenth century,  
to the ultimate destination of the Big-Bang theory of the  
expanding Universe.

*Cosmic Enigmas*

Cosmologists and Their Myths (p. 3)

AIP Press. Woodbury, New York, USA. 1994

**Smith, Logan Pearsall** 1865–1946

American author

I woke this morning...into the well-known, often-dis-  
cussed, but, to my mind, as yet unexplained Universe.

*Trivia*

Book I, To-Day (p. 4)

Doubleday, Page &amp; Company. Garden City, New York, USA. 1917

**Smuts, Jan Christiaan** 1870–1950

South African statesman, military leader, and holistic philosopher

Truth, beauty, goodness, and love are as much structures  
of the evolutionary universe as the sun and the earth and  
the moon.

Contributions to a British Association Discussion on the Evolution of  
the Universe*Nature*, Supplement, October 24, 1931 (p. 718)**Spenser, Edmund** 1552–99

English poet

Why then should witless man so much misween,

That nothing is, but that which he hath seene?

What if in the Moones faire shining speheare?

What if in every other starre unseene,

Of other worldes he happily should heare?

That nothing is, but that which he hath seene?

*The Complete Poetical Works of Edmund Spenser*

The Faerie Queene

Book the Second, Introduction

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Stern, S. Alan**

American planetary scientist and author

The place we call our Universe is, for the most part, cold  
and dark and all but endless. It is the emptiest of emp-  
ties. It is old, and yet very young. It contains much that  
is dead, and yet much that is alive, forever reinventing  
itself, and sometimes inventing something wholly new.

In S. Alan Stern (ed.)

*Our Universe: The Thrill of Extragalactic Exploration as Told by  
Leading Experts*

The Frontier Universe: At the Edge of the Night (p. 1)

Cambridge University Press. Cambridge, England. 2001

**Sullivan, Walter** 1918–96

American science journalist

We do know enough already, however, to believe that no  
myth or legend could be as rich in beauty, wonder, and  
awe as the full reality of the universe that is our home.

In Ray Bradbury, Arthur C. Clarke, Bruce Murray, Carl Sagan, and  
Walter Sullivan*Mars and the Mind of Man*

Walter Sullivan (p. 127)

Harper &amp; Row, Publishers. New York, New York, USA. 1973

**Swann, William Francis Gray** 1884–1962

Anglo-American physicist

There is one great work of art; it is the universe. Ye  
men of letters find the imprints of its majesty in your  
sense of the beauty of words. Ye men of song find it in

the harmony of sweet sounds. Ye painters feel it in the design of beauteous forms, and in the blending of rich soft colors do your souls mount on high to bask in the brilliance of nature's sunshine. Ye lovers are conscious of its beauties in forms ye can but ill define. Ye men of science find it in the rich harmonies of nature's mathematical design.

*The Architecture of the Universe*

Chapter XII (p. 424)

The Macmillan Company. New York, New York, USA. 1934

**Swimme, Brian** 1950–

American mathematical cosmologist

I am convinced that the story of the universe that has come out of three centuries of modern scientific work will be recognized as a supreme human achievement, the scientific enterprise's central gift to humanity, a revelation having a status equal to that of the great religious revelations of the past.

In Connie Barlow (ed.)

*Evolution Extended: Biological Debates on the Meaning of Life*

The MIT Press. Cambridge, Massachusetts, USA. 1994

**Talbot, Michael** 1953–92

American physicist

...we have to begin to view the universe as ultimately constituted not of matter and energy, but of pure information.

*Beyond the Quantum*

Chapter 6 (p. 155)

The Macmillan Company. New York, New York, USA. 1986

**Teller, Woolsey** 1890–1954

Essayist

...the picture of the universe presented by astronomy is one of dismal stretches of time and space and unparalleled desolation. In the eternal abyss of space — bleak, cold, and dark — there are no signs of a Cosmic Consciousness.

*The Atheism of Astronomy*

Chapter VI (p. 120)

Arno Press & The New York Times. New York, New York, USA. 1972

**Tennyson, Alfred (Lord)** 1809–92

English poet

This truth within thy mind rehearse,  
That in a boundless universe  
Is boundless better, boundless worse.

*Alfred Tennyson's Poetical Works*

The Two Voices, Stanza 9

Oxford University Press, Inc. London, England. 1953

**Thompson, Francis** 1859–1907

English writer

The universe is his box of toys. He dabbles his fingers in the day-fall. He is gold-dusty with tumbling amidst

the stars. He makes bright mischief with the moon. The meteors nuzzle their noses in his hand.

*The Works of Francis Thompson*

Shelley (p. 18)

Burns & Oats. London, England. 1913

**Thoreau, Henry David** 1817–62

American essayist, poet, and practical philosopher

The universe is wider than our views of it.

*The Writings of Henry David Thoreau (Volume 2)*

Walden

Chapter XVIII (p. 493)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

...the universe is not rough-hewn, but perfect in its details.

*The Writings of Henry David Thoreau (Volume 9)*

Natural History of Massachusetts (p. 132)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1893

**Toynbee, Arnold J.** 1852–83

English historian

Huddled together in our little earth we gaze with frightened eyes into the dark universe.

*Toynbee's Industrial Revolution*

Notes and Jottings (p. 256)

A.M. Kelley. New York, New York, USA. 1969

**Trimble, V.**

No biographical data available

Those of us who are not directly involved in the fray can only suppose that the universe is open ( $W < 1$ ) on Wednesday, Friday, and Sunday and closed ( $W > 1$ ) on Thursday, Saturday, and Monday. (Tuesday is choir practice.)

Dark Matter in the Universe: Where, What, and Why?

*Contemporary Physics*, Volume 29, 1988 (p. 389)

**Turner, Michael S.**

American astrophysicist

The progress made in our understanding of the universe during the twentieth century is nothing short of stunning.

A Sober Assessment of Cosmology at the New Millennium

*Publications of the Astronomical Society of the Pacific*, Volume 113,

2001 (p. 653)

**Tyron, E. P.**

No biographical data available

If it is true that our Universe has a zero net value for all conserved quantities, then it may simply be a fluctuation of the vacuum of some larger space in which our Universe is imbedded. In answer to the question of why it happened, I offer the modest proposal that our Universe is simply one of those things which happen from time to time.

Is the Universe a Vacuum Fluctuation?

*Nature*, Volume 246, Number 5433, December 14, 1973 (p. 397)

**von Goethe, Johann Wolfgang** 1749–1832  
German poet, novelist, playwright, and natural philosopher

Man is not born to solve the problems of the universe, but to find out where the problems begin, and then to take his stand within the limits of the intelligible.

In Louis Berman

*Exploring the Cosmos*

Chapter 16 (p. 351)

Little, Brown & Company. Boston, Massachusetts, USA. 1973

**Weinberg, Steven** 1933–  
American nuclear physicist

The effort to understand the universe is one of the very few things that lifts human life a little above the level of farce, and gives it some of the grace of tragedy.

*The First Three Minutes*

Epilogue (p. 155)

Basic Books, Inc. New York, New York, USA. 1988

The more the universe seems comprehensible, the more it also seems pointless.

*The First Three Minutes*

Epilogue (p. 154)

Basic Books, Inc. New York, New York, USA. 1988

It is very hard to realize that this all is just a tiny part of an overwhelmingly hostile universe. It is even harder to realize that this present universe has evolved from an unspeakably unfamiliar early condition, and faces a further extinction of endless cold or intolerable heat. The more the universe seems comprehensible, the more it also seems pointless.

*The First Three Minutes*

Epilogue (p. 154)

Basic Books, Inc. New York, New York, USA. 1988

...the urge to trace the history of the universe back to its beginning is irresistible.

*The First Three Minutes*

Chapter I (p. 4)

Basic Books, Inc. New York, New York, USA. 1988

**Wharton, Edith** 1862–1937  
American novelist

...she had never been able to understand the laws of a universe which was so ready to leave her out of its calculations.

*The House of Mirth*

Book I, Chapter III (p. 42)

Charles Scribner's Sons. New York, New York, USA. 1919

**Wheeler, John Archibald** 1911–  
American theoretical physicist and educator

We will first understand how simple the universe is when we recognize how strange it is.

From the Big Bang to the Big Crunch

*Cosmic Search Magazine*, Volume 1, Number 4, Fall 1979

The Universe is a self-excited circuit.

In Freeman Dyson

*Infinite in All Directions*

Part I, Chapter Three (p. 53)

Harper Collins Publisher, Inc. New York, New York, USA. 1988

...this is our universe, our museum of wonder and beauty, our cathedral...

*A Journey into Gravity and Spacetime*

Opening

Scientific American Library. New York, New York, USA. 1990

**Wheeler, John Archibald** 1911–  
American theoretical physicist and educator

**Thorne, Kip S.** 1940–

American theoretical physicist

A model universe that is closed, that obeys Einstein's geometrodynamics law, and that contains a nowhere negative density of mass-energy, inevitably develops a singularity. No one sees any escape from the density of mass-energy rising without limit. A computing machine calculating ahead step by step the dynamical evolution of the geometry comes to the point where it can not go on. Smoke, figuratively speaking, starts to pour out of the computer. Yet physics, surely continues to go on if for no other reason than this: Physics is by definition that which does go on its eternal way despite all the shadowy changes in the surface of reality.

*Gravitation*

Part X, Chapter 44 (p. 1196)

W.H. Freeman & Company. San Francisco, California, USA. 1973

**Whitman, Walt** 1819–92

American poet, journalist, and essayist

Praised be the fathomless universe

For life and joy and for objects and knowledge curious...

*Complete Poetry and Collected Prose*

Memories of President Lincoln, Stanza 14

The Library of America. New York, New York, USA. 1982

The whole theory of the universe is directed unerringly to one single individual — namely to you.

*Complete Poetry and Collected Prose*

Leaves of Grass

By Blue Ontario's Shore, Stanza 15

The Library of America. New York, New York, USA. 1982

The world, the race, the soul —

Space and time, the universes

All bound as is befitting each — all

Surely going somewhere.

*Complete Poems and Collected Prose*

Going Somewhere

The Library of America. New York, New York, USA. 1982

**Wiechert, Emil** 1861–1928

Prussian geophysicist

The universe is infinite in all directions.

In Freeman Dyson

*Infinite in All Directions*

Part One, Chapter Three (p. 53)

HarperCollins Publisher, Inc. New York, New York, USA. 1988

### **Young, Louise B.**

American science writer

The universe is unfinished, not just in the limited sense of an incompletely realized plan but in the much deeper sense of a creation that is a living reality of the present. A masterpiece of artistic unity and integrated Form, infused with meaning, is taking shape as time goes by. But its ultimate nature cannot be visualized, its total significance grasped, until the final lines are written.

*The Unfinished Universe*

Conclusion (p. 205, 208)

Simon & Schuster. New York, New York, USA. 1986

### **Zebrowski, George** 1945–

Polish-American science fiction writer

The rationality of our universe is best suggested by the fact that we can discover more about it from any starting point, as if it were a fabric that will unravel from any thread.

Is Science Rational?

*OMNI Magazine*, June 1994 (p. 50)

In a perfectly rational universe, infinities turn back on themselves...

Is Science Rational?

*OMNI Magazine*, June 1994 (p. 50)

## UNIVERSE AND COSMOGENESIS

### **Ackerman, Diane** 1948–

American writer

Fifteen billion years ago, when the Universe let rip and, in disciplined panic, Creation spewed mazy star-treacle and resin, shrinking balls of debut fire smoldered and glitched.

*The Planets: A Cosmic Pastoral*

Neptune, IV (p. 129)

William Morrow & Company, Inc. New York, New York, USA. 1976

### **Adams, Douglas** 1952–2001

English author, comic radio dramatist, and musician

In the beginning the universe was created. This made a lot of people very angry and has been widely regarded as a bad move. Many races believe that it was created by some sort of god, though the Jatravartid people of Viltvodle VI believe that the entire Universe was in fact sneezed out of the nose of a being called the Great Green Arkle seizure.

*The Ultimate Hitchhiker's Guide to the Galaxy*

The Restaurant at the End of the Universe

Chapter 1 (p. 149)

Ballantine Books. New York, New York, USA. 2002

### **Barrow, John D.** 1952–

English theoretical physicist

One day we may be able to say something about the origins of our own cosmic neighborhood. But we can never know the origins of the universe. The deepest secrets are the ones that keep themselves.

*The Origin of the Universe*

Chapter 8 (p. 137)

Basic Books, Inc. New York, New York, USA. 1994

### **Bowyer, Stuart** 1934–

American astrophysicist

Ultimately, the origin of the universe is, and always will be, a mystery.

In Henry Margenau and Roy Abraham Varghese (eds.)

*Cosmos, Bios, Theos*

Chapter 2 (p. 32)

Open Court. La Salle, Illinois, USA. 1992

### **Cardenal, Ernesto** 1925–

Nicaraguan poet and Roman Catholic priest

In the beginning there was nothing  
neither space  
nor time.

The entire universe concentrated  
in the space of the nucleus of an atom,  
and before that even less,  
much less than a proton,  
and even less still,  
an infinitely dense mathematical point.

Translated by John Lyons

*Cosmic Canticle*

Cantigua 1, Big Bang (p. 11)

Curbstone Press. Willimantic, Connecticut, USA. 1993

### **Egyptian Myth** ca. 2500 B.C.

In the beginning, only the ocean existed, upon which there appeared an egg. Out of the egg came the sun-god and from himself he begat four children: Shu and Tefnut, Keb and Nut. All these, with their father, lay upon the ocean of chaos. Then Shu and Tefnut thrust themselves between Keb and Nut. They planted their feet upon Keb and raised Nut on high so that Keb became the earth and Nut the heavens.

In Eric J. Lerner

*The Big Bang Never Happened*

Chapter 2 (p. 58)

Random House, Inc. New York, New York, USA. 1991

### **Flaubert, Gustave** 1821–90

French novelist

SMARH: How vast creation is! I see the planets rise,  
I see the fiery stars driven along.... Space opens out as

I rise, worlds revolve around me, and I am the center of this bustling creation.

*Early Writings*

Smarh (p. 216)

University of Nebraska Press. Lincoln, Nebraska, USA. 1991

### **Gamow, George** 1904–68

Russian-born American physicist

Before we can discuss the basic problem of the origin of our universe, we must ask ourselves whether such a discussion is necessary.

*The Creation of the Universe*

Chapter I (p. 6)

The Viking Press. New York, New York, USA. 1952

In the beginning God created radiation and ylem. And ylem was without shape or number, and the nucleons were rushing madly over the face of the deep.

*My World Line: An Informal Autobiography*

Chapter 6 (p. 127)

The Viking Press. New York, New York, USA. 1979

### **Hawkins, Gerald S.** 1928–2003

English archaeoastronomer

In the beginning.... A scientist cannot continue this sentence with absolute certainty. It would be like asking a child to give an account of his birth or a description of his conception.

*In Reader's Digest*

Marvels and Mysteries of the World Around Us

Earth's Ancient Drama (p. 10)

The Reader's Digest Association. Pleasantville, New York, USA. 1972

### **Hein, Robert**

No biographical data available

The first world the cosmic colossus created with a word: One lightning word from the golden lips of Truth And electric earth condensed on a creamy cloud, Adorned with a necklace of blue-gold stars and a chain Of peppermint planets in the amphitheater of space.

*Quest of the Singing Tree*

The Larger Creation, Creation of the Earth

H. Harrison. New York, New York, USA. 1938

### **Hoyle, Sir Fred** 1915–2001

English mathematician and astronomer

Without continuous creation, the Universe must evolve toward a dead state in which all the matter is condensed into a vast number of dead stars.

*The Nature of the Universe*

Chapter 6 (pp. 131–132)

The University Press. Cambridge. 1933

### **Kipling, Rudyard** 1865–1936

British writer and poet

Before the High and Far-Off Times, O my Best Beloved, came the Time of the Very Beginnings; and that was in

the days when the Eldest Magician was getting Things ready. First he got the Earth ready; then he got the Sun ready; and then he told all the Animals that they could come out and play.

*Just So Stories*

The Crab that Played with the Sea (p. 171)

Doubleday & Company, Inc. Garden City, New York, USA. 1952

### **Marquesas Islanders**

In the beginning there was nothing. There arose a swelling, a ferment, a black fire, a spinning vortices, a bubbling, a swallowing — there arose a whole series of pairs of props, posts, or piles, large and small, long and short, crooked and bent, decayed and rotten. Similarly there arose pairs of roots, large and small, long and short, and so forth; there arose countless and infinitely many supports. Above all, there now arose the ground, the foundation, the hard rock, there arose the space for light, there arose rocks of different sorts.

In John A. Wood

*Meteorites and the Origin of Planets*

Creation Myth (p. v)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1968

### **Reeves, Hubert** 1932–

Canadian astrophysicist

In the beginning was the absolute rule of the flame: The universe was in limbo. Then after countless eras, the fires slowly abated like the sea at the outgoing tide. Matter awoke and organized itself; the flame gave way to music.

*Atoms of Silence*

Introduction (p. 5)

The MIT Press. Cambridge, Massachusetts. USA. 1984

### **Sagan, Carl** 1934–96

American astronomer and science writer

If the general picture of an expanding universe and a Big Bang is correct, we must then confront still more difficult questions. What were conditions like at the time of the Big Bang? What happened before that? Was there a tiny universe, devoid of all matter, and then the matter suddenly created from nothing? How does that happen? In many cultures it is customary to answer that God created the universe out of nothing. But this is mere temporizing. If we wish courageously to pursue the question, we must of course ask next where God comes from. And if we decide this to be unanswerable, why not save a step and decide that the origin of the universe is an unanswerable question. Or, if we say that God has always existed, why not save a step and conclude that the universe has always existed?

*Cosmos*

Chapter X (p. 257)

Random House, Inc. New York, New York, USA. 1980

**Singh, Jagjit** 1919–2002

Indian mathematician and science writer

In the beginning there was neither heaven nor earth,  
 And there was neither space nor time.  
 And the Earth, the Sun, the Stars, the Galaxies and the  
 whole universe were  
 confined within a small volume like the bottled genie of  
 the Arabian Nights.  
 And then God said, “Go!”  
 And straight way the Galaxies rushed out of their  
 prison, scattering in all  
 directions, and they have continued to run away from  
 one another ever since,  
 afraid lest some cosmic Hand should gather them again  
 and put them back in  
 the bottle (which is not bigger than a pin-point).  
 And they shall continue to scatter thus till they fade  
 from each other’s ken —  
 and thus, for each other, cease to exist at all.

*Mathematical Ideas: Their Nature and Use*

Space and Time (pp. 209–210)

Hutchinson & Company Ltd. London, England. 1972

**Smoot, George** 1945–

American experimental astrophysicist

The question of “the beginning” is as inescapable for  
 cosmologists as it is for theologians.

*Wrinkles in Time*

Chapter 9 (p. 189)

William Morrow & Company, Inc. New York, New York, USA. 1993

**Spenser, Edmund** 1552–99

English poet

Through knowledge we behold the world’s creation,  
 How in his cradle first he fostered was;  
 And judge of Natures cunning operation,  
 How things she formed of a formless mass.

*The Complete Poetical Works of Edmund Spenser*

The Tears of the Muses, I. 499–502

Houghton Mifflin Company. Boston, Massachusetts, USA. 1908

**Sturluson, Snorri** 1179–1241

Icelandic writer

Erst was the age when nothing was;  
 Nor sand nor sea, nor chilling stream-waves;  
 Earth was not found, nor Ether — Heaven,  
 — A Yawning Gap, but grass was none.

*The Prose Edda*

Here Begins the Beguiling of Gylfi (p. 16)

The American-Scandinavian Foundation. New York, New York, USA.  
 1916

**Sufi Creation Myth**

I was a hidden treasure and desired to be known: therefore  
 I created the creation in order to be known.

In George Smoot

*Wrinkles in Time*

Chapter 1 (p. 1)

William Morrow & Company, Inc. New York, New York, USA. 1993

**Tagore, Rabindranath** 1861–1941

Indian poet and philosopher

It seems to me that, perhaps, creation is not fettered by  
 rules,

That all the hubbub, meeting and mingling are blind hap-  
 penings of fate.

Translated by Indu Dutt

*Our Universe* (p. 75)

Jaico Publishing House. Bombay, India. 1969

**The Bible**

In the beginning God created the heaven and the earth.

*The Revised English Bible*

Genesis 1:1

Oxford University Press, Inc. Oxford, England. 1989

**Townes, Charles H.** 1915–

American inventor of the laser

I do not understand how the scientific approach alone,  
 as separated from a religious approach, can explain an  
 origin of all things. It is true that physicists hope to look  
 behind the “big bang,” and possibly to explain the origin  
 of our universe as, for example, a type of fluctuation. But  
 then, of what is it a fluctuation and how did this in turn  
 begin to exist? In my view the question of origin seems  
 always left unanswered if we explore from a scientific  
 view alone.

In Henry Margenau and Roy Abraham Varghese (eds.)

*Cosmos, Bios, Theos*

Chapter 25 (p. 123)

Open Court. La Salle, Illinois, USA. 1992

**Updike, John** 1932–

American novelist, short story writer and poet

By computation, they all must have begun at one place  
 about five billion years ago; all the billions and trillions  
 and quadrillions squared and squared again of tons of  
 matter in the universe were compressed into a ball at the  
 maximum possible density, the density within the nucle-  
 us of the atom; one cubic centimeter of this primeval egg  
 weighed two hundred and fifty tons.

*The Centaur*

Chapter I (p. 38)

Alfred A. Knopf. New York, New York, USA. 1995

**Weinberg, Steven** 1933–

American nuclear physicist

...the urge to trace the history of the universe back to the  
 beginnings is irresistible. From the start of modern sci-  
 ence in the sixteenth and seventeenth centuries, physicists  
 and astronomers have returned again and again to the  
 problem of the origin of the universe.



*The First Three Minutes*

Chapter I (p. 4)

Basic Books, Inc. New York, New York, USA. 1988

**Wilmot, John (2<sup>nd</sup> Earl of Rochester)** 1647–80

English libertine and satirical and bawdy poet

E'er time and place were, time and place were not,  
When Primitive Nothing something straight begot,  
Then all proceeded from the great united — What.

*Collected Works of John Wilmot Earl of Rochester*

Upon Nothing

The Nonesuch Press. London, England. 1926

**Zuni Creation Myth**

In the beginning of things Awonawilona was alone. There was nothing beside him in the whole of time. Everywhere there was black darkness and void. Then Awonawilona conceived in himself the thought, and the thought took shape and got out into space and through this stepped out into the void, into outer space, and from them came nebulae of growths and mists, full of power and growth.

In Raymond Van Over

*Sun Songs*

Zuni Creation Myths

Cosmic Creation (p. 23)

New American Library. New York, New York, USA. 1980

**UNIVERSE, DEATH OF**

**Balfour, Arthur James** 1848–1930

English prime minister

...the energies of our system will decay, the glory of the sun will be dimmed, and the earth, tideless and inert, will no longer tolerate the race which has for a moment disturbed its solitude. Man will go down into the pit, and all his thoughts will perish.

*The Foundations of Belief*

Part I, Chapter I, Section III (p. 33)

Longmans, Green & Company. London, England. 1912

**Byron, George Gordon, 6<sup>th</sup> Baron Byron** 1788–1824

English Romantic poet and satirist

I had a dream, which was not all a dream.  
The bright sun was extinguish'd, and the stars  
Did wander darkling in the eternal space,  
Rayless, and pathless, and the icy earth  
Swung blind and blackening in the moonless air.

*The Complete Poetical Works of Byron*

Miscellaneous Poems, Darkness

Houghton Mifflin Company. Boston, Massachusetts, USA. 1933

**Davies, Paul Charles William** 1946–

British-born physicist, writer, and broadcaster

Many billions of years will elapse before the smallest, youngest stars complete their nuclear burning and shrink

into white dwarfs. But with slow, agonizing finality perpetual night will surely fall.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*

Chapter 5 (p. 50)

Basic Books, Inc. New York, New York, USA. 1994

A universe that came from nothing in the big bang will disappear into nothing at the big crunch. Its glorious few zillion years of existence not even a memory.

*The Last Three Minutes: Conjectures About the Ultimate Fate of the Universe*

Chapter 9 (p. 123)

Basic Books, Inc. New York, New York, USA. 1994

**Dyson, Freeman J.** 1923–

American physicist and educator

Since the universe is on a one-way slide toward a state of final death in which energy is maximally degraded, how does it manage, like King Charles, to take such an unconsciously long time a-dying.

Energy in the Universe

*Scientific American*, Volume 224, Number 3, 1971 (p. 52)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

...the universe will finally become a ball of radiation, becoming more and more rarified and passing into longer and longer wave-lengths. The longest waves of radiation are Hertzian waves of the kind used in broadcasting. About every 1500 million years this ball of radio waves will double in diameter; and it will go on expanding in geometrical progression for ever. Perhaps then I may describe the end of the physical world as — one stupendous broadcast.

*New Pathways in Science*

Chapter III, Section VI (p. 71)

The Macmillan Company. New York, New York, USA. 1935

**Eliot, T. S. (Thomas Stearns)** 1888–1965

American expatriate poet and playwright

This is the way the world ends  
Not with a bang but a whimper.

*The Collected Poems and Plays 1909–1950*

The Hollow Men (p. 59)

Harcourt, Brace & World, Inc. New York, New York, USA. 1952

**Frost, Robert** 1874–1963

American poet

Some say the world will end in fire,  
Some say in ice.

From what I've tasted of desire  
I hold with those who favor fire.  
But if it had to perish twice,  
I think I know enough of hate  
To say that for destruction ice  
Is also great

And would suffice.

*Complete Poems of Robert Frost*

Fire and Ice

Henry Holt & Company. New York, New York, USA. 1949

**Gamow, George** 1904–68

Russian-born American physicist

Galaxies are ever spinnik,  
Stars will burn to final sparrk,  
Till ourr universe is thinnink  
And is lifeless, cold and darrk.

*Mr. Tompkins in Paperback*

Chapter 6 (p. 60)

At The University Press. Cambridge, England. 1965

**Gribbin, John** 1946–

British science writer and astronomer

“Big Crunch” is...an ugly term which hardly seems appropriate for so important an event as the end of the universe. But there is no convention as yet for a label of the moment of destruction at the end of time, and I am free to borrow the term “omega point.”

*The Omega Point: The Search for the Missing Mass and the Ultimate Fate of the Universe*

Introduction (p. 2)

Bantam Books. Toronto, Ontario, Canada. 1988

**Harrison, Edward Robert** 1919–2007

English-born American cosmologist

The stars begin to fade like guttering candles and are snuffed out one by one. Out of the depths of space the great celestial cities, the galaxies, cluttered with the memorabilia of ages, are gradually dying. Tens of billions of years pass in the growing darkness. Occasional flickers of light pierce the fall of cosmic night, and spurts of activity delay the sentence of a universe condemned to become a galactic graveyard.

*Cosmology: The Science of the Universe*

Chapter 18 (p. 360)

Cambridge University Press. Cambridge, England. 1981

**Hawking, Stephen William** 1942–

English theoretical physicist

The present evidence therefore suggests that the universe will probably expand forever, but all we can really be sure of is that even if the universe is going to recollapse, it won't do so for at least another ten thousand million years, since it has already been expanding for at least that long. This should not unduly worry us: by that time, unless we have colonized beyond the Solar System, mankind would long since have died out, extinguished along with our sun!

*A Brief History of Time: From the Big Bang to Black Holes*

Chapter 3 (p. 46)

Bantam Books. Toronto, Ontario, Canada. 1988

**James, William** 1842–1910

American philosopher and psychologist

Though the ultimate state of the universe may be its vital and psychical extinction, there is nothing in physics to interfere with the hypothesis that the penultimate state might be the millennium — in other words a state in which a minimum of difference of energy-level might have its exchanges so skillfully canalised that a maximum of happy and virtuous consciousness would be the only result. In short, the last expiring pulsation of the universe's life might be, “I am so happy and perfect that I can stand it no longer.”

*The Atlantic Monthly*

Letter to Henry Adams dated June 17, 1910

September 1920 (p. 316)

**Jastrow, Robert** 1925–

American space scientist

Within the isolated galaxies, the old stars burn out one by one, and fewer and fewer new stars are formed to replace them. Stars are the source of the energy by which all beings live. When the light of the last star is extinguished, the Universe fades into darkness, and all life comes to an end.

*God and the Astronomers*

Epilogue (p. 117)

W.W. Norton & Company, Inc. New York, New York, USA. 1978

**Jeans, Sir James Hopwood** 1877–1946

English physicist and mathematician

Everything points with overwhelming force to a definite event, or series of events, of creation at some time or times, not infinitely remote. The universe cannot have originated by chance out of its present ingredients, and neither can it have been always the same as now. For in either of these events no atoms would be left save such as are incapable of dissolving into radiation; there would be neither sunlight nor starlight but only a cool glow of radiation uniformly diffused through space. This is, indeed, so far as present-day science can see, the final end towards which all creation moves, and at which it must at last arrive.

*Eos or the Wider Aspects of Cosmogony* (p. 55)

Kegan Paul, Trench, Trubner & Company, Ltd. London, England. 1931

**Jeffers, Robinson** 1887–1962

American poet

Time will come no doubt  
When the sun too shall die; the planets will freeze, and  
the air on them; frozen gases, white flakes of air  
Will be the dust: which no wind will ever stir: this very  
dust in dim starlight glistening  
Is dead wind, the white corpse of wind.  
Also the galaxy will die; the glitter of the Milky Way,  
our universe, all the stars that have names are dead.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 3)

The Double Axe: The Inhumanist (p. 261)

Stanford University Press. Stanford, California, USA. 1988

For man will be blotted out, the blithe earth die, the  
brave sun

Die blind and blacken to the heart...

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 1)

To the Stone-Cutters (p. 5)

Stanford University Press. Stanford, California, USA. 1988

It will contract, the immense navies of stars and  
galaxies,

Dust-clouds and nebulae

Are recalled home, they crush against each other in one  
harbor, they stick in one lump.

*The Beginning and the End and Other Poems*

The Great Explosion (p. 3)

Random House, Inc. New York, New York, USA. 1963

I seem to have stood a long time and watched the stars  
pass.

They also shall perish I believe.

Here to-day, gone to-morrow, desperate wee galaxies

Scattering themselves and shining their substance away

Like a passionate thought. It is very well ordered.

In Tim Hunt (ed.)

*The Collected Poetry of Robinson Jeffers* (Volume 2)

Margrave (p. 171)

Stanford University Press. Stanford, California, USA. 1988

**Joyce, James** 1882–1941

Irish expatriate writer and poet

Gasballs spinning about, crossing each other, passing.  
Same old dingdong always. Gas, then solid, then world,  
then cold, then dead shell drifting around, frozen rock  
like that pineapple rock. The moon.

*Ulysses* (p. 164)

Random House, Inc. New York, New York, USA. 1946

**Lucretius** ca. 99 BCE–55 BCE

Roman poet

And so some day,

The mighty ramparts of the mighty universe

Ringed round with hostile force,

Will yield and face decay and come crumbling to ruin.

In Paul Davies

*About Time: Einstein's Unfinished Revolution*

Header (p. 33)

Simon & Schuster. New York, New York, USA. 1995

**MacLeish, Archibald** 1892–1982

American poet and Librarian of Congress

And there, there overhead, there, there hung over  
Those thousands of white faces, those dazed eyes,  
There in the starless dark the poise, the hover,  
There with vast wings across the canceled skies,  
There in the sudden blackness the black pall

Of nothing, nothing, nothing — nothing at all.

*Collected Poems 1917–1952*

The End of the World

Houghton Mifflin Company. Boston, Massachusetts, USA. 1952

**Nicholson, Norman** 1914–87

English poet

And if the universe

Reversed and showed

The colour of its money;

If now observable light

Flowed inward, and the skies snowed

A blizzard of galaxies,

The lens of night would burn

Brighter than the focused sun,

And man turn blinded

With white-hot darkness in his eyes.

*The Pot Geranium*

The Expanding Universe (p. 212)

Faber & Faber Ltd. London, England. 1994

**Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

In the vast death of the solar system, and the whole temple  
of Man's achievements must inevitable be buried beneath  
all the labours of the ages, all the devotion, all the  
inspiration, all the noonday brightness of human genius,  
are destined to extinction debris of a universe in ruins  
— all these things, if not quite beyond dispute, are yet so  
nearly certain that no philosophy which rejects them can  
hope to stand. Only within the scaffolding of these truths,  
only on the firm foundation of unyielding despair, can the  
soul's habitation henceforth be safely built.

*Why I Am Not a Christian: And Other Essays on Religion and Related  
Subjects* (p. 107)

Watts. London, England. 1927

**Wells, H. G. (Herbert George)** 1866–1946

English novelist, historian, and sociologist

There will be a time when the day will be as long as a  
year is now, and the cooling sun, shorn of its beams, will  
hang motionless in the heavens.

*The Outline of History* (Volume 1)

Book I, Chapter I, Section 3 (p. 15)

Garden City Books. Garden City, New York, USA. 1961

...a steady twilight brooded over the Earth.... All traces  
of the moon had vanished. The circling of the stars,  
growing slower and slower, had given place to creeping  
points of light...the sun, red and very large, halted motionless  
upon the horizon, a vast dome glowing with a dull heat....  
The rocks about me were of a harsh reddish colour, and all the  
traces of life that I could see at first was the intensely green  
vegetation...the same rich green that one sees on forest moss  
or on the lichen in caves: plants which like these grow in a  
perpetual twilight....

I cannot convey the sense of abominable desolation that hung over the world.

*The Great Ideas Today, 1971*

The Time Machine

Chapter Eleven (p. 497)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1971

**Yeats, William Butler** 1865–1939

Irish poet and playwright

When shall the stars be blown about the sky,  
Like the sparks blown out of a smithy, and die?

*The Collected Poems of W.B. Yeats*

The Secret Rose (p. 67)

The Macmillan Company. New York, New York, USA. 1956

## UNKNOWN

**Asimov, Isaac** 1920–92

American author and biochemist

If it is exciting to probe the unknown and shed light on what was dark before, then more and more excitement surely lies ahead of us.

*The Universe*

Chapter 19 (p. 294)

Walker & Company. New York, New York, USA. 1966

**Auvaiyaar** ca. 9<sup>th</sup> century

Tamil sage and poetess

What is known is a handful; the unknown is as vast as the universe.

Attributed

*The Physics Teacher*, Volume 15, Number 9, December 1977 (p. 544)

**Carlson, A. J.** 1875–1956

Swedish-American physiologist

We recognize the unknown but not the unknowable.

Science and the Supernatural

*Science*, Volume 73, Number 1887, February 27, 1931 (p. 221)

When we know that we don't know, that is itself an achievement, for then the field is cleared of the confusing and obstructing rubbish of tradition, and we are free to use all our ingenuity and imagination in contriving methods to find out.

Science and the Supernatural

*Science*, Volume 73, Number 1887, February 27, 1931 (p. 221)

**Chargaff, Erwin** 1905–2002

Austrian biochemist

I have always oscillated between the brightness of reality and the darkness of the unknowable.

*Heraclitean Fire: Sketches from a Life before Nature*

Part I

The Silence of the Heavens (p. 55)

Rockefeller University Press. New York, New York, USA. 1978

**Charles, John**

American planetary geologist

We want to research what we call the “known unknowns”... This will reduce total risk in the face of the unknown unknowns, the true surprises...

In James Olberg

Red Planet Blues

*Popular Science*, July 2003 (p. 64)

**Eddington, Sir Arthur Stanley** 1882–1944

English astronomer, physicist, and mathematician

Something unknown is doing we don't know what...

*The Nature of the Physical World*

Chapter XIII (p. 291)

The Macmillan Company. New York, New York, USA. 1930

**Farmer, Philip José** 1918–

American science fiction and fantasy writer

Some of you have asked why we should set out for a goal that lies we know not how far away or that might not even exist. I will tell you that we are setting sail because the Unknown exists and we would make it the Known. That's all!

*To Your Scattered Bodies Go*

Chapter 13 (p. 98)

Berkley Publishing Corporation. New York, New York, USA. 1971

**Hinshelwood, Sir Cyril** 1897–1967

English chemist

...as the chart of the unknown becomes filled in, judgment of the most profitable course to follow changes. Mysterious inlets may prove dead ends or may open into vast seas.

Science and Scientists

*Supplement to Nature*, Volume 207, Number 5001, 4 September 1965 (p. 1057)

**Huxley, Aldous** 1894–1963

English writer and critic

Cheerfully...let us advance together, men of letters and men of science, further and further into the ever-expanding regions of the unknown.

*Literature and Science*

Chapter 38 (p. 118)

Harper & Row, Publishers. New York, New York, USA. 1963

**Huxley, Thomas Henry** 1825–95

English biologist

The known is finite, the unknown infinite; intellectually we stand on an islet in the midst of an illimitable ocean of inexplicability. Our business in every generation is to reclaim a little more land.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Chapter XIV (p. 557)

D. Appleton & Company. New York, New York, USA. 1896

**Leiber, Jr., Fritz** 1910–92  
American writer of science fiction and horror

Science has only increased the area of the unknown. And if there is a god, her name is Mystery.  
*Our Lady of Darkness* (p. 44)  
Berkley Publishing Corp. New York, New York, USA. 1977

**Lindbergh, Charles H.** 1902–74  
American aviator

Whether outwardly or inwardly, whether in space or in time, the farther we penetrate the unknown, the vaster and more marvelous it becomes.  
*Autobiography of Values*  
Chapter Fifteen (p. 402)  
Harcourt Brace Jovanovich. New York, New York, USA. 1967

**Locke, John** 1632–1704  
English philosopher and political theorist

For the understanding, like the eye, judging of objects only by its own sight, cannot but be pleased with what it discovers, having less regret for what has escaped it, because it is unknown.  
In *Great Books of the Western World* (Volume 35)  
*Concerning Human Understanding*  
Epistle to the Reader (p. 87)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Melville, Herman** 1819–91  
American novelist

...I am tormented with an everlasting itch for things remote. I love to sail the forbidden seas...  
In *Great Books of the Western World* (Volume 48)  
*Moby Dick*  
Chapter 1 (p. 4)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Mencken, H. L. (Henry Louis)** 1880–1956  
American journalist and literary critic

Penetrating so many secrets, we cease to believe in the unknowable. But there it sits nevertheless, calmly licking its chops.  
*Minority Report: H.L. Mencken's Notebooks*  
No. 364 (p. 241)  
Alfred A. Knopf. New York, New York, USA. 1956

**Nicholson, Norman** 1914–87  
English poet

No man has seen it; nor the lensed eye  
That pin-points week by week the same patch of sky  
Records even a blur across its pupil. Only  
The errantry of Saturn, the wry  
Retarding of Uranus, speak  
Of the pull beyond the pattern:  
The unknown is shown  
Only by a bend in the known.  
In Neil Curry (ed.)

*Norman Nicholson Collected Works*  
The Undiscovered Planet (p. 211)  
Faber & Faber Ltd. London, England. 1994

**Nietzsche, Friedrich** 1844–1900  
German philosopher

To trace something unknown back to something known is alleviating, soothing, gratifying and gives moreover a feeling of power, Danger, disquiet, anxiety attend the unknown — the first instinct is to eliminate these distressing states. First principle: any explanation is better than none....  
In Alexander Tille (ed.), Thomas Common (trans.)  
*The Works of Friedrich Nietzsche*, Volume 11  
Twilight of the Idols, The Four Great Errors, Section 5 (p. 138)  
Henry & Company. London, England. 1896

**Oppenheimer, J. Robert** 1904–67  
American theoretical physicist

The problem of doing justice to the implicit, the imponderable and the unknown is always with us in science, it is with us in the most trivial of personal affairs, and it is one of the great problems of all forms of art.  
In Lincoln Barnett  
*Writing on Life: Sixteen Close-Ups*  
Physicist Oppenheimer (p. 358)  
William Sloane Associates, Publishers. New York, New York, USA. 1951

**Pinter, Harold** 1930–  
English absurdist playwright

In other words, apart from the known and the unknown, what else is there?  
*The Homecoming*  
Act Two (p. 52)  
Methuen & Company Ltd. London, England. 1966

**Rabi, Isidor Isaac** 1898–1988  
Austrian-born American physicist

With the beginning of direct exploration of the solar system and promise; in fact science derives its sustenance from the unknown; all the good things have come from that inexhaustible realm.  
Faith in Science  
*The Atlantic Monthly*, Volume 187, Number 1, January 1951 (p. 28)

**Rumsfeld, Donald** 1932–  
American businessman, politician, and secretary of state

As we know, There are known knowns. There are things we know we know. We also know there are known unknowns. That is to say we know there are some things We do not know. But there are also unknown unknowns, The ones we don't know we don't know.  
Department of Defense News Briefing  
February 12, 2002

**Service, Robert William** 1874–1958  
Canadian poet and novelist

Let us probe the silent places,  
let us seek what luck betides us;  
Let us journey to a lonely land I know.  
There's a whisper on the night-wind,  
there's a star a gleam to guide us,  
And the Wild is calling, calling...let us go.

*The Complete Poems of Robert Frost*

The Call of the Wild

Stanza 5

Dodd, Mead & Company, New York, New York, USA. 1940

**Singer, June** 1920–2004  
American Gnostic

As knowledge proceeds with spiraling movement to penetrate the vast universe of black mystery, one is continually astonished to discover that at the outer limit of awareness where science interfaces with the unknown, there is nothing but a growing edge, where knowledge and ignorance meet. The more one learns, the more one discovers the increasing magnitude of the unknown, as anyone who has tried to do "exhaustive" research knows very well!

*Androgyne: Toward a New Theory of Sexuality* (p. 59)

Doubleday & Company, Inc. Garden City, New York, USA. 1967

**Vernon, A. G.**

No biographical data available

It is the successful, or even the unsuccessful, pursuit of truth which gives happiness to each generation of scientific men, and not the value of the truth itself — the energy, the doing, not the thing done. If a time could arrive when all was known, when there could not be a new investigation or experiment, our keenest pleasure would be at an end. We may therefore feel happy in the thought of how much is still unknown.

In Sir Richard Arman Gregory

*Discovery; or, The Spirit and Service of Science*

Chapter II (p. 28)

Macmillan & Company Ltd. London, England. 1918

**Whitney, Willis Rodney** 1868–1958  
American chemical and electrical engineer

Scientists know that research merely discloses parts of the infinite unknown. Paradoxically, the enticing, helpful "unknown" increases as men continue to subtract from it. Progress in every line of experimental science follows the same law. The apparently narrow path gradually expands into unlimited, unexplored territory.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1924*

The Vacuum — There's Something in It (p. 194)

Government Printing Office. Washington, D.C. 1925

## UREA

**Wöhler, Friedrich** 1800–82  
German chemist

The fact that in the union of these substances they appear to change their nature, and give rise to a new body, drew my attention anew to the subject, and research gave the unexpected result that by the combination of cyanic acid with ammonia, urea is formed, a fact that is more noteworthy inasmuch as it furnishes an example of the artificial production of an organic, indeed a so-called animal substance, from inorganic material.

In Henry M. Leicester and Herbert S. Klickstein

*A Source Book in Chemistry: 1400–1900*

Friedrich Wöhler (p. 310)

McGraw-Hill Book Company, Inc. New York, New York, USA. 1952

## URIC ACID

**Wöhler, Friedrich** 1800–82  
German chemist

No other substance in organic chemistry attracts the attention of the physiologist and chemist to a higher degree than uric acid.

In Rolf Huisgen

Adolf von Baeyer's Scientific Achievements — A Legacy

*Angewandte Chemie International Edition in English*, Volume 25, Number 4, April 1986 (p. 302)

## URINANALYSIS

**Addis, Thomas** 1881–1949  
English-American physician

When the patient dies the kidneys may go to the pathologist, but while he lives the urine is ours. It can provide us day by day, month by month, and year by year, with a serial story of the major events going on within the kidney.

*Glomerular Nephritis: Diagnosis and Treatment* (p. 2)

The Macmillan Company. New York, New York, USA. 1948

**Harrington, John** 1561–1612  
English inventor of flush toilet

He called for his urinal and having made water in it, he cast it, & viewed it (as Physicians do) a prettie while; at last he swore soberly, he saw nothing in that man's water, but that he might live.

*The Metamorphosis of Aiax: A New Discourse of a Stale Subject*  
1596

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

FALSTAFF: What says the Doctor to my water?

PAGE: He said, Sir, the water itself was good healthy water; but, for the party that owned it, he might have more diseases than he knows for.

In *Great Books of the Western World* (Volume 26)

*The Plays and Sonnets of William Shakespeare* (Volume 1)

The Second Part of Kink Henry the Fourth

Act I, Scene ii, l. 1–4

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## V

### VACCINATION

**Jeffers, Robinson** 1887–1962  
American poet

They take horses  
And give them sicknesses through hollow needles, their  
blood saves babies: I am here on the mountain making  
Antitoxin for all the happy towns and farms...

In Tim Hunt (ed.)  
*The Collected Poetry of Robinson Jeffers* (Volume 1)  
A Redeemer (p. 407)  
Stanford University Press. Stanford, California, USA. 1988

### VACUUM

**Bacon, Roger** 1214–92  
English philosopher, scientist, and friar

For vacuum rightly conceived of is merely a mathematical  
quantity extended in the three dimensions, existing per se  
without heat and cold, soft and hard, rare and dense, and  
without any natural quality, merely occupying space, as  
the philosophers maintained before Aristotle, not only  
within the heavens, but beyond.

*Opus Majus* (Volume 2)  
Part Five, Ninth Distinction, Chapter II (p. 485)

**Huygens, Christiaan** 1629–95  
Dutch mathematician, astronomer, and physicist

...but what God has bin pleas'd to place beyond the  
Region of the Stars, is as much above our Knowledge, as  
it is our Habitation.

Or what if beyond such a determinate space he has left  
an infinite Vacuum; to show, how inconsiderable is all  
that he has made is, to what his Power could, had he so  
pleas'd, have produc'd?

*The Celestial Worlds Discover'd; or, Conjectures Concerning the Plan-  
etary Worlds, Their Inhabitants and Productions*  
Book the Second (p. 156)  
Printed for T. Childe. London, England. 1698

**Marquis, Don** 1878–1937  
American newspaperman, poet, and playwright

he i said is afraid of a vacuum  
what is there in a vacuum to make one afraid said the  
flea there is nothing in it i said  
and that is what makes one afraid to contemplate it  
a person can t think of a place with nothing at all in it  
without going nutty  
and if he tries to think that nothing is something after all  
he gets nuttier

*the lives and times of archy & mehitabel*

the merry flea (p. 45)  
Doubleday, Doran & Company, Inc. Garden City, New York, USA. 1933

**Morris, Richard** 1939–2003  
American physicist and science writer

In modern physics, there is no such thing as “nothing.”  
Even in a perfect vacuum, pairs of virtual particles are  
constantly being created and destroyed. The existence of  
these particles is no mathematical fiction. Though they  
cannot be directly observed, the effects they create are  
quite real. The assumption that they exist leads to predic-  
tions that have been confirmed by experiment to a high  
degree of accuracy.

*The Edges of Science*  
Chapter II (p. 25)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1955

**Pagels, Heinz R.** 1939–88  
American physicist and science writer

Once our minds accept the mutability of matter and the  
new idea of the vacuum, we can speculate on the origin  
of the biggest thing we know — the universe. Maybe the  
universe itself sprang into existence out of nothingness  
— a gigantic vacuum fluctuation which we know today  
as the big bang. Remarkably, the laws of modern physics  
allow for this possibility.

*The Cosmic Code: Quantum Physics as the Language of Nature*  
Part II, Chapter 8 (p. 278)  
Simon & Schuster. New York, New York, USA. 1982

**Pascal, Blaise** 1623–62  
French mathematician and physicist

Because...you have believed from childhood that a box  
was empty when you saw nothing in it, you have believed  
in the possibility of a vacuum.

In *Great Books of the Western World* (Volume 33)  
*Pensées*  
Section II, 82  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Whitehead, Alfred North** 1861–1947  
English mathematician and philosopher

You cannot have first space and then things to put into  
it, any more than you can have first a grin and then a  
Cheshire cat to fit on to it.

In Sir Arthur Stanley Eddington  
*New Pathways in Science*  
Chapter II, Section VI (p. 48)  
The Macmillan Company. New York, New York, USA. 1935

**Williams, Tennessee** 1911–83  
American playwright

...a vacuum is a hell of a lot better than some of the stuff  
that nature replaces it with.

*Cat on a Hot Tin Roof*

Act 2

A New Directions Book. New York, New York, USA. 1975

**VALUE****Bronowski, Jacob** 1908–74

Polish-born British mathematician and polymath

The values by which we are to survive are not rules for just and unjust conduct, but are those illuminations in whose light justice and injustice, good and evil, means and ends are seen in fearful sharpness of outline.

*Science and Human Values*

The Sense of Human Dignity (p. 73)

Harper &amp; Row, Publishers. New York, New York, USA. 1965

**Poincaré, Henri** 1854–1912

French mathematician and theoretical astronomer

If a new result has value it is when, by binding together long-known elements, until now scattered and appearing unrelated to each other, it suddenly brings order where there reigned apparent disorder.

*Annual Report of the Board of Regents of the Smithsonian Institution, 1909*

The Future of Mathematics (p. 126)

Government Printing Office. Washington, D.C. 1910

**VARIANCE****Boring, Edwin Garrigues** 1886–1968

American psychologist

McDougall's freedom was my variance. McDougall hoped that variance would always be found in specifying the laws of behavior, for there freedom might still persist. I hoped then — less wise than I think I am now (it was 31 years ago) — that science would keep pressing variance towards zero as a limit. At any rate this general fact emerges from this example: freedom, when you believe it is operating, always resides in an area of ignorance. If there is a known law, you do not have freedom.

When Is Human Behavior Predetermined

*The Scientific Monthly*, Volume 84, 1957 (p. 190)**Cooley, Charles Horton** 1864–1929

American sociologist

It is clear that one who attempts to study precisely things that are changing must have a great deal to do with measures of change.

Observations on the Measure of Change

*Journal of the American Statistical Association*, New Series, Number 21, March 1893**Crichton, Michael** 1942–

American novelist

The computer informed her that three spaces accounted for eighty-one percent of variance.

*The Terminal Man*

Chapter 6 (p. 47)

Alfred A. Knopf. New York, New York, USA. 1972

**VARIATION****Darwin, Charles Robert** 1809–82

English naturalist

...individuals of the same species often present, as is known to every one, great differences of structure, independently of variation, as in the two sexes of various animals, in the two or three castes of sterile females or workers amongst insects, and in the immature and larval states of many of the lower animals.

*In Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection*

Chapter II (p. 25)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

Many laws regulate variation, some few of which can be dimly seen.... I will here only allude to what may be called correlated variation. Important changes in the embryo or larva will probably entail changes in the mature animal.... Breeders believe that long limbs are almost always accompanied by an elongated head...cats which are entirely white and have blue eyes are generally deaf.... [I]t appears that white sheep and pigs are injured by certain plants whilst dark-colored individuals escape....

*In Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection*

Chapter I (p. 11)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

But at present, after drawing up a rough copy on this subject, my conclusion is that external conditions do extremely little, except in causing mere variability. This mere variability (causing the child not closely to resemble the parent) I look at as very different from the formation of a marked variety or new species.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)C. Darwin to J.D. Hooker, November 23<sup>rd</sup> [1856] (p. 445)

D. Appleton &amp; Company. New York, New York, USA. 1896

...the number of intermediate varieties, which must have formerly existed, [must] be truly enormous. Why then is not every geological formation and every stratum full of such intermediate links? Geology assuredly does not reveal any such finely graduated organic chain; and this, perhaps, is the most obvious and gravest objection which can be urged against the theory.

*In Great Books of the Western World* (Volume 49)*The Origin of Species by Means of Natural Selection*

Chapter X (p. 152)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Fieller, E. C.**

American statistician



Before the inherent variability of the test-animals was appreciated, assays were sometimes carried out on as few as three rabbits: as one pharmacologist put it, those were the happy days.

The Biological Standardization of Insulin

*Supplement to the Journal of the Royal Statistical Society*, Volume 7, Number 1, 1940–41 (p. 3)

**Harvey, William** 1578–1657

English physician

...to me the form of the egg has never appeared to have aught to do with the engenderment of the chick, but to be a mere accident; and to this conclusion I come the rather when I see the diversities in the shapes of the eggs of different hens.

In *Great Books of the Western World* (Volume 28)

*Anatomical Exercises on the Generation of Animals*

Exercise 59 (p. 462)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Hume, David** 1711–76

Scottish philosopher and historian

Nothing so like as eggs; yet no one, on account of this appearing similarity, expects the same taste and relish in all of them.

In *Great Books of the Western World* (Volume 35)

*An Enquiry Concerning Human Understanding*

Section IV, Part II (p. 462)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Huxley, Thomas Henry** 1825–95

English biologist

The student of anatomy is perfectly well aware that there is not a single organ of the human body the structure of which does not vary, to a greater or less extent, in different individuals.

*Man's Place in Nature and Other Anthropological Essays*

Chapter III (p. 185)

D. Appleton & Company. New York, New York, USA. 1896

**Leibniz, Gottfried Wilhelm** 1646–1716

German philosopher and mathematician

...there are never in nature two beings which are exactly alike...

*Philosophical Papers and Letters* (Volume 2)

Monadology, 9 (p. 1044)

The University of Chicago Press. Chicago, Illinois, USA. 1956

**Pallister, William Hales** 1877–1946

Canadian physician

What shall we say of a plot of ground  
Planted in similar seed,  
Where thousands of similar plants are found  
But one is a new type indeed;  
When dissimilar comes from similar,  
And freedom has its hour,

When the scion is not as ancestors are,  
What is this latent power?

*Poems of Science*

De Ipsa Natura, Variation (p. 213)

Playford Press. New York, New York, USA. 1931

**Peirce, Charles Sanders** 1839–1914

American scientist, logician, and philosopher

The endless variety in the world has not been created by law. It is not the nature of uniformity to originate variation, nor of law to beget circumstance.

*Collected Papers* (Volume 6)

Chapter 6, Section 2 (p. 373)

Harvard University Press. Cambridge, Massachusetts, USA. 1960

**Tippett, L. C.**

English statistician

Variation is, of course, an important characteristic of populations that individuals cannot have.... A thousand exactly similar steel bearing balls (if such were possible) would be no more than one ball multiplied one thousand times. It is the quality of variation that makes it difficult at first to carry in mind a population in its complexity.

*The World of Mathematics* (Volume 3)

Sampling and Standard Error (p. 1480)

Simon & Schuster. New York, New York, USA. 1956

**Waddington, Conrad Hal** 1905–75

British biologist and paleontologist

To suppose that the evolution of the wonderfully adapted biological mechanisms has depended only on a selection out of a haphazard set of variations, each produced by blind chance, is like suggesting that if we went on throwing bricks together into heaps, we should eventually be able to choose ourselves the most desirable house.

*The Listener*, 13 February 1952

**Wheeler, William Morton** 1865–1937

American entomologist

Since no two events are identical, every atom, molecule, organism, personality, and society is an emergent and, at least to some extent, a novelty.

Emergent Evolution of the Social

*Proceedings of the Sixth International Congress of Philosophers*,

Cambridge, Massachusetts, USA, 1926.

**Ricklefs, R.**

No biographical data available

Variation in the environment is a fact of life for all plants and animals, except perhaps for inhabitants of the abyssal depths of the sea.

*Ecology* (2<sup>nd</sup> edition) (p. 159)

Chiron Press. New York, New York, USA

American humorist and critic

**VARIETY**

**Cowper, William** 1731–1800  
English poet

Variety's the very spice of life,  
That gives it all its flavor.

*The Poetical Works of William Cowper*

The Task, Book II (The Timepiece), l. 606

John W. Lovell Company. New York, New York, USA. No date

**Feyerabend, Paul K.** 1924–94

Austrian-born American philosopher of science

Unanimity of opinion may be fitting for a church, for the frightened or greedy victims of some (ancient, or modern) myth, or for the weak and willing followers of some tyrant. Variety of opinion is necessary for objective knowledge. And a method that encourages variety is also the only method that is comparable with a humanitarian outlook.

*Against Method: Outline of an Anarchistic Theory of Knowledge*

Chapter 3 (p. 46)

Verso. London, England. 1978

**VECTOR**

**Kelvin, Lord William Thomson** 1824–1907

Scottish engineer, mathematician, and physicist

Quaternions came from Hamilton...and have been an un-mixed evil to those who have touched them in any way. Vector is a useless survival...and has never been of the slightest use to any creature.

In Jerrold E. Marsden and Anthony J. Tromba

*Vector Calculus*

Chapter 1 (p. 1)

W.H. Freeman & Company. New York, New York, USA. 2003

**Warren, Robert Penn** 1905–89

American writer and critic

What if angry vectors veer  
Round your sleeping head, and form.

There's never need to fear

Violence of the poor world's abstract storm.

*Poems*

Lullaby: Smile in Sleep

Louisiana State University Press. Baton Rouge, Louisiana, USA. 1998

**VECTOR ANALYSIS**

**Gibbs, J. Willard** 1839–1903

American mathematician

If I wished to attract the student of any of these sciences to an algebra for vectors, I should tell him that the fundamental notions of this algebra were exactly those with which he was daily conversant.... In fact, I should tell him that the notions which we use in vector analysis are

those which he who reads between the lines will meet on every page of the great masters of analysis, or of those who have probed the deepest secrets of nature.

Quaternions and the Algebra of Vectors

*Nature*, Volume 47, Number 1220, 16 March, 1893 (p. 464)

The numerical description of a vector requires three numbers, but nothing prevents us from using a single number for its symbolical designation. An algebra or analytical method in which a single letter or other expression is used to specify a vector may be called a vector algebra or vector analysis.

*Elements of Vector Analysis Arranged for the Use of Students in Physics*, 1881

**VEGETARIAN**

**Hutchison, Sir Robert Grieve** 1871–1960

English radiologist

Don't scrape your insides with much roughage as it is more likely to do harm than good. Vegetarianism is harmless enough though it is apt to fill a man with wind and self-righteousness.

Address

British Medical Association, Winnipeg, Canada, 1930

**VEGETATION**

**Carson, Rachel** 1907–64

American marine biologist and author

The earth's vegetation is a part of the web of life in which there are intimate and essential relations between plants and the earth, between plants and other plants, between plants and animals, and we must learn to respect that fine and fragile web if there is to be anything left for the next generation.

*Silent Spring*

Chapter 6 (p. 64)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1961

**White, Gilbert** 1720–93

English naturalist and cleric

Vegetation is highly worthy of our attention; and in itself is of the utmost consequence to mankind, and productive of many of the greatest comforts and elegancies of life.

*The Natural History of Selborne*

Letter XL (p. 192)

Robert M. McBride & Company. New York, New York, USA. 1925

**VENUS, TRANSIT OF**

**Harkness, William** 1837–1903

Scottish-American astronomer and surgeon

We are now on the eve of the second transit of a pair [of two transits of Venus as it passes directly between the

Earth and the Sun], after which there will be no other till the twenty-first century of our era has dawned upon the earth, and the June flowers are blooming in 2004. When the last transit season occurred the intellectual world was awakening from the slumber of ages, and that wondrous scientific activity which has led to our present advanced knowledge was just beginning. What will be the state of science when the next transit season arrives God only knows. Not even our children's children will live to take part in the astronomy of that day. As for ourselves, we have to do with the present...

Address by William Harkness

*Proceedings of the AAAS 31<sup>st</sup> Meeting* (Salem, 1883), August, 1882 (p. 77)

**Proctor, Richard A.** 1837–88

English astronomer

I think the astronomers of the first years of the twenty first century, looking back over the long transit-less period which will then have passed, will understand the anxiety of astronomers in our own time to utilize to the full whatever opportunities the coming transits may afford...; and I venture to hope...they will not be disposed to judge over harshly what some in our own day may have regarded as an excess of zeal.

*Transits of Venus, a Popular Account* (p. 231)

Longmans, Green & Company. London, England. 1882

American humorist and critic

## VERNAL EQUINOX

**Cuppy, Will** 1884–1929

American humorist and critic

Among things you might be thinking about today is the vernal equinox — it's March 21, you know. The vernal equinox is the point at which the sun apparently crosses the celestial equator toward the north, or you can say it is the moment at which this occurs, or you can simply say: "Hooray! Spring is here!" Exactly why the sun does this on March 21 is a long story.

*How to Get from January to December*

March 21 (p. 61)

Holt. New York, New York, USA. 1951

## VERNIER

**Langley, Samuel Pierpoint** 1834–1906

American astronomer and aviation pioneer

That little Vernier, on whose slender lines  
The midnight taper trembles as it shines,  
Tells through the mist where dazzled Mercury burns,  
And marks the point where Uranus returns.

*The New Astronomy*

Chapter I (p. 3)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1889

## VERTEBRATE

**Lamarck, Jean-Baptiste Pierre Antoine** 1744–1829

French biologist

...if the vertebrates differ markedly from one another in their organisation, it is because nature only started to carry out her plan in their respect with the fishes; that she made further advances with the reptiles; that she carried it still nearer perfection with the birds, and that finally she only attained the end with the most perfect mammals.

Translated by Hugh Elliot

*Zoological Philosophy: An Exposition with Regard to the Natural History of Animals*

Chapter VI (p. 81)

The University of Chicago Press. Chicago, Illinois, USA. 1984

## VIBRATION

**Tuttle, Hudson** 1836–1910

American spiritualist

There is no breath of air so gentle, no wave breaking on the sands, but the vibrations of these movements run through all space.

In Ludwig Buchner

*Force and Matter*

Chapter III (p. 16)

Trubner & Company. London, England. 1864

## VIEW

**Dewey, John** 1859–1952

American philosopher and educator

It is not truly realistic or scientific to take short views, to sacrifice the future to immediate pressure, to ignore facts and forces that are disagreeable and to magnify the enduring quality of whatever falls in with immediate desire. It is false that the evils of the situation arise from absence of ideals; they spring from wrong ideals.

*Reconstruction in Philosophy*

Chapter V (p. 130)

Beacon Press. Boston, Massachusetts, USA. 1920

## VIRUS

**Cudmore, Lorraine Lee**

American cell biologist

All living things need their instruction manual (even nonliving things like viruses) and that is all they need, carried in one very small suitcase.

*The Center of Life: A Natural History of the Cell*

The Universal Cell (p. 8)

New York Times Book Company. New York, New York, USA. 1977

**Newman, Michael**

No biographical data available

Observe this virus: think how small  
 Its arsenal, and yet how loud its call;  
 It took my cell, now takes your cell,  
 And when it leaves will take our genes as well.

*The Sciences*

Cloned Poem, 1982

**Thomas, Lewis** 1913–93

American physician and biologist

We live in a dancing matrix of viruses; they dart, rather like bees, from organism to organism, from plant to insect to mammal to me and back again, and into the sea, tugging along pieces of this genome, strings of genes from that, transplanting grafts of DNA, passing around heredity as though at a great party. They may be a mechanism for keeping new, mutant kinds of DNA in the widest circulation among us. If this is true, the odd virus disease on which we must focus so much of our attention in medicine, may be looked on as an accident, something dropped.

*The Lives of a Cell: Notes of a Biology Watcher*

The Lives of a Cell (p. 5)

The Viking Press. New York, New York, USA. 1974

## VITALITY

**Burroughs, John** 1837–1921

American naturalist and writer

Biological science has hunted the secret of vitality like a detective, and it has done some famous work; but it has not yet unraveled the mystery.

*The Breath of Life*

Chapter IV (p. 76)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1915

## VITAMIN

**Drummond, Jack Cecil** 1891–1952

English biochemist

The suggestion is now advanced that the final “-e” [of Funk’s “vitamine”] be dropped, so that the resulting word Vitamin is acceptable under the standard scheme of nomenclature adopted by the Chemical Society.... It is recommended that the somewhat cumbersome nomenclature introduced by McCollum (Fat-soluble A, Water-soluble B), be dropped, and that the substances be spoken of as Vitamin A, B, C, etc.

The Nomenclature of the So-Called Accessory Food Factors (Vitamins)

*Biochemical Journal*, Volume 14, 1920

## VOID

**Blake, William** 1757–1827

English poet, painter, and engraver

For the Chaotic Voids outside of the Stars are measured  
 by The Stars...

*The Complete Poetry and Prose of William Blake*

*Milton*

Book the Second

University of California Press. Berkeley, California, USA. 1982

**Pagels, Heinz R.** 1939–88

American physicist and science writer

The nothingness “before” the creation of the universe is the most complete void that we can imagine — no space, time, or matter existed. It is a world without place, without duration or eternity, without number — it is what mathematicians call “the empty set.” Yet this unthinkable void converts itself into the plenum of existence — a necessary consequence of physical laws. Where are these laws written into that void? What “tells” the void that is pregnant with a possible universe? It would seem that even the void is subject to law, a logic that exists prior to space and time.

*Perfect Symmetry: The Search for the Beginning of Time*

Part Three, Chapter 5 (p. 347)

Simon & Schuster. New York, New York, USA. 1985

**Thomson, James** 1700–48

Scottish poet

With what an awful, world-revolving power,  
 Were first the unwieldy planets launched along  
 The illimitable void! There  
 to remain

Amidst the flux of many  
 thousand years,

That oft has swept the toiling race of men,  
 And all their labored monuments, away.

In Eli Maor

*To Infinity and Beyond: A Cultural History of the Infinite* (p. 206)

Birkhäuser. Boston, Massachusetts, USA. 1987

## VOLATILITY

**Bowen, Norman L.** 1887–1956

Canadian geologist

To many petrologists a volatile component is exactly like a Maxwell demon; it does just what one may wish it to do.

*The Evolution of the Igneous Rocks*

Chapter XVI (p. 282)

Dover Publication, Inc., New York, New York, USA. 1956

## VOLCANO

**Anderson, Tempest** 1846–1913

British ophthalmic surgeon

Very few branches of science still remain available for the amateur of limited leisure. Electricity, Chemistry,

Bacteriology, most branches of Geology and Mineralogy, have all led to results of highest economic value, and they are cultivated by a large body of professional men subsidized by Colleges or by the Government. They are in a position to give their whole time to their work, and their results are so voluminous that to keep abreast of the literature of any single branch would occupy more than the entire leisure of most men, yet this is a necessary preliminary to any attempt at original work. I was consequently led to seek some branch of Science which gave no prospect of pecuniary return, and I determined on Vulcanology, which had the additional advantage of offering exercise in the open air, and in districts often remote and picturesque.

*Volcanic Studies in Many Lands*

Preface (p. ix)

John Murray. London, England. 1917

**Anyidoho, Kofi** 1947–

Ghanaian poet

Our Earth survives recurring furies  
of her stomach pains and quakes  
From the bleeding anger of her wounds  
volcanic ash becomes the hope  
that gives rebirth to abundance of seedtimes.

*Earthchild, with Brain Surgery: Poems*

The Homing Call of Earth

Woeli Publishing Services. 1985

### Author undetermined

Among the many wonderful works of God, none exhibits so much of awful grandeur as an active volcano.

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Preface

T. Nelson. London, England. 1890

For the clouds that overhang an active volcano during an eruption of its vapours are, in reality, thunderclouds highly charged with electricity. They accordingly produce what Baron Humboldt calls the volcanic storm. It includes all the most terrible of atmospheric phenomena — lightnings of extraordinary vividness; thunders that peal and reverberate as if they would rend the echoes asunder; torrents of rain that pour down upon the mountain and its neighborhood, hissing like thousands of serpents when they fall on the glowing lava-torrent; and whirlwinds that sweep the volcanic ashes round and round in vast eddies, and before whose violence no man of mortal mould is able for a moment to stand.

*Wonders of Creation: A Descriptive Account of Volcanoes and Their Phenomena*

Chapter I

T. Nelson. London, England. 1890

A volcano is a mountain that is busted and squirts out stuff.

In C. Judson Herrick

*The Evolution of Human Nature*

Chapter Five (p. 57)

University of Texas Press. Austin, Texas, USA. 1956

**Bradley, Jr., John Hodgdon** 1898–1962

American geologist

Volcanoes are personalities that resist classification.

*Autobiography of Earth*

Chapter VII (p. 211)

Coward-McCann, Inc. New York, New York, USA. 1935

**Burnet, Thomas** 1635–1715

English cleric and scientist

There is nothing certainly more terrible in all Nature than Fiery Mountains, to those that live within the view or noise of them; but it is not easier for us, who never see them nor heard them, to represent to our selves with such just and lively imaginations as shall excite us in the same passions, and the same horror as they would excite, if present to our senses.

*The Sacred Theory of the Earth* (2<sup>nd</sup> edition)

Book III, Chapter VII (p. 272)

Printed by R. Norton. London. 1691

**Cassius Dio** 150–235

Roman senator and historian

Thus day was turned into night and light into darkness. Some thought that the Giants were rising again in revolt (for at this time also many of their forms could be discerned in the smoke and, moreover, a sound as of trumpets was heard), while others believed that the whole universe was being resolved into chaos or fire.

*Dio's Roman History*

Epitome of Book LXVI (p. 211)

Heinemann. London, England. 1914–27

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

This day, as I fly, the lava world is calm. There is something surprising in the tranquility of this deserted landscape where once a thousand volcanoes boomed to each other in their great subterranean organs and spat forth their fire. I fly over a world mute and abandoned, strewn with black glaciers.

*Wind, Sand and Stars*

Chapter 5, Section I (pp. 99–100)

Reynal & Hitchcock. New York, New York, USA. 1939

He carefully cleaned out his active volcanoes. He possessed two active volcanoes; and they were very convenient for heating his breakfast in the morning. He also had one volcano that was extinct. But, as he said, “One never knows!” So he cleaned out the extinct volcano, too. If they are well cleaned out, volcanoes burn slowly and steadily, without any eruptions. Volcanic eruptions are like fires in a chimney.

Translated by Katherine Woods

*The Little Prince*

Chapter IX (p. 32)

Harcourt, Brace & Company. New York, New York, USA. 1943

**Decker, Robert** 1927–2005

American volcanologist

**Decker, Barbara**

American science writer

Volcanoes are nature's forges and stills where the elements of the Earth, both rare and common, are moved and sorted.

*Volcanoes* (3<sup>rd</sup> edition)

Chapter 13 (p. 168)

W.H. Freeman & Company. San Francisco, California, USA. 1981

Volcanoes assail the senses. They are beautiful in repose and awesome in eruption; they hiss and roar, they smell of brimstone. Their heat warms, their fires consume; they are the homes of gods and goddesses.

Volcanoes are described in words and pictures, but they must be experienced to be known. Their roots reach deep inside the Earth; their products are scattered in the sky. Understanding volcanoes is an unconquered challenge.

*Volcanoes* (3<sup>rd</sup> edition)

Preface (p. vii)

W.H. Freeman & Company. San Francisco, California, USA. 1981

**Francis, Peter** 1944–99

English volcanologist

If mountains can have personalities, then volcanoes are schizophrenic — they have split personalities. For most of their life, they are dormant, and one tends to think of them as graceful unsweeping cones, delicately capped with snow, dreaming serenely over the cherry-blossom-draped landscapes of calendars and travel posters. Sometimes, perhaps not very often during their lifetimes, volcanoes erupt and present a wholly different character. Convolute eruption clouds tower above them, raining hot ashes on the helpless humans who live on their flanks, and glowing tongues of liquid rock ooze inexorably downwards, engulfing the flimsy structures which stand in their way.

*Volcanoes: A Planetary Perspective*

Chapter 1 (p. 13)

Penguin Books Ltd. Middlesex, England. 1976

**Guterson, David** 1956–

American writer

“Everything up here is crumbling,” he said. “Erosion city or something.”

Basalt lava,” Christine said.

“Old volcanoes.”

“Very old volcanoes.”

“Like fifty million years.”

“Even older.”

*East of the Mountains*

Chapter Two (pp. 37–38)

Harcourt Brace & Company. New York, New York, USA. 1999

**Hutton, James** 1726–97

Scottish geologist, chemist, and naturalist

A volcano is not made on purpose to frighten superstitious people into fits of piety and devotion, nor to overwhelm devoted cities with destruction; a volcano should be considered as a spiracle to the subterranean furnace, in order to prevent the unnecessary elevation of land and fatal effects of earthquakes.

*The Theory of the Earth* (Volume 1)

Part I, Section III (p. 146)

Messrs. Cadwell, Junior & Davies. London, England. 1795

**Krafft, Katia** 1942–91

French volcanologist and photographer

I would always like to be near craters, drunk with fire, gas, my face burned by the heat... It's not that I flirt with my death, but at this point I don't care about it, because there is the pleasure of approaching the beast and not knowing if he is going to catch you.

In Stanley Williams and Fen Montaigne

*Surviving Galeras*

Chapter 6 (p. 101)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2001

**Lowry, Malcolm** 1909–57

English novelist

...it was in eruption, yet no, it wasn't the volcano, the world itself was bursting, bursting into black spouts of villages catapulted into space with himself falling through it all, through the blazing of ten million bodies, falling...

*Under the Volcano*

Chapter XII (p. 375)

Penguin Books, USA. New York, New York, USA. 1971

**McBirney, Alexander R.** 1924–

American geologist and founder of Center for Volcanology

The progress that volcanology has made since ancient scholars explained the lavas of Vesuvius and Etna as products of combustion and subterranean storms is more apparent than real. The sad fact is that we desperately need a coherent and demonstrable theory on volcanism. Why do volcanoes erupt? The only honest answer is that we do not have the vaguest idea.

In Katia Krafft

*Volcanoes: Earths Awakening* (p. 4)

Hamond World Atlas Corporation. 1916

**Michener, James A.** 1907?–97

American novelist

For nearly forty million years the first island struggled in the bosom of the sea, endeavoring to be born as

observable land. For nearly forty million submerged years its subterranean volcano hissed and...spewed forth rock, but it remained nevertheless hidden beneath the dark waters of the restless sea...a small climbing pretentious thing of no consequence.

*Hawaii*

Chapter I (p. 5)

Random House, Inc. New York, New York, USA. 1959

**Miller, Hugh** 1802–56

Scottish geologist and theologian

The billows fall back in boiling eddies; the solid strata are upheaved into a flat dome, crusted with corals and shells; it cracks, it severs, a dark gulf yawns suddenly in the midst; a dense strongly variegated cloud of mingled smoke and steam arises black as midnight in its central volumes, but checquered, where the boiling waves hiss at its edge, with wreaths of white....

*Sketch-Book of Popular Geology*

Lecture Third (p. 109)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

And over the roar of waves or the rush of tides we may hear the growling of a subterranean thunder, that now dies away in low deep mutterings, and no, ere some fresh earthquake-shock tern — pests the sea, bellows wildly from the abyss.

*Sketch-Book of Popular Geology*

Lecture Third (pp. 109)

William P. Nimmo & Company. Edinburgh, Scotland. 1880

**Muir, John** 1838–1914

American naturalist

Like gigantic geysers, spouting hot stone instead of hot water, they work and sleep, and we have no sure means of knowing whether they are only sleeping or dead.

*Steep Trails*

Chapter III (p. 56)

Norman S. Berg, Publisher. Dunwoody, Georgia, USA. 1970

**Ovid** 43 BCE–17 AD

Roman poet

Near Troezen, ruled by Pittheus, there is a hill, high and treeless, which once was a perfectly level plane, but now a hill; for (horrible to relate) the wild forces of the winds, shut up in dark regions underground, seeking an outlet for their flowing and striving vainly to obtain a freer space, since there was no chink in all their prison through which their breath could go, puffed out and stretched the ground, just as when one inflates a bladder with his breath, or the skin of a horned goat. That swelling in the ground remained, has still the appearance of a high hill, and has hardened as the years went by.

Translated by Frank Justus Miller

*Metamorphoses* (Volume 2)

Chapter XV (pp. 385–387)

William Heinemann. London, England. 1916

**Perry, Lilla Cabot** 1848–1933

American poet

Forgive me not! Hate me and I shall know  
Some of love's fire still burns in your breast!  
Forgiveness finds its home in hearts at rest,  
On dead volcanoes only lies the snow.

*Ode to Volcanoes and the Living Earth*

**Scrope, George Poulett** 1797–1876

English geologist and political economist

The action of a Volcano, in its simplest and most general form, may be described as the rise of earthly substances in a liquefied state and at a high temperature, from beneath the outer crust of the earth; accompanied by prodigious volumes of elastic fluids, which, appearing to be evolved from the interior of the mass, burst upwards with violent successive detonations, scattering into the air, to a considerable height, numerous fragments, still in a liquid state, of the lava, through which they tear their way, together with shattered blocks of the solid pre-existing rocks, which obstructed their expansion.

*Considerations on Volcanoes*

Chapter I (pp. 1–2)

W. Phillips & George Yarp. London, England. 1825

**Shelley, Percy Bysshe** 1792–1822

English poet

Nature's most secret steps  
He like her shadow has pursued, where'er  
The red volcano overcanopies  
Its fields of snow and pinnacles of ice  
With burning smoke.

*The Complete Poetical Works of Percy Bysshe Shelley*

Alastor

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Shindler, Tom**

Musician

Those lovely white snow peaks, those rulers of mountains,  
Who knows what secrets they keep?

But when they look like forever, just stop and remember

The Giants are only asleep.

*The Giants Are Only Asleep*

Source undetermined

**Tazieff, Haroun** 1914–98

Polish-born French volcanologist

In all ages volcanoes have frightened, fascinated and attracted man, because what they hold is at once terrifying, splendid, and mysterious.

*Craters of Fire*

Chapter XVIII (p. 209)

Hamish Hamilton. London, England. 1952

**Tennyson, Alfred (Lord)** 1809–92

English poet

Fires that shook me once, but now to silent ashes fallen away.

Cold upon the dead volcano sleeps the gleam of dying day.

*Alfred Tennyson's Poetical Works*

Locksley Hall, Sixty Years After, Stanza 21

Oxford University Press, Inc. London, England. 1953

Had the fierce ashes of some fiery Peak  
Been hurled so high they ranged round the World,  
For day by day through many a blood-red eve  
The wrathful sunset glared.

*Alfred Tennyson's Poetical Works*

St. Telemachus

Oxford University Press, Inc. London, England. 1953

### Thompson, Dick

American science journalist

Volcanoes are magnificent primordial beasts. They are geology's living dinosaurs.

*Volcano Cowboys: The Rocky Evolution of a Dangerous Science*

Introduction (p. 1)

St. Martin's Press. New York, New York, USA. 2000

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American writer and humorist

Here was a yawning pit upon whose floor the armies of Russia could camp, and have room to spare...over a mile square of it was ringed and streaked and striped with a thousand branching streams of liquid and gorgeously brilliant fire! Occasionally the molten lava flowing under the superincumbent crust broke through — split a dazzling streak, from five hundred to a thousand feet long, like a sudden flash of lightning, and then acre after acre of the cold lava parted into fragments, turned up edgewise like cakes of ice when a great river breaks up, plunged downwards, and were swallowed in the crimson cauldron.

*Roughing It* (Volume 2)

Chapter XXXIII (pp. 296, 298, 299)

Harper & Brothers Publishers. New York, New York, USA. 1899

### Virgil 70 BCE–19 BCE

Roman epic, didactic, and idyllic poet

There is an isle hard by Sicania's coast.  
That rises, and Aeolian Lipare,  
With smoking rocks precipitous, where beneath  
Thunders a cave, and Aetna's vaults, scooped out  
By Cyclopean forges; the strong strokes  
Of anvils to the ear bring echoing groans;  
Hisses the steel ore through its hollow depths,  
And from its furnaces pants fire — the home  
of Vulcan, and Vulcania the land's name.

In *Great Books of the Western World* (Volume 13)

*The Aeneid*

Book VIII, l. 416–424 (p. 270)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## VOLCANOLOGIST

### Tazieff, Haroun 1914–98

Polish-born French volcanologist

Studying dormant volcanoes is of no more profit to the volcanologist who is attempting to make forecasts than is the study of healthy people for the practicing physician.

In Stanley Williams and Fen Montaigne

*Surviving Galeras*

Chapter 6 (p. 101)

Houghton Mifflin Company. Boston, Massachusetts, USA. 2001

### Twain, Mark (Samuel Langhorne

Clemens) 1835–1910

American writer and humorist

I found the reddest-faced set of men I almost ever saw. In the strong light every countenance glowed like red-hot iron, every shoulder was suffused with crimson and shaded rearward into dingy, shapeless obscurity! The place below looked like the infernal regions and these men like half-cooked devils just come up on furlough. The smell of sulphur is strong, but not unpleasant to a sinner.

*Mark Twain's Letters from Hawaii*

Volcano House, June 3<sup>rd</sup> — Midnight (p. 294)

The University Press of Hawaii. Honolulu, Hawaii, USA. 1975

## VOLUME

### Avogadro, Amedeo 1776–1856

Italian chemist

It must then be admitted that very simple relations also exist between the volumes of gaseous substances and the numbers of simple or compound molecules which form them. The first hypothesis to present itself in this connection, and apparently even the only admissible one, is the supposition that the number of integral molecules in any gases is always the same for equal volumes, or always proportional to the volumes.

Essay on a Manner of Determining the Relative Masses of the Elementary Molecules of Bodies, and the Proportions in Which They Enter into These Compounds

*Journal de Physique de Chimie d'histoire Naturelle et des Artes,*

Volume 73, 1811

### Shenstone, W. A. 1850–1908

American science teacher and silica glass-blowing inventor

Avogadro's hypothesis affords a bridge by which we can pass from large volumes of gases, which we can handle, to the minuter molecules, which individually are invisible and intangible.

In Joseph William Mellor

*Mellor's Modern Inorganic Chemistry*

Chapter 5 (p. 73)

Longmans. London, England. 1967



## W

### WARNING

**Churchill, Winston Spencer** 1882–1965  
British prime minister, statesman, soldier, and author

The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to its close. In its place we are entering a period of consequences.

In Al Gore

*An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (pp. 101–102)

From a 1936 speech to citizens of Great Britain  
Rodale. New York, New York, USA. 2006

### WATER

**Abbey, Edward** 1927–89  
American environmentalist and nature writer

Water, water, water. ... There is no shortage of water in the desert but [in] exactly the right amount, a perfect ratio of water to rock, of water to sand, insuring that wide, free, open, generous spacing among plants and animals, homes and towns and cities, which makes the arid West so different from any other part of the nation. There is no lack of water here, unless you try to establish a city where no city should be.

*Desert Solitaire*

Water (pp. 144–145)

Ballantine Books. New York, New York, USA. 1968

**Bangs, Richard** 1950–  
Adventure writer

...of all our planet's activities — geological movements, the reproduction and decay of biota, and even the disruptive propensities of certain species (elephants and humans come to mind) — no force is greater than the hydrologic cycle.

*Rivergods: Exploring the World's Great Wild Rivers*

Introduction (p. xiii)

Sierra Club Books. San Francisco, California, USA. 1958

**Bradley, Jr., John Hodgdon** 1898–1962  
American geologist

The history of the land has been written very largely in water.

*Autobiography of Earth*

Chapter III (p. 72)

Coward-McCann, Inc. New York, New York, USA. 1935

**Buckley, Arabella B.** 1840–1929  
English naturalist and science writer

We are going to spend an hour today in following a drop of water on its travels. If I dip my finger in this basin of water and lift it up again, I bring with it a small glistening drop out of the water below and hold it before you. Tell me, have you any idea where this drop has been? What changes it has undergone, and what work it has been doing during all the long ages water has lain on the face of the earth?

*The Fairy-Land of Science*

Lecture IV (pp. 95–96)

D. Appleton & Company. New York, New York, USA. 1899

**Burke, Edmund** 1729–97  
English statesman and philosopher

Water, when simple is insipid, inodorous, colorless, and smooth; it is found, when not cold, to be a great resolver of spasms, and lubricator of the fibers; this power it probably owes to its smoothness.

*On the Sublime and the Beautiful*

Part IV, Section XXI (p. 166)

Cassell & Company Ltd. London, England. 1887

**Butler, Samuel** 1612–80  
English novelist, essayist, and critic

Water is frozen steam, and ice frozen water.

*The Note-Books of Samuel Butler* (Volume 1)

1874–1883 (p. 74)

University Press of America, Inc. Lanham, Maryland, USA. 1984

**Coleridge, Samuel Taylor** 1772–1834  
English lyrical poet, critic, and philosopher

Water, water, everywhere,

And all the boards did shrink;

Water, water, everywhere,

Nor any drop to drink.

*The Rime of the Ancient Mariner and Other Poems*

Rime of the Ancient Mariner, Part II, l. 114–118

Little Leather Library Corporation. New York, New York, USA. 1915

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

The water wears away the mountains and fills up the valleys, and if it had the power it would reduce the earth to a perfect sphere.

Translated by Edward MacCurdy

*The Notebooks of Leonardo da Vinci* (Volume 1)

Physical Geography (p. 317)

George Braziller. New York, New York, USA. 1958

If a drop of water falls into the sea when it is calm, it must of necessity be that the whole surface of the sea is raised imperceptibly, seeing that water cannot be compressed within itself, like air.

*Leonardo da Vinci's Note Books* (p. 101)

Duckworth & Company. London, England. 1906

**Davy, Sir Humphry** 1778–1829  
English chemist

...I have come to [the] conclusion...that water is the basis of all the gases, and that oxygen, hydrogen, nitrogen, ammonia, nitrous acid, &c., are merely electrical forms of water...

*Fragmentary Remains*

Chapter IV

Letter to T.A. Knight (p. 129)

John Churchill. London, England. 1858

**de Saint-Exupéry, Antoine** 1900–44

French aviator and writer

Water, thou hast no taste, no color, no odor; canst not be defined, art relished while ever mysterious. Not necessary to life, but rather life itself, thou fillest us with a gratification that exceeds the delight of the senses.

*Wind, Sand and Stars*

Chapter 8 (p. 234)

Reynal & Hitchcock. New York, New York, USA. 1939

**Earle, Sylvia Alice** 1935–

American oceanographer and education advocate

It doesn't matter where on Earth you live, everyone is utterly dependent on the existence of that lovely, living saltwater soup. There's plenty of water in the universe without life, but nowhere is there life without water.

*Sea Change: A Message of the Oceans*

Introduction (p. xii)

G.P. Putnam's Sons. New York, New York, USA. 1995

**Eiseley, Loren C.** 1907–77

American anthropologist, educator, and author

If there is magic on this planet, it is contained in water.

*The Immense Journey*

The Flow of the River (p. 15)

Vintage Books. New York, New York, USA. 1957

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

Water...transports vast boulders of rock in its iceberg a thousand miles. But its far greater power depends on its talent of becoming little, and entering the smallest holes and pores. By this agency, carrying in solution elements needful to every plant, the vegetable world exists.

*The Complete Works of Ralph Waldo Emerson* (Volume 7)

Society and Solitude

Chapter VI (p. 146)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Esar, Evan** 1899–1995

American humorist

A beautiful blonde is chemically three-fourths water, but what lovely surface tension.

*20,000 Quips and Quotes* (p. 127)

Doubleday & Company, Inc. Garden City, New York, USA. 1968

**Franks, Felix**

English chemist and water researcher

Of all known liquids, water is probably the most studied and least understood. ...

*Water: A Comprehensive Treatise*

Introduction — Water, the Unique Chemical (p. 18)

Plenum Press. New York, New York, USA. 1972–82

**Herbert, Sir Alan** 1890–1971

English novelist, playwright, poet, and politician

The rain is plenteous but, by God's decree,

Only a third is meant for you and me;

Two-thirds are taken by the growing things

Or vanish Heavenward on vapour's wings:

Nor does it mathematically fall

With social equity on one and all.

The population's habit is to grow

In every region where the water's low:

Nature is blamed for failings that are Man's,

And well-run rivers have to change their plans.

*Water*

Source undetermined

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

The water is supple because it is incompressible. It glides away from under the effort. Borne down on one side, it escapes on the other. It is thus that the water becomes a wave. The wave is its liberty.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter II (p. 402)

The Heritage Press. New York, New York, USA. 1961

**Huxley, Thomas Henry** 1825–95

English biologist

...we live in the hope and the faith that, by the advance of molecular physics, we shall by and by be able to see our way as clearly from the constituents of water to the properties of water, as we are now able to deduce the operations of a watch from the form of its parts and the manner in which they are put together.

*Collected Essays* (Volume 1)

*Method and Result*

On the Physical Basis of Life (p. 152)

Macmillan & Company Ltd. London, England. 1904

**Lawrence, D. H. (David Herbert)** 1885–1930

English writer

Water is H<sub>2</sub>O, hydrogen two parts, oxygen one, but there is also a third thing, that makes water, and nobody knows what that is.

*Pansies*

The Third Thing

Martin Secker. London, England. 1930

**Le Févre, Nicholas** 1615–79

French chemist

That insipid liquor which commonly is called Water, hath by the Chymists the name of Phlegm given unto it, when it is separated from all other Mixture...

*A Complete Body of Chymistry*

Part I

Chapter III, Section II (p. 22)

Printed for O. Pully. London, England. 1640

### **McKay, Christopher**

American planetary scientist

If some alien called me up [and said]..., “Hello, this is Alpha, and we want to know what kind of life you have,” — I’d say, waterbased.... Earth organisms figure out how to make do without almost anything else. The single non-negotiable thing life requires is water.

Interview

*OMNI Magazine*, July 1992 (p. 66)

### **Norse, Elliot A.**

American marine conservation biologist

In every glass of water we drink, some of the water has already passed through fishes, trees, bacteria, worms in the soil, and many other organisms, including people.... Living systems cleanse water and make it fit, among other things, for human consumption.

In R.J. Hoage (ed.)

*Animal Extinctions: What Everyone Should Know*

The Value of Animal and Plant Species for Agriculture, Medicine, and Industry (p. 62)

Smithsonian Institution Press. Washington, D.C. 1985

### **Overstreet, Harry Allen** 1875–1970

American social psychologist and civic awareness advocate

Water, however, is not simply the sum of hydrogen and oxygen. It is something qualitatively new, something that cannot be found by the most searching examination of the gas, hydrogen, nor of the gas, oxygen. No amount of previous knowledge of the atomic structure of hydrogen and oxygen could, apparently, give a knowledge of this peculiar fluid that results from combining the two gasses.

*The Enduring Quest*

Chapter IV (p. 59)

W.W. Norton & Company, Inc. New York, New York, USA. 1931

### **Russell, Bertrand Arthur William** 1872–1970

English philosopher, logician, and social reformer

A drop of water is not immortal; it can be resolved into oxygen and hydrogen. If, therefore, a drop of water were to maintain that it had a quality of aqueousness which would survive its dissolution we should be inclined to be skeptical.

*What I Believe*

Chapter I (p. 6)

E.P. Dutton & Company. New York, New York, USA. 1925

### **Snicket, Lemony (Daniel Handler)** 1970–

American writer

After a great deal of time examining oceans, investigating rainstorms, and staring very hard at several drinking fountains, the scientists of the world developed a theory regarding how water is distributed around our planet, which they have named the “water cycle.” The water cycle consists of three key phenomena — evaporation, precipitation, and collection — and all of them are equally boring.

*A Series of Unfortunate Events. Book the Eleventh: The Grim Grotto*

HarperCollins Publishers. New York, New York, USA. 2004

### **Strauss, Maurice B.**

In the beginning the abundance of the sea

Led to profligacy.

The ascent through the brackish waters of the estuary

To the salt-poor lakes and ponds

Made immense demands

Upon the glands.

Salt must be saved, water is free.

In the never-ending struggle for security,

Man’s chiefest enemy.

According to the bard of Stratford on the Avon,

The banks were climbed and life established on dry land

Making the incredible demand

Upon another gland

That water, too, be saved.

*Body Water in Man: The Acquisition and Maintenance of the Body Fluids*

Salt and Water

Chapter XII (p. 238)

Little, Brown & Company. Boston, Massachusetts, USA. 1957

### **Maury, Matthew Fontaine** 1806–73

American hydrographer and naval officer

The tooth of running water is very sharp.

*The Physical Geography of the Sea*

Chapter XIV (p. 321)

Harper & Brothers. New York, New York, USA. 1855

### **van Helmont, Jean-Baptista** 1579–1644

Flemish chemist

That all plants immediately and substantially stem from the element water alone I have learnt from the following experiment. I took an earthen vessel in which I placed two hundred pounds of earth dried in an oven, and watered with rain water. I planted in it the stem of a willow tree weighing five pounds. Five years later it had developed a tree weighing one hundred and sixty-nine pounds and three ounces. Nothing but rain (or distilled water) had been added. The large vessel was placed in earth and covered by an iron lid with a tin-surface that was pierced with many holes. I have not weighed the leaves that came off in the four autumn seasons. Finally I dried the earth in the vessel again and found the same two hundred pounds of it diminished by about two ounces. Hence one hundred and sixty-four pounds of wood, bark and roots had come up from water alone.

In William H. Brock  
*The Norton History of Chemistry*  
 Introduction (p. xxi)  
 W.W. Norton & Company, Inc. New York, New York, USA. 1933

**Walton, Izaak** 1593–1683  
 English writer

And an ingenious Spaniard says that rivers and the inhabitants of the watery element were made for wise men to contemplate, and fools to pass by without consideration...for you may note, that the waters are Nature's storehouse, in which she locks up her wonders.

*The Complete Angler*  
 First Day, Chapter I (p. 31, 34)  
 T.N. Foulis. London, England. 1913

## WAVE

**Crew, Henry**  
 American physicist

To the mathematician the problems of wave-motion offer a field for his highest power of analysis; to the physicist they suggest experiments demanding all the skill at his disposal; to the engineer and to those who go down to the sea in ships these problems are matters of life and death, while to the poet and the artist they are “the sea dancing to its own music.”

In Lloyd William Taylor  
*Physics: The Pioneer Science* (Volume 1)  
 Chapter 24 (p. 327)  
 Houghton Mifflin Company. Boston, Massachusetts, USA. 1941

**Thomson, Sir George Paget** 1892–1975  
 British physicist

The wind catches the filaments and the spider is carried where the filaments take it. In much the same way the point which represents the energy of the electron is guided by the waves which surround it, and extend possibly to an indefinite distance in all directions. If the waves pass over an obstacle like an atom their direction is modified and the modification is transmitted back to the electron and enables it to guide its path in accordance with the distribution of matter which it finds around it.

*The Atom*  
 Chapter VII (p. 110)  
 Oxford University Press, Inc. London, England. 1956

## WAVE MECHANICS

**Eddington, Sir Arthur Stanley** 1882–1944  
 English astronomer, physicist, and mathematician

Schrödinger's wave-mechanics is not a physical theory, but a dodge — and a very good dodge too.

*The Nature of the Physical World*

Chapter X (p. 219)  
 The Macmillan Company. New York, New York, USA. 1930

**Gamow, George** 1904–68  
 Russian-born American physicist

In wave mechanics there are no impenetrable barriers, ... as the British physicist R.H. Fowler [also] put it after my lecture on that subject at the Royal Society of London...

*My World Line: An Informal Autobiography*  
 Chapter 3 (p. 60)  
 The Viking Press. New York, New York, USA. 1979

## WAVE-PARTICLE DUALITY

**Glashow, Sheldon L.** 1932–  
 American physicist

One quantum notion that mystifies the novice is the wave-particle duality. Does light consist of a beam of particles or is it a wave phenomenon? the question is hundreds of years old. Newton thought light was probably a stream of particles. Maxwell seemed to answer the problem decisively by showing light to be an electromagnetic wave. Yet Einstein in 1905, demonstrated that under some circumstances light behaves as if it were a beam of discrete particles, which are now called photons.

*Interactions: A Journey Through the Mind of a Particle Physicist and the Matter of This World*  
 Chapter 3 (p. 51)  
 Warner Books. New York, New York, USA. 1988

## WEAPON

**Amis, Martin** 1949–  
 English writer

Nuclear weapons...are remarkable artifacts. They derive their power from an equation: when a pound of uranium-235 is fissioned, the “liberated mass” within its 1,132,000,000,000,000,000,000,000,000 atoms is multiplied by the speed of light squared — with the explosive force, that is to say, of 186,000 miles per second times 186,000 miles per second. Their size, their power, has no theoretical limit. They are biblical in their anger.

*Einstein's Monsters*  
 Introduction: Thinkability (p. 8)  
 Jonathan Cape Ltd. London, England. 1987

## WEATHER

**Hopfield, John** 1933–  
 American physicist and neural scientist

You might understand how a few gas molecules interact with one another, but you wouldn't imagine that putting millions of them together would get you weather.

In Ti Sanders

*Weather: A User's Guide to the Atmosphere*  
Chapter 1 (p. 1)  
Icarus Press. South Bend, Indiana, USA. 1985

**Mitchell, Margaret** 1900–49  
American author

You can always tell the weather by the sunsets.

*Gone With the Wind*  
Part One, Chapter I (p. 7)  
The Macmillan Company. New York, New York, USA. 1936

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

Who watched the forms of the clouds over this part of the earth a thousand years ago? Who watches them to-day?

*The Journal of Henry David Thoreau* (Volume 13)  
December 13. P.M. (p. 23)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1906

## WEED

### Author undetermined

Weeds are unuseful flowers.

In John Burroughs  
*Birds and Bees Essays*  
Introduction (p. 6)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1914

**Bailey, William Whitman** 1843–1914  
American botanist

Weeds are active enemies, not to be despised so much as hated. They are cut down or uprooted whenever found. So great a pest are they that man has taken them for a type of rank, rapid and useless growth. Yet, when curiosity leads us to observe them, we find beauty even in the meanest.

*The American Botanist*  
Volume I, Number 4, October 1901 (p. 50)

**Emerson, Ralph Waldo** 1803–82  
American lecturer, poet, and essayist

What is a weed? A plant whose virtues have not yet been discovered...

*The Complete Works of Ralph Waldo Emerson* (Volume 11)  
Miscellanies  
Chapter XXX (p. 512)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1904

**Larcom, Lucy** 1824–93  
American writer

I like these plants that you call weeds  
Sedge, hardhack, mullein, yarrow, —  
That knit their roots and sow their seeds  
Where any grassy wheel-track leads  
Through country by-ways narrow.

I Like These Plants that You Call Weeds: Historicizing American

Women's Nature Writing  
*Nineteenth Century*, Volume 58, June 2003

**Shakespeare, William** 1564–1616  
English poet, playwright, and actor

Now 'tis the spring and weeds are shallow rooted;  
Suffer them now and they'll outgrow the garden  
And choke the herbs for lack of husbandry.

In *Great Books of the Western World* (Volume 26)  
*The Plays and Sonnets of William Shakespeare* (Volume 1)  
The Second Part of King Henry the Sixth  
Act III, Scene I  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## WEIGHT

**da Vinci, Leonardo** 1452–1519  
Italian High Renaissance painter and inventor

Weight, pressure, and accidental movement together with resistance are the four accidental powers in which all the visible works of mortals have their existence and their end.

*Leonardo da Vinci's Note Books* (p. 55)  
Duckworth & Company. London, England. 1906

## WEIGHTLESSNESS

**Verne, Jules** 1828–1905  
French novelist

Fancy has depicted men without reflection, others without shadow. But here reality, by the neutralizations of attractive forces, produced men in whom nothing had any weight, and who weighed nothing themselves.

*From the Earth to the Moon, and Round the Moon*  
Chapter VIII (p. 228)  
A.L. Burt Company. New York, New York, USA. 1890

## WETLANDS

**Beebe, William** 1877–1962  
American ornithologist

The marsh, to him who enters it in a receptive mood, holds, besides mosquitoes and stagnation, — melody, the mystery of unknown waters, and the sweetness of Nature undisturbed by man.

*The Log of the Sun*  
Night Music of the Swamp (p. 172)  
Henry Holt and Company. New York, New York, USA. 1906

**Lanier, Sidney** 1842–81  
American writer and musician

Ye marshes, how candid and simple and nothing-with-holding and free  
Ye publish yourselves to the sky and offer yourselves to the sea!

In Goodridge Bliss Roberts  
*Younger American Poets, 1830–1890*  
 The Marshes of Glynn  
 Griffith, Farran, Okeden & Welsh. London, England. 1891

## WHIRLPOOL

**Poe, Edgar Allan** 1809–49  
 American short story writer

I became possessed with the keenest curiosity about the whirl itself. I positively felt a wish to explore its depths, even at the sacrifice I was going to make; and my principal grief was that I should never be able to tell my old companions on shore about the mysteries I should see.

In H. Beaver (ed.)  
*The Science Fiction of Edgar Allan Poe*  
 A Descent into the Maelstrom (p. 83)  
 Penguin Books. Hammondsworth, England. 1976

## WHITE DWARF

**Updike, John** 1932–  
 American novelist, short story writer, and poet

You offer cheer to tiny Man  
 ‘Mid galaxies Gargantuan  
 A little pill in endless night,  
 An antidote to cosmic fright.

White Dwarf  
 Source undetermined

## WILDERNESS

**Abbey, Edward** 1927–89  
 American environmentalist and nature writer

We would guard and defend and save it [wilderness] as a place for all who wish to discover the nearly lost pleasures of adventure, adventure not only in the physical sense, but also mental, spiritual, moral, aesthetic, and intellectual adventure. A place for the free.

*The Journey Home: Some Words in Defense of the American West*  
 Chapter 8 (p. 88)  
 E.P. Dutton & Company. New York, New York, USA. 1977

The idea of wilderness needs no defense. It only needs more defenders.

*The Journey Home: Some Words in Defense of the American West*  
 Chapter 21 (p. 223)  
 E.P. Dutton & Company. New York, New York, USA. 1977

On this great river [the Colorado River] one could glide forever — and here we discover the definition of bliss, salvation, Heaven, all the old Mediterranean dreams: a journey from wonder to wonder, drifting through eternity into ever deeper, always changing grandeur, through beauty continually surpassing itself: the ultimate Homeric voyage.

*The Journey Home: Some Words in Defense of the American West*  
 Chapter 17 (p. 201)  
 E.P. Dutton & Company. New York, New York, USA. 1977

Now I can do no more than offer one final prayer to the young, to the bold, to the angry, to the questioning, to the lost. Beyond the wall of the unreal city, beyond the security fences topped with barbed wire and razor wire, beyond the asphalt belting of the superhighways, beyond the cemented banksides of our temporarily stopped and mutilated rivers, beyond the rage of lies that poisons the air, there is another world waiting for you. It is the old true world of the deserts, the mountains, the forests, the islands, the shores, the open plains. Go there. Be there. Walk gently and quietly deep within it.

*Beyond the Wall*  
 Author's Introduction (p. xvi)  
 Ballantine Books. New York, New York, USA. 1968

Come on in. The earth, like the sun, like the air, belongs to everyone — and to no one.

*The Journey Home: Some Words in Defense of the American West*  
 Chapter 8 (p. 88)  
 E.P. Dutton & Company. New York, New York, USA. 1977

But the love of wilderness is more than a hunger for what is always beyond reach; it is also an expression of loyalty to the earth, the earth which bore us and sustains us, the only home we shall ever know, the only paradise we ever need — if only we had the eyes to see.

*Desert Solitaire*  
 Down the River (p. 190)  
 Ballantine Books. New York, New York, USA. 1968

How difficult to imagine this place without a human presence; how necessary. I am almost prepared to believe that this sweet virginal primitive land will be grateful for my departure and the absence of the tourists, will breathe metaphorically a collective sigh of relief — like a whisper of wind — when we are all and finally gone and the place and its creations can return to their ancient procedures unobserved and undisturbed by the busy, anxious, brooding consciousness of man. Grateful for our departure? One more expression of human vanity. The finest quality of this stone, these plants and animals, this desert landscape is the indifference manifest to our presence, our absence, our coming, our staying or our going. Whether we live or die is a matter of absolutely no concern whatsoever to the desert.

*Desert Solitaire*  
 Bedrock and Paradox (p. 300)  
 Ballantine Books. New York, New York, USA. 1968

It is my fear that if we allow the freedom of the hills, and the last of the wilderness to be taken from us, then the very idea of freedom may die with it.

*Down the River*  
 Part II, Chapter 8 (p. 121)  
 E.P. Dutton & Company. New York, New York, USA. 1982

**Berry, Wendell** 1934–  
American essayist, poet, critic, and farmer

There does exist a possibility that we can live more or less in harmony with our native wilderness; I am betting my life that such a harmony is possible. But I do not believe that it can be achieved simply or easily or that it can ever be perfect, and I am certain that it can never be made, once and for all, but it is the forever unfinished lifework of our species.

*The Land of Harmony*  
Preserving Wilderness (pp. 138–139)  
Five Seasons Press. Hereford, England. 1987

This wilderness, the universe, is somewhat hospitable to us, but it is also absolutely dangerous to us (it is going to kill us, sooner or later), and we are absolutely dependent upon it.

*The Land of Harmony*  
Preserving Wilderness (pp. 138–139)  
Five Seasons Press. Hereford, England. 1987

We live in a wilderness, in which we and our works occupy a tiny space and play a tiny part. We exist under its dispensation and by its tolerance.

*The Land of Harmony*  
Preserving Wilderness (pp. 138–139)  
Five Seasons Press. Hereford, England. 1987

**Brower, David** 1912–2000  
American environmentalist

My feeling is we need to save wilderness for its own sake, for the mysterious and complex knowledge it has within it. Thoreau was right when he said, “In wilderness is the preservation of the world.”

In Jonathan White  
*Talking on the Water*  
Sierra Club Books. San Francisco, California, USA. 1994

...we need boundaries around cities, not around wilderness.

*Let the Mountains Talk, Let the Rivers Run*  
Chapter 5 (p. 43)  
HarperCollins Publishers. New York, New York, USA. 1995

**Carr, William H.** 1902–85  
American desert environmentalist and writer

I am thankful for the wild spaces that are yet untouched. May they not decrease in size and number!

*The Stir of Nature*  
Chapter Eight (p. 116)  
Oxford University Press, Inc. New York, New York, USA. 1930

**Gerould, Katherine Fullerton** 1879–1944  
American writer

The wilderness is a good place to cry in; the echoes are magnificent.

*Modes and Morals*

The Extirpation of Culture (p. 67)  
Charles Scribner's Sons. New York, New York, USA. 1920

**Gould, Stephen Jay** 1941–2002  
American paleontologist and evolutionary biologist

I can easily understand why, for most naturalists, the highest form of beauty, inspiration, and moral value might be imputed to increasingly rare patches of true wilderness — that is, to parcels of nature devoid of any human presence, either in current person or by previous incursion.

*Leonardo's Mountain of Clams and the Diet of Worms*  
Introduction (p. 1)  
Harmon Brown. New York, New York, USA. 1998

**Hopkins, Frederick Gowland** 1844–89  
English biochemist

What would the world be, once bereft  
Of wet and of wilderness? Let them be left,  
O let them be left, wilderness and wet;  
Long live the weeds and the wilderness yet.

In W.H. Gardner and N.H. MacKenzie (eds.)  
*The Poems of Gerard Manley Hopkins*  
Inversnaid, Stanza 4  
Oxford University Press, Inc. London, England. 1930

**Krutch, Joseph Wood** 1893–1970  
American naturalist, conservationist, and writer

The Wilderness and the idea of wilderness is one of the permanent homes of the human spirit.

*Grand Canyon: Today and All Its Yesterday.*  
William Sloane Associates, Publishers. New York, New York, USA. 1958

**Lindbergh, Charles A.** 1902–74  
American aviator

In wilderness I sense the miracle of life, and behind it our scientific accomplishments fade to trivia.

The Wisdom of Wilderness  
*Life*, Volume 63, Number 25, December 22, 1967 (p. 10)

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

In wildness is the preservation of the world.  
Walking  
*The Atlantic Monthly*, Volume 9, Number 56, June 1862 (p. 665)

## WILDLIFE

**Borland, Hal** 1900–78  
American writer

The newcomer to the country will find the first signs of “wild life” in his own house. Even before he explores the dooryard he can sharpen his eyes indoors. He may be surprised at the outsiders who want to share that house with him.

*Beyond Your Doorstep: A Handbook to the Country*  
Chapter 1 (p. 1)  
Alfred A. Knopf. New York, New York, USA. 1962

**Hornaday, William Temple** 1854–1937  
American naturalist

And yet the game of North America does not belong wholly and exclusively to the men who kill! The other ninety-seven per cent of the People have vested rights in it.... Posterity has claims upon it that no man can ignore.... A continent without wild life is like a forest with no leaves on the trees.

*Our Vanishing Wild Life*  
Preface (p. ix)

C. Scribner's Sons. New York, New York, USA. 1913

**Myers, Norman** 1934–  
British environmentalist

Without knowing it, we utilize hundreds of products each day that owe their origin to wild animals and plants. Indeed our welfare is intimately tied up with the welfare of wildlife. Well may conservationists proclaim that by saving the lives of wild species, we may be saving our own.

*A Wealth of Wild Species: Storehouse for Human Welfare*  
Wild Species (p. 3)  
Westview Press. Boulder, Colorado. 1983

**Prince Philip (Philip Mountbatten), Duke of Edinburgh** 1921–  
British naturalist

Miners used to take a canary around the coal mines to warn them when the air was so foul that the canary died. This is the importance of wildlife to us; because if wildlife dies it is our turn next. If any part of the life of this planet is threatened, all is threatened. If you say "not interested" to wildlife conservation then you are signing your own death warrant.

*The Times (London)*, May 17, 1988

## WIND

**Conrad, Joseph** 1857–1924  
Polish-born English novelist

It was something formidable and swift, like the sudden smashing of a Vial of Wrath. It seemed to explode all around the ship with an overpowering concussion and a rush of great waters, as if an immense dam had been blown up to windward. It destroyed at once the organised life of the ship by its shattering effect. In an instant the men lost touch of each other. This is the disintegrating power of a great wind. It isolates one from one's kind. An earthquake, a landslip, an avalanche, overtake a man incidentally, as it were — without passion. A furious

gale attacks him like a personal enemy, tries to grasp his limbs, fastens upon his mind, seeks to rout the very spirit out of him.

*Typhoon*

Chapter X (p. 77)

Doubleday, Page & Company. Garden City, New York, USA. 1920

**Longfellow, Henry Wadsworth** 1807–82  
American poet

Through woods and mountain passes  
The winds, like anthems, roll.

*The Poetical Works of Henry Wadsworth Longfellow*

Midnight Mass for the Dying Year

Houghton Mifflin Company. Boston, Massachusetts, USA. 1883

**Maury, Matthew Fontaine** 1806–73  
American hydrographer and naval officer

Properly to appreciate the various offices which the winds and the waves perform, we must regard nature as a whole, for all the departments thereof are intimately connected. If we attempt to study in one of them, we often find ourselves tracing clews which lead us off insensibly into others, and, before we are aware, we discover ourselves exploring the chambers of some other department.

*The Physical Geography of the Sea*

Chapter X (p. 181)

Harper & Brothers. New York, New York, USA. 1855

**Peattie, Donald Culrose** 1896–1964  
American botanist, naturalist, and author

The oldest voice in the world is the wind. When you see it fitfully turning the blades of a mill lazily to draw water, you think of it as an unreliable servant of man. But in truth it is one of our masters, obedient only to the lord sun and the whirling of the great globe itself.

*Weather: A National Journal* (p. 24)

Weldon Owen Pty Ltd. Sydney, Australia. 1996

## WISDOM

**Abelard, Peter** 1079–1142  
French scholastic philosopher

Assiduous and frequent questioning is indeed the first key to wisdom.

*Sic et Non (Yes and No)*

**Aquinas, St. Thomas** 1227?–74  
Dominican philosopher and theologian

Wisdom is a kind of science in so far as it has that which is common to all the sciences, namely, to demonstrate conclusions from principles. But since it has something proper to itself above the other sciences, in so far, that is, as it judges of them all, not only as to their conclusions, but also as to their first principles, therefore it is a more perfect virtue than science.



*Summa Theologica*  
I–II, 57, 2

**Aristotle** 384 BCE–322 BCE  
Greek philosopher

Again, we do not regard any of the senses as wisdom; yet surely these give us the most authoritative knowledge of particulars. But they do not tell us the “why” of anything — e.g., why fire is hot; they only say that it is hot.

In *Great Books of the Western World* (Volume 8)  
*Metaphysics*

Book I, Chapter 1 (pp. 499–500)  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Bell, E. T. (Eric Temple)** 1883–1960  
Scottish-American mathematician and educator

Wisdom was not born with us, nor will it perish when we descend into the shadows with a regretful backward glance that other eyes than ours are already lit by the dawn of a new and truer mathematics.

*The Queen of the Sciences*  
Chapter X (p. 138)

The Williams & Wilkins Company. Baltimore, Maryland, USA. 1931

**Berrill, Norman John** 1903–96  
English-born American biologist

Wisdom, the highest product of the human mind, comes late; the young are rarely wise and are not expected to be.

*Man's Emerging Mind*  
Chapter I (p. 14)

Dodd, Mead & Company. New York, New York, USA. 1955

**Bush, Vannevar** 1890–1974  
American electrical engineer and physicist

There are also the old men, whose days of vigorous building are done, whose eyes are too dim to see the details of the arch or the needed form of its keystone, but who have built a wall here and there, and lived long in the edifice; who have learned to love it and who have even grasped a suggestion of its ultimate meaning; and who sit in the shade and encourage the young men.

*Endless Horizons*  
Chapter 17 (p. 181)

Public Affairs Press. Washington, D.C. 1946

**Campbell, Donald T.** 1916–96  
American evolutionary philosopher and social scientist

In going beyond what is already known, one cannot but go blindly. If one can go wisely, this indicates already achieved wisdom of some general sort.

In Paul Arthur Schlipp (ed.)  
*The Philosophy of Karl R. Popper*  
Evolutionary Epistemology (p. 422)  
Open Court. La Salle, Illinois, USA. 1974

**Collingwood, Robin George** 1889–1943  
English historian and philosopher

A man ceases to be a beginner in any given science and becomes a master in that science when he has learned that...he is going to be a beginner all his life.

*The New Leviathan; or, Man, Society, Civilization and Barbarism*  
Part I, Chapter I, aphorism I.46 (p. 3)  
At The Clarendon Press. Oxford, England. 1942

**Davies, Robertson** 1913–95  
Canadian novelist

Knowledge may enable you to memorize the whole of Gray's Anatomy and Osler's Principles and Practice of Medicine, but only wisdom can teach you what to do with what you have learned.

*The Merry Heart*  
Chapter 5 (p. 105)

McClelland & Stewart. Toronto, Ontario, Canada. 1996

Knowledge and Wisdom and they are not the same, - because Knowledge is what you are taught, but Wisdom is what you bring to it.

*The Cunning Man* (p. 167)

McClelland & Stewart. Toronto, Ontario, Canada. 1994

**Descartes, René** 1596–1650  
French philosopher, scientist, and mathematician

...human wisdom...always remains one and the same, however applied to different subjects, and suffers no more differentiation proceeding from them than the light of the sun experiences from the variety of things which it illumines....

In *Great Books of the Western World* (Volume 31)

*Rules for the Direction of the Mind*

Rule 1 (p. 1)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Eisenschiml, Otto** 1880–1963  
Austrian-American chemist and historian

Wisdom, if inarticulate, is as impotent as loud-mouthed stupidity.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Nine (p. 112)

Duell, Sloan & Pearce. New York, New York, USA. 1947

Learn as much as you can, but remember that wisdom is more than a mere accumulation of facts. No one hires a man because he knows the encyclopedia by heart.

*The Art of Worldly Wisdom: Three Hundred Precepts for Success Based on the Original Work of Baltasar Gracian*  
Part Nine (p. 108)

Duell, Sloan & Pearce. New York, New York, USA. 1947

**Gregory, Sir Richard Arman** 1864–1952  
British science writer and journalist

The love of truth is the beginning and end of wisdom.

*Discovery; or, The Spirit and Service of Science*  
Chapter II (p. 27)

Macmillan & Company Ltd. London, England. 1918

**Kingsley, Charles** 1819–75  
English clergyman and author

Wise men know that their business is to examine what is,  
and not to settle what is not.

*The Water-Babies*  
Chapter II (p. 62)  
Dodd, Mead & Company. New York, New York, USA. 1910

**Milton, John** 1608–74  
English poet

...to know  
That which before us lies in daily life  
Is the prime Wisdom...

In *Great Books of the Western World* (Volume 32)  
*Paradise Lost*  
Book VIII, l. 192–194  
Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Narby, Jeremy**  
Swiss-born anthropologist and author

...wisdom requires not only the investigation of many  
things, but the contemplation of the mystery.  
*The Cosmic Serpent: DNA and the Origins of Knowledge*  
Chapter 11 (p. 162)  
Tarcher/Putnam. New York, New York, USA. 1998

**Procter, Bryan Waller** 1787–1874  
English poet

...he who can draw a joy  
From rocks, or woods, or weeds, or things  
That seem all mute, and does it — is wise.  
*The Poetical Works of Barry Cornwall*  
A Haunted Stream  
Henry Colburn & Company London, England. 1822

## The Bible

...I applied my mind to study and explore by means of  
wisdom all that is done under heaven. It is a worthless task  
that God has given to mortals to keep them occupied.

*The Revised English Bible*  
Ecclesiastes 1:13  
Oxford University Press, Inc. Oxford, England. 1989

For in much wisdom is much vexation; the more knowl-  
edge, the more suffering.

*The Revised English Bible*  
Ecclesiastes 1:18  
Oxford University Press, Inc. Oxford, England. 1989

## WONDER

**Chesterton, G. K. (Gilbert Keith)** 1874–1936  
English author

The world will never starve for want of wonders; but  
only for want of wonder.

*Tremendous Trifles*

*Tremendous Trifles*, I  
Dodd, Mead & Company New York, New York, USA. 1909

**Cole, William** 1530–1600  
English man of letters

When we contemplate the works of creation in the con-  
struction of the planetary system, and the stupendous  
parts of the universe, we are struck with admiration at  
their magnitude; so, when we descend the scale of nature,  
and contemplate the minutiae of material objects, we dis-  
cover an equal harmony and beauty in their disposition,  
and are equally lost in wonder.

*Philosophical Remarks on the Theory of Comets, a Dissertation on the  
Nature and Properties of Light*  
Conclusion (p. 93)

B.J. Holdsworth. London, England. 1823

**Dawkins, Richard** 1941–  
British ethologist, evolutionary biologist, and popular science writer

We have an appetite for wonder, a poetic appetite, which  
real science ought to be feeding but which is being hi-  
jacked, often for monetary gain, by purveyors of super-  
stition, the paranormal and astrology.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 6 (p. 114)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

I believe that astrologers, for instance, are playing on —  
misusing, abusing — our sense of wonder. I mean when  
they hijack the constellations, and employ sub-poetic  
language like the moon moving into the fifth house of  
Aquarius. Real astronomy is the rightful proprietor of the  
stars and their wonder. Astrology gets in the way, even  
subverts and debauches the wonder.

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12<sup>th</sup>, 1996

The fact that we slowly apprehend our world, rather  
than suddenly discover it, should not subtract from its  
wonder.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 1 (p. 5)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

The feeling of awed wonder that science can give us  
is one of the highest experiences of which the human  
psyche is capable. It is a deep aesthetic passion to rank  
with the finest that music and poetry can deliver. It is  
truly one of the things that makes life worth living and it  
does so, if anything, more effectively if it convinces us  
that the time we have for living it is finite.

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Preface (p. x)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

There is an appetite for wonder, and isn't true science  
well qualified to feed it?

*Science, Delusion and the Appetite for Wonder*  
Richard Dimpleby Lecture, BBC1 Television, November 12<sup>th</sup>, 1996

The mystic is content to bask in the wonder and revel in a mystery that we were not “meant” to understand. The scientist feels the same wonder but is restless, not content; recognizes the mystery as profound, then adds, “But we’re working on it.”

*Unweaving the Rainbow: Science, Delusion and the Appetite for Wonder*  
Chapter 2 (p. 17)  
Houghton Mifflin Company. Boston, Massachusetts, USA. 1998

**Gardner, Martin** 1914–

American writer and mathematics games editor

...almost all scientists believe that as their knowledge increases, their sense of wonder also grows. The scientist sees a flower, said physicist John Tyndall, “with a wonder superadded.”

Science vs. Beauty?

*Skeptical Inquirer*, March 1, 1995

**Guiducci, Mario** 1585–1646

Italian follower of and ghost writer for Galileo Galilei

When new or rarely seen things awaken in our minds more wonder than those which are common and ordinary, our desire to learn their causes should be aroused accordingly, and with it our wish to put to test those things reported to us by others or supplied by our own minds.

*Discourse on the Comets*

Discourse on the Comet (p. 2)

Published by the author. Florence, Italy. 1619

**Hardy, Thomas** 1840–1928

English poet and regional novelist

Until a person has thought out the stars and their inter-spaces, he has hardly learnt that there are things more terrible than monsters of shape, namely, monsters of magnitude without known shape. Such monsters are the voids and waste places of the sky.

*Two on a Tower*

Chapter IV (p. 34)

Harper & Brothers, Publishers. New York, New York, USA. No date

**Herschel, Sir John Frederick William** 1792–1871

English astronomer and chemist

Accustomed to trace the operation of general causes, and the exemplification of general laws, in circumstances where the uninformed and uninquiring eye perceives neither novelty nor beauty, [the scientist and natural philosopher] walks in the midst of wonders.

*A Preliminary Discourse on the Study of Natural Philosophy*

Part I, Chapter I, Section 10 (p. 15)

Printed for Longman, Rees, Orme, Brown & Green. London, England. 1831

**Krauss, Lawrence M.** 1954–

American theoretical physicist

There is plenty of wonder left in the universe even after we have examined all the clues nature has thrown our

way. I really believe that our imaginations have not even begun to exhaust the possibilities of existence. To proclaim the slogan “The Truth IS Out There” is perhaps too trite. I prefer “You ain’t seen nothin’ yet!”

*Beyond Star Trek: Physics from Alien Invasions to the End of Time*  
Epilogue (p. 175)

Basic Books, Inc. New York, New York, USA. 1997

**Poe, Edgar Allan** 1809–49

American short story writer

...wonders and wild fancies...strangely rife among mankind.

In H. Beaver (ed.)

*The Science Fiction of Edgar Allan Poe*

The Conversation of Eiros and Charmion (p. 67)

Penguin Books. Hammondsworth, England. 1976

**Pope, Alexander** 1688–1744

English poet

Pretty! in amber to observe the forms

Of hairs, of straws, or dirt, or grubs, or worms!

The things, we know, are neither rich nor rare,

But wonder how the devil they got there.

*The Complete Poetical Works*

Prologue to the Satires, l. 169

Houghton Mifflin Company. New York, New York, USA. 1903

**Sagan, Carl** 1934–96

American astronomer and science writer

Claims that cannot be tested, assertions immune to disproof are veridically worthless, whatever value they may have in inspiring us or in exciting our sense of wonder.

*The Demon-Haunted World: Science as a Candle in the Dark*

Chapter 10 (p. 171)

Random House, Inc. New York, New York, USA. 1995

**Steeff, Duncan**

No biographical data available

There is philosophy, and hope, in this great enterprise [of planetary exploration]. What a tribute to the human mind it is! We are replete with ambitions and egotisms, and with our love of the temporal — and yet we project our consciousness to the moons of Jupiter and light-years beyond, to the edges of the universe. This fascination, which has endured in some form since our ancestors first contemplated the stars, has nothing to do with the material. It exists because we already possess the greatest treasure of all, wonder. wonder. For such a species, there is hope indeed.

In Nigel S. Hey

*Solar System*

Ices in the Solar System (p. 257)

Weidenfield & Nicolson. London, England. 2002

**Verhoeven, Cornelis** 1928–2001

Dutch philosopher and essayist

Wonder is a certainty which has only just been established and has not yet lost the expectation of seeing its opposite appear. This does not exclude the knowledge of that which is incited by wonder. On the contrary: the more we know about something the more we realize that this knowledge is never exhaustive. Knowledge may nourish wonder since it can postulate the possibility that things may be different than they are.... Wonder that a thing is so is motivated by the possibility that it might be different. This movement is endless since this “difference” remains completely undefined.

Translated by Mary Foran  
*The Philosophy of Wonder*

Two (p. 27)

The Macmillan Company. New York, New York, USA. 1972

## WORD

**Becker, Carl L.** 1873–1945

American historian

If we would discover the little backstairs door that for any age serves as the secret entranceway to knowledge, we will do well to look for certain unobtrusive words with uncertain meanings that are permitted to slip off the tongue or the pen without fear and without research; words which, having from constant repetition lost their metaphorical significance, are unconsciously mistaken for objective realities.

*The Heavenly City of the Eighteenth Century Philosophers*

Chapter II (p. 47)

Yale University Press. New Haven, Connecticut, USA. 1932

**Heisenberg, Werner Karl** 1901–76

German physicist and philosopher

Words have no well-defined meaning. We can sometimes by axioms give a precise meaning to words, but still we never know how these precise words correspond to reality, whether they fit reality or not.

In Paul Buckley and F. David Peat (eds.)

*Glimpsing Reality: Ideas in Physics and the Link to Biology*

Werner Heisenberg (p. 7)

University of Toronto Press. Toronto, Ontario, Canada. 1996

**Horace (Quintus Horatius Flaccus)** 65 BCE–8 BCE

Roman philosopher and dramatic critic

If so be there are abstruse things which absolutely require new terms to make them clear, it will be in your power to frame words which never sounded in the ears of a cinctured Cethegus, and free pardon will be granted if the license be used modestly.... Each generation has been allowed, and will be allowed still to issue words that bear the mint-mark of the day.

In James Boswell

*Boswell's "Life of Samuel Johnson"*

*Ars Poetica* 48 (Wickham) (fn p. 158, year 1750)

Oxford University Press, Inc. Oxford, England. 1965

**Lewis, Gilbert Newton** 1875–1946

American chemist

There is always the danger is scientific work that some word or phrase will be used by different authors to express so many ideas and surmises that, unless redefined, it loses all real significance.

Valence and Tautomerism

*Journal of the American Chemical Society*, Volume 35, 191 (p. 144S)

**Maxwell, James Clerk** 1831–79

Scottish physicist

When a physical phenomenon can be completely described as a change in the configuration and motion of a material system, the dynamical explanation of that phenomenon is said to be complete. We cannot conceive any further explanation to be either necessary, desirable, or possible, for as soon as we know what is meant by the words configuration, mass and force, we see that the ideas which they represent are so elementary that they cannot be explained by means of anything else.

*Scientific Papers*

II, On the Dynamical Evidence of the Molecular Constitution of Bodies

(p. 419)

**Popper, Karl R.** 1902–94

Austrian/British philosopher of science

The relationship between a theory (or a statement) and the words used in its formulation is in several ways analogous to that between written words and the letters used in writing them down.

In Paul Arthur Schlipp (ed.)

*The Philosophy of Karl Popper* (Volume 1)

Book I, Part I

Autobiography of Karl Popper

Section 7 (p. 15)

The Open Court Publishing Company. LaSalle, Illinois, USA. 1974

**Schuster, Sir Arthur** 1851–1934

English physicist

Scientific controversies constantly resolve themselves into differences about the meaning of words.

In C. K. Ogden and I. A. Richards

*The Meaning of Meaning*

Introductory Quotations (p. xxiv)

Harcourt, Brace & Company. New York, New York, USA. 1949

**Whewell, William** 1794–1866

English philosopher and historian

I am always glad to hear of the progress of your researches, and never the less so because they require the fabrication of a new word or two. Such a coinage has always taken place at the great epochs of discovery; like the medals that are struck at the beginning of a new reign — or rather like the change of currency produced by the

accession of a new sovereign; for their value and influence consists in their coming into common circulation.

In Silvanus P. Thompson

*Michael Faraday: His Life and Work*

Chapter IV

Letter from Whewell to Faraday

14 October 1837 (p. 163)

Cassell & Company Ltd. London, England. 1901

**Wolfenden, John Frederick** 1906–85

English education leader

The everyday difficulty is to use words “pure and simple,” without getting entangled in their emotional lives.... [T]he scientist is to a large extent freed from this temptation. He knows very well the danger of using words.

*The Gap—The Bridge*

Essay on institutional dichotomy

## WORK

**Darwin, Charles Robert** 1809–82

English naturalist

I forget whether I ever told you what the object of my present work is, — it is to view all facts that I can master (ehue, ehue, how ignorant I find I am) in Natural History (as on geographical distribution, palaeontology, classification, hybridism, domestic animals and plants, &c., &c., &c.) to see how far they favor or are opposed to the notion that wild species are mutable or immutable: I mean with my utmost power to give all arguments and facts on both sides.

In Francis Darwin (ed.)

*The Life and Letters of Charles Darwin* (Volume 1)

Letter to Fox, March 27, 1855 (p. 409)

D. Appleton & Company. New York, New York, USA. 1896

**Davy, Sir Humphry** 1778–1829

English chemist

The most important part of the history of a man of science is necessarily recorded in his work.

*The Collected Works of Sir Humphry Davy* (Volume 1)

Memories of the Life of Sir Humphry Davy

Chapter I (p. 1)

London, England. 1839–1840

## Editor

No man is truly equal to his work until he is superior to it.

Editor's Outlook

*Journal of Chemical Education*, Volume 10, Number 2, February 1933

(p. 66)

**Hardy, G. H. (Godfrey Harold)** 1877–1947

English pure mathematician

Good work is not done by “humble” men.

*A Mathematician's Apology*

Chapter 2 (p. 66)

Cambridge University Press. Cambridge, England. 1967

**Littlewood, John E.** 1885–1977

British mathematician

Most of the best work starts in hopeless muddle and floundering, sustained on the “smell” that something is there.

In Béla Bollabás (ed.)

*Littlewood's Miscellany*

Academic Life (p. 144)

Cambridge University Press. New York, New York, USA. 1986

**Lowell, Percival** 1855–1916

American astronomer

Gauge your work by its truth to nature, not by the plaudits it receives from man. In the end the truth will prevail and though you may never live to see it, your work will be recognized after you are gone.

In William Graves Hoyt

*Lowell and Mars*

Chapter 15 (p. 300)

University of Arizona Press. Tucson, Arizona, USA. 1976

## WORLD

**Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

The world is the geologists great puzzle box.

In Loren Eiseley

*The Firmament of Time*

Chapter II (p. 31)

Athenaeum. New York, New York, USA. 1960

**Bennett, Arnold** 1867–1931

English novelist and playwright

Well, my deliberate opinion is — it's a jolly strange world.

In A.E. Trueman

*This Strange World*

Chapter I (p. 15)

The Scientific Book Club. London, England

**Bridgman, F. W.**

No biographical data available

The world is not a world of reason, understandable by the intellect of man.... It is probable that new methods of education will have to be painfully developed and applied to very young children in order to inculcate the instinctive and successful use of habits of thought so contrary to those which have been naturally acquired.

*Harper's Magazine*, March 1919

**Bronk, William** 1918–99

American poet and author

Whether what we sense of this world is the what of this world only, or the what of which of several possible worlds — which what?

*The World, the Worldless*

Metonymy as an Approach to a Real World  
New Directions. New York, New York, USA. 1964

**Bruno, Giordano** 1548–1600

Italian philosopher and pantheist

God is infinite.... He is glorified not in one, but in countless suns; not in a single earth, a single world, but in a thousand thousand, I say in an infinity of worlds.

*On the Infinite Universe and Worlds*

**Davies, Sir John** 1569–1626

English poet

Behold the world how it is whirled round,  
And for it is so whirl'd, is named so;  
In whose large volume many rules are found  
Of this new Art, which it doth fairly show:  
For your quick eyes in wandering too and fro  
From East to West, on no one thing can glance,  
But if you make it well, it seemes to daunce.

*Orchestra*

Stanza 34

1596

**Emerson, Ralph Waldo** 1803–82

American lecturer, poet, and essayist

The world is an immense picture-book of every passage in human life.

*Letters and Social Aims*

Poetry and Imagination (pp. 8–9)

James R. Osgood & Company. Boston, Massachusetts, USA. 1876

**Hazlitt, William Carew** 1834–1913

English bibliographer

If the world were good for nothing else, it is a fine subject for speculation.

In W. Carew Hazlitt (ed.)

*The Round Table; Northcotes Conversations; Characteristics*

Characteristics, CCCII (p. 505)

George Bell & Sons. London, England. 1884

**Lec, Stanislaw** 1909–66

Polish poet and aphorist

Who created the world? So far only God admits to it.

Translated by Jacek Galazka

*More Unkempt Thoughts* (p. 52)

Funk & Wagnalls. New York, New York, USA. 1968

How did they get a permit to create the world?

Translated by Jacek Galazka

*More Unkempt Thoughts* (p. 57)

Funk & Wagnalls. New York, New York, USA. 1968

**Mach, Ernst** 1838–1916

Austrian physicist and philosopher

Properly speaking the world is not composed of “things” as its elements, but colors, tones, pressures, spaces, times, in short what we ordinarily call individual sensations.

*The Science of Mechanics* (5<sup>th</sup> edition)

Chapter IV, Part IV, Section 2 (p. 580)

Open Court. La Salle, Illinois, USA. 1942

**Mumford, David** 1937–

English-born mathematician

The world is a very complicated place, as babies know.

*International Congress of Mathematics 2002*

Beijing

August 21, 2002

**Pascal, Blaise** 1623–62

French mathematician and physicist

The whole visible world is only an imperceptible atom in the ample bosom of nature. No idea approaches it. We may enlarge our conceptions beyond all imaginable space; we only produce atoms in comparison with the reality of things.

In *Great Books of the Western World* (Volume 33)

*Pensées*

Section II, 72

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Regnault, Noël** 1702–62

Jesuit mathematician

Till you have discovered to me the Mysteries of the Loadstone, I shall be no more at Quiet than a Loadstone itself, which is not in its natural Situation, and which is seeking out the Poles of the Earth.

*Philosophical Conversations* (Volume 1)

Conversation XV (p. 196)

Printed for W. Innys, C. Davis & N. Prevost. London, England. 1731

We have not... Eyes piercing enough to penetrate so far as the Surface of the World; we don't see the external Figure of it: But if we judge it by the common Persuasion, and by what is offered to our Senses, when the Weather is serene, and the Heavens sparkle with Stars, the World is round: It is a Sphere.

*Philosophical Conversations* (Volume 1)

Conversation XIII (p. 158)

Printed for W. Innys, C. Davis & N. Prevost. London, England. 1731

**Seneca (Lucius Annaeus Seneca)** 4 BCE–65 AD

Roman playwright

The world is a poor affair if it does not contain matter for investigation for the whole world in every age. Nature does not reveal all her secrets at once. We imagine we are initiated in her mysteries: we are as yet, but hanging around her outer courts.

*De Aurmentis Scientiarum*

De Cometis

**Shelley, Percy Bysshe** 1792–1822  
English poet

Worlds on worlds are rolling ever  
From creation to decay

Like the bubbles on a river

Sparkling, bursting, borne away.

*The Complete Poetical Works of Percy Bysshe Shelley*

Worlds on Worlds

Houghton Mifflin Company. Boston, Massachusetts, USA. 1901

**Stevenson, Robert Louis** 1850–94  
Scottish essayist and poet

The world is so full of a number of things,  
I'm sure we should all be as happy as kings.

*A Child's Garden of Verses*

Happy Thought

Delacorte Press. New York, New York, USA. 1985

**Tennyson, Alfred (Lord)** 1809–92  
English poet

Come, my friends,

'T s not too late to seek a newer world.

...

To sail beyond the sunset, and the baths

Of all the western stars.

*Alfred Tennyson's Poetical Works*

Ulysses, l. 56–57, 60–61

Oxford University Press, Inc. London, England. 1953

**Thoreau, Henry David** 1817–62  
American essayist, poet, and practical philosopher

This curious world which we inhabit is more wonderful  
than it is convenient, more beautiful than it is useful; it is  
more to be admired than to be used.

Commencement address

*Harvard University, 1837*

**Toulmin, Stephen** 1922–  
English philosopher

**Goodfield, June**

Science writer, screenwriter, and historian

The picture of the natural world we all take for granted today has one remarkable feature, which cannot be ignored in any study of the ancestry of science: it is a historical picture. Not content with achieving intellectual command over the world of their own times, men have been anxious to go further, and discover how the present state of things came to be as it is. Having mapped the existing topography of the heavens and grasped the principles now governing the world of matter, they have also reached back into the darkness of past time, to a period which earlier generations would have found inconceivably remote.

*The Discovery of Time*

Introduction (p. 17)

Harper & Row, Publishers. New York, New York, USA. 1965

**Twain, Mark (Samuel Langhorne Clemens)** 1835–1910

American writer and humorist

It takes a long time to prepare a world for man, and such a thing is not done in a day. Some of the great scientists, carefully ciphering the evidence furnished by geology, have arrived at the conviction that our world is prodigiously old, and they may be right, but Lord Kelvin is not of their opinion. He takes the cautious, conservative view, in order to be on the safe side, and feels sure it is not so old as they think. As Lord Kelvin is the highest authority in science now living, I think we must yield to him and accept his view. He does not concede that the world is more than a hundred million years old.

In Bernard Devoto (ed.)

*Letters from the Earth*

The Damned Human Race

Chapter I (pp. 211–212)

Harper & Row, Publishers. New York, New York, USA. 1959

**Weyl, Hermann** 1885–1955

German mathematician

The world does not happen, it simply is.

*Symmetry*

Bilateral Symmetry (p. 5)

Princeton University Press. Princeton, New Jersey, USA. 1960

**Wordsworth, William** 1770–1850

English poet

... worlds unthought of till the searching mind  
Of Science laid them open to mankind.

*The Complete Poetical Works of William Wordsworth*

To the Moon, Rydal, l. 40

Crowell. New York, New York, USA. 1888

## WRITING

**Cohen, I. Bernard** 1914–2003

American physicist and science historian

The writings of all great men stand as a perpetual challenge to each succeeding generation which attempts to make an interpretation suitable to its own age.

*Franklin and Newton*

Chapter One (p. 3)

Harvard University Press. Cambridge, Massachusetts, USA. 1966

**Einstein, Albert** 1879–1955

German-born physicist

Your exposition is of matchless clarity and perspicuity. You did not dodge any problems but took the bull by the horns, said all that is essential, and omitted all that is inessential.

*The Collected Papers of Albert Einstein* (Volume 8)

Letter 297. Letter to Moritz Schlick, 6 February 1917 (p. 284)

**Emerson, William** 1701–82

English mathematician

I am very sensible how difficult a thing it is to write well upon the science of Astronomy; by reason the subject is so comprehensive, and consists of so many parts, and is connected with so many other sciences, which it requires the perfect knowledge of; and besides, is a work of so much time, that a man had need have the life of Mathusalem, to go thro' the whole of it.

*A System of Astronomy: Containing the Investigation and Demonstration of the Elements of that Science*

The Preface (p. iii)

Printed for J. Nourse. London, England. 1769

**Kepler, Johannes** 1571–1630

German astronomer

...prolixity of phrases has it own obscurity, no less than terse brevity. The latter evades the mind's eye while the former distracts it; the one lacks the light while the other overwhelms with superfluous glitter; the latter does not arouse the sight while the former quite dazzles it.

*New Astronomy*

Author's introduction (p. 47)

At The University Press. Cambridge, England. 1992

**Locke, John** 1632–1704

English philosopher and political theorist

I have put into thy hands what has been the diversion of some of my idle and heavy hours. If it has the good luck to prove so of any of thine, and thou hast but half so much pleasure in reading as I had in writing it, thou wilt as little think thy money, as I do my pains, ill bestowed.

In *Great Books of the Western World* (Volume 35)

*An Essay Concerning Human Understanding*

Epistle to the Reader (p. 87)

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

**Lowell, Percival** 1855–1916

American astronomer

I believe that all writing should be a collection of precious stones of truth which is beauty. Only the arrangement differs with the character of the book. You string them into a necklace for the world at large, pigeon hole them in drawers for the scientist. In the necklace you have the cutting of your thought, i.e., the expressing of it and the arrangement of the thoughts among themselves.

In Ferris Greenslet

*The Lowells and Their Seven Worlds*

Book VII, Chapter I (p. 355)

Houghton Mifflin Company. Boston, Massachusetts, USA. 1946

**Moog, Florence** 1915–87

American biologist

Good writing, after all, is just clear thinking. Anyone who can think well enough to make advances in any learned field ought to be able to write about his work. I am, of course, aware than many research papers submitted to scientific journals are, from a literary standpoint, putrid; but usually such essays are scientifically not very fragrant either.

Can Scientists Write for the General Public

*Science*, Volume 119, Number 3095, 23 April, 1954 (p. 567)

**Oersted, Hans Christian** 1777–1851

Danish physicist and chemist

So much is certain: that nothing is better adapted to form a mind which is capable of great development, than living and participating in great scientific revolutions. I would therefore counsel all those whom the period they live in has not naturally presented with this advantage, to procure it artificially for themselves, by reading the writings of those periods in which the sciences have suffered great changes. To pursue the writings of the most opposite systems, and to extract their hidden truth, to answer questions raised by these opposite systems, to transfer the chief theories of the one system into the other, is an exercise which cannot be sufficiently recommended to the student. He would certainly be rewarded for this labour, by becoming as independent as possible of the narrow opinions of his age.

*The Soul in Nature with Supplementary Contributions*

Observations on the History of Chemistry: A Lecture 1805–1807

(p. 322)

Henry G. Bohn. London, England. 1852

**Rossi, Hugo** 1935–

American mathematician

It is extremely hard for mathematicians to do expository writing. It is not in our nature. In fact, the very nature of mathematical meaning and grammar militates against it. However, this puts us at a distinct disadvantage relative to other sciences. ... Good exposition should be valued, not only for the success in communication but also as evidence of real mathematical insight. It is no accident that among our greatest mathematicians are our greatest teachers and expositors.

From the Editor

*Notices of the American Mathematical Society*, Volume 42, Number 1,

January 1995 (p. 4)

**von Braun, Wernher** 1912–77

German-born rocket scientist

When a good scientific paper earns a student as much glory as we shower upon the halfback who scored the winning touchdown, we shall have restored the balance that is largely missing from our schools.

Text of Address by von Braun Before the Publishers' Group Meeting Here

*New York Times*, 29 April 1960, L 20, column 5



**WRONG**

**Kingsley, Charles** 1819–75  
English clergyman and author

You must not say that this cannot be, or that that is contrary to nature. You do not know what Nature is, or what she can do; and nobody knows, not even Sir Roderick Murchison, or Professor Owen, or Professor Sedg-

wick, or Professor Huxley, or Mr. Darwin, or Professor Faraday, or Mr. Grove.... They are very wise men; and you must listen respectfully to all they say: but even if they should say, which I am sure they never would, "That cannot exist. That is contrary to nature, you must wait a little and see; for perhaps even they may be wrong."

*The Water-Babies*

Chapter II (p. 58)

Dodd, Mead & Company. New York, New York, USA. 1910

## X

### X-RAY

#### Author undetermined

The Roentgen Rays, The Roentgen Rays  
What is this craze,  
The town's ablaze,  
With the new phase  
of X-rays ways  
I'm full of daze,  
Shock and amaze,  
For nowadays,  
I hear they'll gaze,  
Thro' cloak and gown — and even stays,  
These naughty, naughty Roentgen Rays.  
In John G. Taylor  
*The New Physics*  
Chapter 2 (p. 46)  
Basic Books, Inc. New York, New York, USA. 1972

**Bacon, Roger** 1214–92  
English philosopher, scientist, and friar

No substance is so dense as altogether to prevent rays from passing. Matter is common to all things, and thus there is no substance on which the action involved in the passage of a ray may not produce a change. Thus it is that rays of heat and sound penetrate through the walls of a vessel of gold or brass. It is said by Boethius that a lynx's eye will pierce through thick walls. In this case the wall would be permeable to visual rays. In any case there are many dense bodies which altogether interfere with the visual and other senses of man, so that rays cannot pass with such energy as to produce an effect on human sense, and yet nevertheless rays do really pass, though without our being aware of it.

In Victor Robinson  
*The Story of Medicine*  
Chapter VII (pp. 208–209)  
The New York Home Library. New York, New York, USA. 1943

**Jauncey, G. E. M.** 1888–1947  
Australian physicist

O Roentgen, then the news is true  
And not a trick of idle rumor  
That bids us each beware of you  
And of your grim and graveyard humor.  
*Scientific American*, February 22, 1896

**Lewis, Edwin Herbert** 1866–1938  
American rhetorician, novelist, and poet

...left alone with the X-ray man, Marvin plied him with questions. He so fascinated the radiographer that presently he was rewarded with a mystery even greater than

that of the subtle unseen light. He was taken into a dark closet and permitted to peer into a small instrument containing salts of radium.

He saw a flight of stars, a sheaf of rays, a faint fierce sparkling! The heavy metallic radium atom was exploding! It was bombarding a small black screen with cannon flashes!

Instantly the boy inquired why somebody did not capture the power of that explosion and set it to work. He was told that any such achievement was impossible. The show was not affected by heat or cold, and would continue for a thousand years or more till the radium was all used up.

What were those flashes? How could he learn more about them? He must wait till he had enough physics to follow the writings of a man named Rutherford.

*White Lightning*  
Chapter 2 (p. 8)  
Covici-McGee. Chicago, Illinois, USA. 1923

**Polanyi, Michael** 1891–1976  
Hungarian-born English scientist, philosopher, and social scientist

One of the greatest and most surprising discoveries of our own age, that of the diffraction of X-rays by crystals (in 1912) was made by a mathematician, Max von Laue, by the sheer power of believing more concretely than anyone else in the accepted theory of crystals and X-rays.

*Personal Knowledge*  
Chapter 9, Section 5 (p. 277)  
Harper & Row, Publishers. New York, New York, USA. 1962

**Röntgen, Wilhelm Conrad** 1845–1923  
German physicist

For brevity's sake I shall use the expression "rays," and to distinguish them from others of this name I shall call them "x-rays."

In Otto Glasser  
*Dr. W.C. Röntgen*  
Chapter IV (p. 42)  
Charles C. Thomas, Publisher. Springfield, Illinois, USA. 1945

**Russell, Bertrand Arthur William** 1872–1970  
English philosopher, logician, and social reformer

Everybody knows something about X-rays, because of their use in medicine. Everybody knows that they can take a photograph of the skeleton of a living person, and show the exact position of a bullet lodged in the brain. But not everybody knows why this is so. The reason is that the capacity of ordinary matter for stopping the rays varies approximately as the fourth power of the atomic number of the elements concerned....

*The ABC of Atoms* (p. 97)  
E.P. Dutton & Company. New York, New York, USA. 1923

**Russell, L. K.**

No biographical data available

She is so tall, so slender, and her bones —  
Those frail phosphates, those carbonates of lime —  
Are well produced by cathode rays sublime,  
By oscillations, amperes and by ohms.  
Her dorsal vertebrae are not concealed  
By epidermis, but are well revealed.

Line on an X-Ray Portrait of a Lady

*Life*, March 12, 1896

**Shakespeare, William** 1564–1616

English poet, playwright, and actor

Come, come, and sit you down, you shall not budge;  
You go not till I set you up a glass

Where you may see the innermost part of you.

In *Great Books of the Western World* (Volume 27)

*The Plays and Sonnets of William Shakespeare* (Volume 2)

Hamlet, Prince of Denmark

Act III, Scene iv, l. 18–20

Encyclopædia Britannica, Inc. Chicago, Illinois, USA. 1952

## Y

### YELLOW FEVER

**Theiler, Max** 1899–1972

South African-born American microbiologist

By the intelligent application of antimosquito measures combined with vaccination, public-health officials have now the means available to render what was once a prevalent epidemic disease to one which is now a comparatively rare infection of man.

*Nobel Lectures, Physiology or Medicine 1942–1962*

Nobel lecture for award received in 1951

The Development of Vaccines Against Yellow Fever (p. 359)

Elsevier Publishing Company. Amsterdam, Netherlands. 1964

## Z

### ZEEMAN EFFECT

**Zeeman, Pieter** 1865–1943  
Dutch physicist

In consequence of my measurements of Kerr's magneto-optical phenomena, the thought occurred to me whether the period of the light emitted by a flame might be altered when the flame was acted upon by magnetic force. It has turned out that such an action really occurs.

The Effect of Magnetisation on the Nature of Light Emitted by a Substance  
*Nature*, Volume 55, Number 1424, 11 February 1897 (p. 347)

### ZERO

**Bôcher, Maxime** 1867–1918  
American mathematician

...there is what may perhaps be called the method of optimism which leads us either willfully or instinctively to shut our eyes to the possibility of evil. Thus the optimist who treats a problem in algebra or analytic geometry will say, if he stops to reflect on what he is doing: "I know that I have no right to divide by zero; but there are so many other values which the expression by which I am dividing might have that I will assume that the Evil One has not thrown a zero in my denominator this time."

The Fundamental Conceptions and Methods in Mathematics  
*Bulletin of the American Mathematical Society*, 2<sup>nd</sup> Series, Volume 11, 1904 (pp. 134–135)

**Dunham, William**  
American mathematician

Dividing by zero is the closest thing there is to arithmetic blasphemy.

*The Mathematical Universe: An Alphabetical Journey Through the Great Proofs, Problems, and Personalities*  
Quotient (p. 203)  
John Wiley & Sons, Inc. New York, New York, USA. 1994

**Hugo, Victor** 1802–85  
French author, lyric poet, and dramatist

One microscopic glittering point; then another; and another, and still another; they are scarcely perceptible, yet they are enormous. This light is a focus; this focus, a star; this star, a sun; this sun, a universe; this universe, nothing. Every number is zero in the presence of the infinite.

Translated by Isabel F. Hapgood  
*The Toilers of the Sea*  
Part II, Book Second, Chapter V (p. 370)  
The Heritage Press. New York, New York, USA. 1961

**Oken, Lorenz** 1779–1851  
German naturalist

The whole science of mathematics depends upon zero. Zero alone determines the value in mathematics.

Zero is in itself nothing. Mathematics is based upon nothing, and, consequently, arises out of nothing.

*Elements of Physiophilosophy*  
Part I (p. 5)  
The Ray Society. London, England. 1847

**Zamyatin, Yevgeny** 1884–1937  
Russian novelist, playwright, and satirist

The circles are at times golden, sometimes they are bloody, but all have 360 degrees. They go from 0 degrees to 10 degrees, 20 degrees, 200 degrees, 360 degrees — and then again 0 degrees. Yes we have returned to zero. But for a mathematically working mind it is obvious that this zero is different.

Translated by Gregory Zilboorg  
*We*  
Record Twenty (p. 110)  
E.P. Dutton & Company. New York, New York, USA. 1952

### ZETA

**Conrey, B.**  
No biographical data available

It's a whole beautiful subject and the Riemann zeta function is just the first one of these, but it's just the tip of the iceberg. They are just the most amazing objects, these L-functions — the fact that they exist, and have these incredible properties are tied up with all these arithmetical things — and it's just a beautiful subject. Discovering these things is like discovering a gemstone or something. You're amazed that this thing exists, has these properties and can do this.

In K. Sabbagh  
*The Riemann Hypothesis: The Greatest Unsolved Problem in Mathematics*  
Chapter 12 (p. 196)  
Farrar, Straus & Giroux. New York, New York, USA. 2002

**Gutzwiller, M. C.**  
Swiss-born American physicist

The zeta function is probably the most challenging and mysterious object of modern mathematics, in spite of its utter simplicity.... The main interest comes from trying to improve the Prime Number Theorem, i.e., getting better estimates for the distribution of the prime numbers. The secret to the success is assumed to lie in proving a conjecture which Riemann stated in 1859 without much fare, and whose proof has since then become the single most desirable achievement for a mathematician.

*Chaos in Classical and Quantum Mechanics*

Chapter 17.9 (p. 308)  
Springer-Verlag, New York, New York, USA. 1990

### Sabbagh, K.

Writer and television producer

In 1859, a German mathematician called Bernhard Riemann, a “timid diffident soul with a horror of attracting attention to himself,” published a paper that drew more attention to him than to almost any other mathematician in the 19<sup>th</sup> century. In it he made an important statement: the non-trivial zeros of the Riemann zeta function all have real part equal to  $1/2$ . That is the Riemann Hypothesis: 15 words encapsulating a mystery at the heart of our number system.

In Ernst Peter Fischer  
*Beautiful Mathematics*  
Prospect, January 2002

## ZETA FUNCTION

### Bombieri, Enrico 1940–

Italian mathematician

I am firmly convinced that the most important unsolved problem in mathematics today is the truth or falsity of a conjecture about the zeros of the zeta function, which was first made by Riemann himself.... Even a single exception to Riemann’s conjecture would have enormously strange consequences for the distribution of prime numbers.... If the Riemann hypothesis turns out to be false, there will be huge oscillations in the distribution of primes. In an orchestra, that would be like one loud instrument that drowns out the others — an aesthetically distasteful situation.

Prime Territory: Exploring the Infinite Landscape at the Base of the Number System  
*The Sciences*, Sept/Oct 1992

### Borwein, J. 1951–

Scottish mathematician

### Bradley, D.

No biographical data available

It is intriguing that any of the various new expansions and associated observations relevant to the critical zeros arise from the field of quantum theory, feeding back, as it were, into the study of the Riemann zeta function. But the feedback of which we speak can move in the other direction, as techniques attendant on the Riemann zeta function apply to quantum studies.

Computational Strategies for the Riemann Zeta Function  
*Journal of Computational and Applied Mathematics*, Volume 121, 2000

### Sarnak, P. 1953–

South African-born American mathematician

[It has been] said that the zeros [of the Riemann zeta function] weren’t real, nobody measured them. They

are as real as anything you will measure in a laboratory — this has to be the way we look at the world.

1999 *Mathematical Science Research Institute lecture*  
Random Matrix Theory and Zeroes of Zeta Functions – A Survey

## ZOO

### Diolé, Philippe 1908–77

French biologist

The world of animals in captivity offers us at once a prophetic glimpse and a caricature of the world in which modern man lives out his life. The animal suffers psychologically and his suffering is not unlike that of man himself, since its world is characterized by deterioration of its environment and by its own degradation. The causes are the same in both cases: the increase in the number of individual animals in a zoo — baboons, for example — suffer from, and are deformed by, lack of sufficient space for them to lead a harmonious social existence. When captivity has done its work and an animal has become truly dangerous, it then becomes necessary to isolate it in a cage of its own.

Translated by J.F. Bernard  
*The Errant Ark: Man’s Relationship with Animals*  
The Cruelty of Paradise  
Putnam, New York, New York, USA. 1974

### Hediger, Heini 1908–92

Swiss zoologist

One of the most frequent misconceptions which is constantly met in the zoo is the business of regarding the animals as prisoners. This is as false and old-fashioned as if in these days everybody still thought that radio and television sets contained little men who talked, sang and danced inside the sets.

Translated by Gwynne Vevers and Winwood Reade  
*Man and Animal in the Zoo*  
Chapter 3 (p. 99)  
Delacorte Press, New York, New York, USA. 1969

### Queneau, Raymond 1903–76

French poet, novelist, and publisher

In the dog days while I was in a bird cage at feeding time I noticed a young puppy with a neck like a giraffe who, like the toad, ugly and venomous, wore yet a precious beaver upon his head. This queer fish obviously had a bee in his bonnet and was quite bats; he started yak-yakking at a wolf in sheep’s clothing claiming that he was treading on his dogs with his beetle-crushers, but the sucker got a flea in his ear; that foxed him, and quiet as a mouse he ran like a hare for a perch.

I saw him again later in front of the Zoo with a young buck who was telling him to bear in mind a certain drill about his fevers.

*Exercises in Style*

Zoological (p. 179)

New Direction Publishing Corporation. New York, New York, USA. 1981

**Wynne, Annette**

American poet

Excuse us, Animals in the Zoo,  
I'm sure we're very rude to you;  
Into your private house we stare  
And never ask you if you care;  
And never ask you if you mind.  
Perhaps we really are not kind:  
I think it must be hard to stay  
And have folks looking in all day,  
I wouldn't like my house that way.

*All Through the Year*

Excuse Us, Animals in the Zoo

Frederick A. Stokes. New York, New York, USA. 1932

**ZOOLOGIST****Agassiz, Jean Louis Rodolphe** 1807–73

Swiss-born American naturalist, geologist, and teacher

Lay aside all conceit. Learn to read the book of nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search.

In David Stair Jordan

*Popular Science Monthly*, Volume 40, 1891**Wheeler, William Morton** 1865–1937

American entomologist

...I shall strenuously endeavor to be modern, I can only beg you, if I fail to come within hailing distance of the advance guard of present-day zoologists, to remember that the range of adaptability in all organisms, even zoologists, is very limited.

*Essays in Physiological Biology*

Essay I (p. 4)

Harvard University Press. Cambridge, Massachusetts, USA. 1939

**ZOOLOGY****Bierce, Ambrose** 1842–1914

American newspaperman, wit, and satirist

**HIPPOGRIF**, n. An animal (now extinct) which was half horse and half griffin. The griffin was a compound creature, half lion and half eagle. The hippogriff was, therefore, only one quarter eagle, which is \$2.50 in gold. Zoology is full of surprises.

*The Devil's Dictionary*

Doubleday &amp; Company, Inc. Garden City, New York, USA. 1967

**Bock, W. J.**

No biographical data available

Communication — information exchange — among zoologists is the core of zoological nomenclature; everything else pales in the light of the importance of communication.

History and Nomenclature of Avian Family Group Names

*Bulletin of the American Museum of Natural History*, Volume 221, 1994 (p. 8)**Doyle, Sir Arthur Conan** 1859–1930

Scottish writer

Living, as I do, in an educated and scientific atmosphere, I could not have conceived that the first principles of zoology were so little known. Is it possible that you do not know the elementary fact in comparative anatomy, that the wing of a bird is really the forearm, while the wing of a bat consists of three elongated fingers with membranes between?

*The Lost World*

Chapter IV (p. 55)

The Colonial Press. Clinton, Massachusetts, USA. 1959

**Elton, Charles S.** 1900–91

English biologist

...the discoveries of Darwin, himself a magnificent field naturalist, had the remarkable effect of sending the whole zoological world flocking indoors, where they remained hard at work for fifty years or more, and whence they are now beginning to put forth cautious heads again into the open air.

*Animal Ecology*

Chapter I (p. 3)

Sidgwick &amp; Jackson, Ltd. London, England. 1927

**Feynman, Richard P.** 1918–88

American theoretical physicist

I began to read the paper. It kept talking about extensors and flexors, the gastrocnemius muscle, and so on. This and that muscle were named, but I had not the foggiest idea of where they were located in relation to the nerves or to the cat. So I went to the librarian in the zoology section and asked her if she could find me a map of the cat.

“A map of the cat, sir?” she asked horrified. “You mean a zoological chart!”

*Surely You're Joking, Mr. Feynman!: Adventures of a Curious Character*

A Map of a Cat? (p. 72)

W.W. Norton &amp; Company, Inc. New York, New York, USA. 1985

**Hugo, Victor** 1802–85

French author, lyric poet, and dramatist

Zoology is as limitless as cosmography.

Translated by Isabel F. Hapgood

*The Toilers of the Sea*

Part II, Book Third, Chapter III (p. 418)  
The Heritage Press. New York, New York, USA. 1961

**Kovalevskii, V. O.**

Russian paleontologist

And so, the task of modern zoology consists in this; it should acquaint us with the entire variety of animal forms which populate our world, not in terms of a disorganized multitude from which this or that form happens to catch our attention, but as a structured whole, in which each form occupies a designated place, so one can instantly note and critically analyze all the particularities of each separate member; it should show us the inner structure of these groups and of their individual members, and in what relationship they stand to members of other groups; it should present the history of each member, beginning with its [first] appearance...it should open the ancient

tombs of the earth and demonstrate to us the endless series of ancestors and relatives which proceed those animals which we now see.

In William Coleman and Camille Limoges (eds.)

*Studies in History of Biology* (Volume 2)

Kovalevskii and Paleontology (pp. 112–113)

The Johns Hopkins University Press. Baltimore, Maryland, USA.  
1977–84

**Polanyi, Michael** 1891–1976

Hungarian-born English scientist, philosopher, and social scientist

The existence of animals was not discovered by zoologists, nor that of plants by botanists, and the scientific value of zoology and botany is but an extension of man's pre-scientific interests in animals and plants.

*Personal Knowledge*

Chapter 6, Section 2 (p. 139)

Harper & Row, Publishers. New York, New York, USA. 1962



# Index

## Symbols

19th Century Naval Song 1457  
6th Baron Byron 762

## A

Abbe, Cleveland 1246  
Abbey, Edward 26, 67, 156, 172, 256, 334, 337, 432, 451, 653, 710, 740, 759, 928, 942, 959, 968, 970, 1064, 1143, 1161, 1197, 1208, 1230, 1260, 1262, 1269, 1417, 1579, 1640, 1649, 1715, 1720  
Abbey, Henry 1056  
Abbot, Charles 186  
Abbot, Charles Greeley 116, 509, 774  
Abbott, Donald Putnam 696, 1025, 1091, 1574  
Abbott, Edwin A. 345, 517  
Abbott, Roy L. 41  
Abel, Niels Henrik 803, 1459  
Abel, Reuben 436  
Abelard, Peter 1722  
Abelson, Philip H. 509  
Abernethy, John 1073, 1365  
Accreditation Board for Engineering and Technology 447  
Ace, Goodman 641, 894  
Achard, Franz Karl 1117  
Ackerman, Diane 26, 54, 59, 66, 75, 79, 144, 188, 322, 759, 970, 1010, 1143, 1153, 1155, 1188, 1374, 1696  
Ackerman, Edward A. 1417  
Ackoff, Russell Lincoln 270, 970  
Acton, F. S. 1575  
Acton, John Emerich 653  
Acton, Loren 1502  
Adam, John A. 1624  
Adams, Abby 970  
Adams, Charles C. 383  
Adams, Douglas 37, 336, 375, 510, 679, 711, 759, 1007, 1025, 1076, 1108, 1174, 1215, 1244, 1430, 1477, 1551, 1595, 1673, 1696  
Adams, Franklin Pierce 437  
Adams, George 12, 281, 437, 515, 516, 547, 609, 664, 711, 889, 892, 920, 963, 970, 1046, 1244, 1246, 1382, 1502, 1624, 1649  
Adams, Henry Brooks 80, 224, 486, 517, 581, 606, 803, 869, 1109, 1269, 1382, 1526  
Adams, John 1174  
Adams, Robert 1091  
Adams, Roger 74  
Adams, Samuel Hopkins 894, 1072  
Addis, Thomas 261, 1704  
Addison, Joseph 377, 633, 712, 942, 971  
Addison, Thomas 8  
Adelman, Leonard 1164  
Adler, Alfred 305, 804, 870, 1579  
Advertisement 310, 620, 1526  
Aeschylus 284, 1013, 1040, 1167  
Aesop 230, 1206  
Agassiz, Jean Louis Rodolphe 26, 48, 213, 257, 278, 292, 301, 451, 517, 591, 959, 962, 968, 971, 1039, 1081, 1143, 1409, 1426, 1494, 1549, 1727, 1737  
Ager, Derek 378  
Agnew, Neil McK. 1246, 1421  
Agnew, Ralph Palmer 559, 567, 653, 1188, 1430  
Agre, Peter 1411  
Agricola, Georgius 929  
Aiken, Conrad 1502  
Airy, George Biddell 116, 1144  
Ajello, Libero 568  
Akenside, Mark 201, 670, 1270  
Albright, Fuller 894  
Albritton, William Foxwell 91  
Albritton, Jr., Claude 304  
Albutt, Thomas Clifford 11

- Alcott, Louisa May 517  
 Aldersey-Williams, Hugh 236, 937  
 Alderson, M. H. 147  
 Aldrich Thomas Bailey 971  
 Aleksandrov, Aleksandre Danilovic 804  
 Alexander, Burton F. 1575  
 Alexander, Christopher 222  
 Alexander, Franz 310  
 Alexander, R. McNeill 347  
 Alexander, William 911  
 Alexander the Great 1093  
 Alfven, Hannes 299, 1477, 1673  
 Alger, John R. M. 408, 1188, 1498  
 Alger, William R. 942  
 Alighieri, Dante 633, 712, 774, 918, 1270, 1502  
 Alison, Richard 1585  
 Allaby, (John) Michael 383  
 Allee, Warder C. 26, 54, 169  
 Allen, Charles M. 1579  
 Allen, Dave 609  
 Allen, Durward L. 169, 322  
 Allen, Elizabeth Akers 1636  
 Allen, Ethan 609  
 Allen, Grant 49, 452, 968  
 Allen, Robert Porter 46, 222  
 Allen, Roy George Douglas 21, 1526  
 Allen, Woody 294, 804, 1063, 1551, 1617  
 Allison, G. Burgess 389  
 Allman, David 322, 1093  
 Allport, Gordon 1382  
 Allport, Susan 188, 1270  
 Alon, Noga 505  
 Alpher, Ralph Asher 1382  
 Alphonsus X 162  
 Altmann, Jeanne 1025  
 Alvarez, Luis Walter 183, 1117, 1215, 1262, 1501  
 Alves, Reuben 1270  
 Amaldi, Ginestra Giovane 312, 1010, 1673  
 Amati, Danielle 1549  
 Ambler, Eric 213  
 Amend, Bill 510  
 American Geophysical Union 259  
 American Institute of Biological Science 1963 1084  
 American Museum of Natural History 517  
 American Society for Engineering Education 422  
 Ames, Bruce 1161  
 Ames, Nathaniel 1206  
 Amiel, Henri-Frédéric 11, 310, 437, 578, 628, 1270  
 Amis, Martin 1718  
 Ammons, Archie Randolph 64  
 Ampere, Andre-Marie 517  
 Amundson, Ronald 642  
 Anaxagoras 446, 684, 1048  
 Anderson, Peggy 1022  
 Anderson, Poul 209, 1188  
 Anderson, Tempest 1710  
 Andreas, Brian 1502  
 Andreski, Stanislav 145  
 Andric, Ivo 191  
 Angell, Roger 1526  
 Angelou, Maya 347  
 Anglin, William S. 804  
 Anscombe, Francis John 328, 437, 1025, 1521  
 Anyidoho, Kofi 1711  
 Apfel, Necia H. 1673  
 Apollo 11 107  
 Apostle, Hippocrates George 804  
 Appleton, Sir Edward 1354, 1430  
 Appleyard, Bryan 1270, 1382, 1430  
 Aquinas, St. Thomas 201, 213, 452, 1722  
 Arabic Proverb 1270  
 Arago, Francois 116, 387, 804  
 Aratus 284, 289, 1502  
 Arber, Agnes Robertson 167, 1421  
 Arbuthnot, John 14, 712, 804, 1175  
 Archilochus 381  
 Archimedes of Syracuse 450, 759, 1013, 1265  
 Archytas of Tarentum 689  
 Ardrey, Robert 82, 694, 760, 792, 1365  
 Arendt, Hannah 1144  
 Argelander, Friedrich Wilhelm August 1025  
 Arieti, Silvano 305  
 Aristo, Chian 805  
 Aristophanes 548  
 Aristotle 105, 156, 188, 202, 209, 222, 257, 517, 547,  
 609, 640, 654, 679, 712, 782, 805, 971, 1013,  
 1144, 1472, 1567, 1625, 1649, 1723  
 Armitage, Simon 737  
 Armour, Richard 8, 25, 1073  
 Armstrong, David Malet 1163, 1459  
 Armstrong, Henry Edward 231, 236  
 Armstrong, John 181, 188, 894  
 Armstrong, Martin D. 573  
 Armstrong, Neil A. 946, 1165, 1482  
 Arnaldus de Villa Nova 1093  
 Arnauld, Antoine 270, 1230  
 Arnheim, Rudolf 231, 1266  
 Arnold, James R. 1482  
 Arnold, John E. 80  
 Arnold, Matthew 517, 972  
 Arnold, Sir Edwin 1564, 1640  
 Arnold, Thurman 328  
 Arnoldus 341  
 Arnott, Neil 621, 1665  
 Aron, Raymond 213, 295, 557  
 Aronin, Ben 408  
 Aronowitz, Stanley 1649  
 Arp, Halton Christian 1025

- Arthur, Timothy Shay 202  
 Artstein, Zvi 805  
 Artuad, Antonin 1430  
 Arwaker, Edmund 408  
 Ascham, Roger 870  
 Ashby, Sir Eric 1579  
 Ashlock, P. D. 737  
 Asimov, Isaac 86, 179, 236, 323, 422, 490, 609, 712,  
 788, 792, 805, 889, 954, 1013, 1084, 1165, 1240,  
 1246, 1270, 1354, 1369, 1396, 1406, 1482, 1495,  
 1595, 1620, 1702  
 Askey, Vincent 641  
 Asphaug, Erik 106  
 Asquith, Herbert 642  
 Association of American Colleges 1580  
 Astaire, Fred 213, 1081  
 Astbury, William Thomas 1270  
 Aston, Francis W. 402  
 Astronomy Survey Committee 1470  
 Atchity, Kenneth 670  
 Aterman, Kurt 781  
 Athenaeus 1547  
 Atherton, Gertrude 147, 202, 972  
 Atiyah, Sir Michael 1665  
 Atkins, Peter William 81, 128, 231, 236, 270, 276, 504,  
 805, 1077, 1617, 1673  
 Atkins, Russell 1175  
 Atkinson, Brooks 32  
 Atkinson, Richard John Copeland 91  
 A Traveler 517  
 Atwood, Margaret 1010  
 Auden, W. H. 870, 1430  
 Audubon, John James 35, 39, 40, 45, 46, 378, 712, 972,  
 1056  
 Auenbrugger, Leopold 1077  
 Aurelius Antoninus, Marcus 202, 445, 452, 689, 1025,  
 1093, 1502, 1625, 1673  
 Austen, Jane 195, 950, 1175  
 Auster, Paul 1013, 1169, 1200  
 Austin, Alfred 236  
 Austin, Mary Hunter 68, 74, 335, 792, 950, 1269  
 Author undetermined 14, 30, 46, 51, 58, 64, 66, 68, 72,  
 78, 83, 101, 144, 184, 231, 264, 331, 352, 374,  
 376, 378, 389, 400, 401, 408, 436, 517, 561, 574,  
 593, 743, 805, 927, 928, 929, 936, 954, 1008,  
 1056, 1070, 1090, 1093, 1109, 1117, 1139, 1214,  
 1246, 1262, 1270, 1369, 1421, 1557, 1576, 1640,  
 1665, 1711, 1719, 1732  
 Auvaiyaar 1702  
 Avedon, Richard 1649  
 Avicenna 950  
 Avogadro, Amedeo 1714  
 Awiakta, Marilou 156  
 Ayala, Francisco J. 642, 1084, 1586  
 Ayer, Alfred Jules 1070, 1596  
 Aylett, Robert 1557  
 Ayres, Clarence Edwin 1025, 1164  
 Aytoun, William Edmondstoune 144
- B**
- Babbage, Charles 744  
 Babylonian Inscription 264  
 Babylonian Sun-God Marduk 285  
 Bach, Richard 712  
 Bachelard, Gaston 402  
 Bachrach, Arthur J. 1246  
 Bacon, Leonard 1673  
 Bacon, Roger 805, 1705, 1732  
 Bacon, Sir Francis 2, 23, 85, 97, 152, 156, 202, 211,  
 213, 341, 344, 353, 367, 452, 491, 517, 574, 670,  
 681, 696, 704, 712, 805, 894, 972, 1013, 1048,  
 1094, 1117, 1225, 1265, 1271, 1350, 1377, 1431,  
 1549, 1625, 1649, 1665, 1674  
 Baden-Powell, Robert Stephenson Smyth 128  
 Baeyer, Adolf von 275  
 Baez, Joan 642  
 Bagehot, Walter 2, 654, 1175, 1674  
 Baggott, Jim 211  
 Bagnold, Enid 545  
 Bagnold, Ralph A. 1469  
 Bahn, Paul 88, 91, 1188  
 Bailar, Jr., John C. 236  
 Bailey, Edward Battersby 1160  
 Bailey, Geoff 91  
 Bailey, Janet 1464  
 Bailey, Liberty Hyde 1640  
 Bailey, Percival 1094  
 Bailey, Philip James 408, 684, 972, 1477, 1503, 1551  
 Bailey, Thomas D. 147  
 Bailey, W. B. 1522, 1527  
 Bailey, William Whitman 1157, 1640, 1719  
 Baillie, Joanna 408  
 Baily, Francis 381  
 Bain, Alexander 257, 806  
 Baines, J. A. 1527  
 Bajer, Francis J. 916  
 Bak, Per 452  
 Baker, Adolph 1109  
 Baker, Henry 437, 916, 972, 1026, 1457  
 Baker, Russell 905, 1431  
 Baker, W. R. 345  
 Bakker, Robert T. 347, 1061  
 Balard, Antoine-Jérôme 1271  
 Balchin, Nigel 295, 518, 1523, 1527  
 Baldwin, J. Mark 1621  
 Baldwin, Joseph G. 1094  
 Balfour, Arthur James 87, 486, 889, 1649, 1699  
 Balifour, Arthur J. 793

- Ball, John 931  
 Ball, Philip 162, 231, 389, 760, 937, 1144, 1204  
 Ball, Sir Robert S. 1156, 1246  
 Ball, Walter William Rouse 1117  
 Ballard, Chris 91  
 Ballard, James Graham 1406, 1580  
 Ballard, Robert 760  
 Banach, Stefan 19  
 Bangs, Richard 1715  
 Banks, Iain M. 17  
 Banks, Sir Joseph 1139  
 Banting, Frederick G. 698  
 Barbauld, Anna Laetitia 61  
 Barbellion, Wilhelm Nero Pilate 372, 452, 1674  
 Barbour, Julian 1665  
 Barcroft, Joseph 344  
 Barfield, Owen 270, 642, 670, 713, 1649  
 Baring, Maurice 367  
 Barley, Nigel 83  
 Barnard, Christiaan N. 630  
 Barnard, Edward Emerson 1153  
 Barnes, Barry 1064  
 Barnes, Bishop 1477  
 Barnes, Djuna 104, 630, 1022, 1462  
 Barnes, Michael R. 1076  
 Barnett, I. A. 1021  
 Barnett, Lincoln 1109, 1271, 1491, 1617, 1625  
 Barnett, P. A. 806, 1230  
 Baron Munchausen 702  
 Baron von Frankenstein 972  
 Barr, Amelia Edith Huddleston 1431  
 Barr, H. F. 559  
 Barrell, Joseph 1144  
 Barrett-Browning, Elizabeth 37, 39, 43, 549, 581, 638, 1013, 1527, 1641  
 Barrie, Sir James M. 14, 44, 518, 713, 1246, 1360  
 Barrow, Gordon M. 937  
 Barrow, Isaac 806, 870, 1625  
 Barrow, John D. 402, 1045, 1070, 1084, 1175, 1208, 1244, 1468, 1696  
 Barry, Dave 387, 1396  
 Barry, Frederick 518, 642, 713, 806, 1175  
 Barth, John 353, 1674  
 Barthelme, Donald 1081  
 Barthes, Roland 740  
 Bartlett, Albert A. 806  
 Bartlett, Elisha 172, 236, 642  
 Bartlett, Elizabeth 684  
 Bartlett, Maurice Stevenson 155, 1527  
 Bartol, C. A. 579  
 Bartow, Edward 236  
 Bartram, William 432  
 Bartusiak, Marcia 744  
 Baruch, Bernard M. 129, 310, 447, 518, 1271  
 Barwise, Jon 1460  
 Barzun, Jacques 756, 1271, 1576, 1580  
 Bashford, Sir Henry Howarth 576  
 Baskerville, Charles 1271  
 Bass, Murray H. 1094  
 Bass, William M. 1272  
 Bassler, Thomas J. 323  
 Bastin, Ted 209  
 Batchelor, G. K. 1421  
 Bates, Henry Walter 59, 452  
 Bates, Marston 282, 323, 518, 760, 793, 1246, 1272  
 Bates, R. L. 593  
 Bates, Rhonda 1161  
 Bateson, William 209, 452, 485, 635, 963, 1245  
 Batten, Henry L. 1288  
 Battles, William Snowden 642  
 Baudelaire, Charles 1503  
 Baudrillard, Jean 697, 1272, 1527  
 Baudrimont, A. E. 1225  
 Bauer, Georg (Agricola or Georgius Agricola) 1026  
 Bauer, Henry H. 81, 312, 1084, 1272, 1396, 1411, 1417  
 Baum, Harold 375, 1091  
 Baum, L. Frank 1247  
 Baumel, Judith 631, 1021  
 Baxter, Richard 1637  
 Bayliss, William Maddock 1409  
 Baynes, Ernest Harold 36  
 Beacock, Cal 553  
 Beadle, George Wells 575  
 Beale, Thomas 75  
 Beam, Alex 263  
 Beard, Charles A. 1272, 1363  
 Beard, George M. 437  
 Beattie, James 222, 1272  
 Beaumarchais, Pierre-Augustin Caron de 1230  
 Beaumont, Francis 310, 972  
 Beaumont, William 518, 1650  
 Beaver, Wilfred 64  
 Becher, Johann Joachim 232  
 Beck, Lewis White 1230  
 Becker, Carl L. 713, 793, 1411, 1665, 1726  
 Becker, Ernest 1650  
 Beckett, Chris 946  
 Beckett, Samuel 638, 1022, 1647  
 Beckmann, Petr 567, 1138  
 Bednyi, Demian 129  
 Beebe, William 31, 62, 518, 806, 973, 1040, 1272, 1452, 1719  
 Beecher, Henry Ward 453, 549, 1215, 1637  
 Beer, Stafford 1580  
 Beerbohm, Max 689  
 Begley, Sharon 806, 1013  
 Beguinus, Jean 237  
 Behe, Michael 453

- Belinfante, Frederik Jozef 1208  
 Belinsky, Vissarion Grigorievich 654, 1197  
 Belinsky, Vissarion Grigoryevich 518  
 Belitz, K. 934  
 Belkora, Leila 316  
 Bell, David F. 1299  
 Bell, E. T. (Eric Temple) 1, 21, 105, 213, 270, 402, 598, 625, 779, 785, 806, 871, 1013, 1118, 1200, 1215, 1495, 1527, 1592, 1723  
 Bell, J. A. 889  
 Bell, R. P. 1081  
 Bell, Sir Charles 1059  
 Bellamy, David 1144  
 Belleville, Nicholas 1096  
 Bellman, Richard 402, 807  
 Belloc, Hilaire 45, 47, 71, 72, 73, 74, 76, 195, 211, 271, 367, 953, 1247, 1523, 1527  
 Bellow, Saul 1523  
 Benchley, Peter 53  
 Benchley, Robert 129, 209, 262, 389  
 Benét, William Rose 1503  
 Benford, Gregory 1592  
 Benjamin, Arthur 331  
 Bennett, Arnold 117, 271, 1727  
 Bennett, Charles H. 195  
 Bennett, Jeffrey O. 108  
 Bennett, William Cox 1272  
 Bent, Henry Albert 237  
 Bentley, Arthur 807  
 Bentley, Richard 129, 609  
 Bentley, Wilson 1472  
 Benzer, Seymour 575  
 Bergaust, Erik 1477, 1666  
 Berger, J. O. 1527  
 Berger, John 1452  
 Berger, Peter L. 1382  
 Bergman, Charles 283  
 Bergman, Torbern Olaf 1666  
 Bergmann, P. 1109  
 Bergson, Henri 202, 453, 699, 807, 1118, 1477, 1625, 1637, 1674  
 Berkeley, Edmund C. 195, 318, 1189, 1596  
 Berkeley, George 334, 553, 598, 684, 1360, 1666  
 Berkenhout, John 894  
 Berlinski, David 198, 581, 778, 807, 1491  
 Bernal, John Desmond 237, 263, 504, 692, 760, 957, 1200, 1272, 1355, 1382, 1483  
 Bernard, Claude 147, 167, 202, 353, 437, 491, 502, 503, 518, 638, 642, 654, 713, 744, 760, 808, 894, 912, 1026, 1046, 1053, 1082, 1085, 1094, 1230, 1273, 1360, 1365, 1411, 1425, 1528, 1545, 1596, 1650  
 Bernoulli, Daniel 871  
 Bernstein, Al 1206  
 Bernstein, Jeremy 8, 19, 183, 664, 1396, 1596  
 Berrett, Wayne 377  
 Berrill, Norman John 760, 1576, 1723  
 Berry, Arthur 664  
 Berry, D. A. 1528  
 Berry, Daniel M. 1014  
 Berry, James H. 1585  
 Berry, M. V. 1118, 1258  
 Berry, Richard 1503  
 Berry, Richard James Arthur 383  
 Berry, Sir Michael 1244  
 Berry, Wendell 283, 1721  
 Berryman, John 67, 88  
 Bers, Lipman 808  
 Berselius, Jöns Jacob 737  
 Berthelot, Marcellin 4, 11, 129, 237, 1273, 1569  
 Berthollet, C. L. 230  
 Bertotti, Bruno 665  
 Berzelius, Jöns Jacob 227, 237, 1052, 1596  
 Bessey, Charles E. 1496  
 Besso, Michele 576  
 Bester, Alfred 337, 579, 1592, 1636  
 Beston, Henry 26, 32, 44, 256, 973, 1010, 1040, 1144, 1379, 1452  
 Bethe, Hans 331, 1596  
 Bevan, Aneurin 639  
 Beveridge, William Ian Beardmore 277, 353, 486, 643, 670, 920, 1189, 1230, 1247, 1417, 1431  
 Bialac, Richard N. 271  
 Bianchi, Leonardo 188  
 Bianco, Margery Williams 931, 1225  
 Bibby, Geoffrey 344  
 Bice, James 581  
 Bichat, Xavier 117  
 Bicknell, Alexander 883  
 Bierce, Ambrose 73, 331, 335, 581, 927, 1041, 1587, 1737  
 Bigelow, Jacob 895  
 Bigelow, S. Lawrence 1596  
 Biggs, Noah 237  
 Bilaniuk, Oleksa-Myron 1174  
 Bill, Max 808  
 Billings, John Shaw 1528  
 Billings, Josh (Henry Wheeler Shaw) 11, 147, 195, 519, 713  
 Billington, David 422  
 Billroth, Theodor 912  
 Binford, Lewis R. 19, 88, 318  
 Bing, Ilse 688  
 Birch, Arthur J. 305, 1247, 1273, 1502  
 Birchmore, Sue 409  
 Bird, J. M. 167  
 Bird, R. T. 554  
 Birkeland, Kristian 389

- Birkhoff, Garrett 1048  
 Birkhoff, George David 808, 1109, 1118  
 Birmingham Brown 636  
 Birrell, Augustine 1555  
 Bisch, Louis E. 668  
 Bishop, Elizabeth 973  
 Bishop, Errett 808  
 Bishop, Jim 92  
 Bishop, Morris 403  
 Bishop, Samuel 1206  
 Bishop Joseph Hall 1041  
 Bishop of Birmingham 1067  
 Black, Hugh 1273  
 Black, Joseph 232, 237, 1273  
 Black, Max 808, 871, 1426  
 Blackett, Lord Patrick Maynard Stuart 1118  
 Blackie, John Stuart 72, 224, 350, 581, 609  
 Blackmore, Sir Richard 1139, 1155, 1157  
 Blackwelder, R. E. 1574  
 Blackwell, Elizabeth 1094  
 Blagonravov, Anatoly A. 1483  
 Blaise, Clarke 920  
 Blake, William 31, 43, 129, 213, 403, 549, 622, 670, 685, 689, 793, 942, 1026, 1077, 1175, 1200, 1273, 1369, 1503, 1567, 1576, 1625, 1710  
 Blalock, Jr., Hubert M. 1528  
 Blane, Gilbert Sir 1546  
 Blanshard, Brand 61  
 Blavatsky, Elena Petrovna 1273  
 Bleckley, Logan E. 1175  
 Bloch, Arthur 491, 744, 1076, 1189, 1267, 1528, 1674  
 Bloch, Felix 195  
 Bloch, Marc 713  
 Blodgett, James H. 1523, 1528  
 Bloom, Allan 1273  
 Bloom, Orly Castel 577  
 Bloom, Samuel W. 895  
 Bloomfield, Leonard 740  
 Bloomfield, Robert 973  
 Bloor, David 713, 808, 1216  
 Blough, Roger M. 409  
 Blount, Sir Thomas Pope 378, 640, 1674  
 Blum, Harold 1617  
 Blumenbach, Johann Friedrich 561, 1496  
 Blumenberg, Hans 761  
 Blundeville, Thomas 1265  
 Bly, Robert 654  
 Boas, Franz 83  
 Boas, George 920, 1274  
 Boas, Jr., Ralph P. 1238  
 Boas, Ralph P. 198  
 Bobrow, Daniel Gureasko 1565  
 Bôcher, Maxime 598, 1735  
 Bochner, Salomon 808  
 Bock, W. J. 1737  
 Boeham, George A. W. 21  
 Boehm, G. A. W. 802  
 Boelter, L. M. K. 409  
 Boerhaave, Herman 237, 928, 1576  
 Boethius 115, 214, 688, 1014  
 Bogert, Marston Taylor 232  
 Bohm, David 2, 519, 609, 744, 774, 793, 883, 973, 1085, 1216, 1274, 1625  
 Bohn, H. G. 486  
 Bohr, Niels Henrik David 21, 129, 277, 486, 491, 680, 714, 740, 761, 809, 973, 1065, 1118, 1165, 1208, 1226, 1274, 1431, 1476, 1491, 1596, 1617, 1650  
 Bolles, Edmund Blair 1026  
 Bolton, Henrietta 1404  
 Bolton, Henry Carrington 195, 491, 1077, 1274  
 Boltzmann, Ludwig Edward 13, 156, 343, 574, 643, 871, 1109, 1216, 1594, 1618  
 Bolyai, János 353  
 Bolyai, Wolfgang 353  
 Bolz, Ray E. 306  
 Bombieri, Enrico 1169, 1216, 1258, 1736  
 Bonaparte, Napoleon 627, 872, 895, 1094, 1205, 1274  
 Bond, J. 668  
 Bond, S. 668  
 Bondi, Sir Hermann 297, 889, 1085, 1274, 1596, 1625  
 Bonnett, O. T. 668  
 Bonnor, William Bowen 609  
 Boole, George 2, 202, 1175  
 Boole, Mary Everest 14  
 Boone, John Allen 31, 79  
 Boorde, Andrew 1092  
 Boorse, Christopher 545  
 Boorstin, Daniel J. 787, 1198, 1528, 1546  
 Bordes, Francois 1663  
 Borel, Félix Edouard 680, 714  
 Borel, Félix Edouard Justin Emile 214, 279, 437, 598, 1014, 1175  
 Borges, Jorge Luis 26, 685, 739, 1014, 1567, 1625  
 Boring, Edwin Garrigues 1706  
 Borland, Hal 41, 59, 383, 453, 671, 690, 761, 793, 959, 973, 1144, 1157, 1503, 1626, 1641, 1721  
 Borlase, William 549, 962  
 Borman, Frank 942  
 Born, Max 129, 214, 312, 343, 389, 403, 409, 486, 609, 671, 883, 931, 1082, 1118, 1176, 1208, 1226, 1256, 1274, 1381, 1409, 1412, 1431, 1596, 1647, 1650, 1674  
 Bornstein, Kate 328  
 Borwein, J. 1736  
 Boscowitz, Arnold 378  
 Bosler, Jean 1275  
 Bostwick, Arthur Elmore 312, 1176  
 Boswell, James 883, 1176

- Bottomley, Gordon 787  
 Boulding, Kenneth E. 376, 569, 575, 714, 1085  
 Bouille, Pierre 744  
 Boulton, Matthew 1163  
 Boundy, Cather 608  
 Bounoure, Louis 454  
 Bourbaki, Nicholas 872, 1065  
 Bourdillon, Francis William 1551  
 Bourne, William 1046  
 Boutroux, Émile 328, 744, 809, 1383  
 Boutroux, Pierre 782  
 Bove, Ben 1674  
 Bowditch, Nanthaniel 809  
 Bowen, Elizabeth 486  
 Bowen, Norman L. 790, 1710  
 Bowley, Arthur L. 147, 1523, 1528, 1529  
 Bowman, Scotty 1529  
 Bowman, W. E. 1529  
 Bowyer, Stuart 1696  
 Box, George E. P. 690, 931, 1026  
 Boycott, A. E. 1409  
 Boyd, Lyle B. 1419  
 Boyd, William Andrew Murray 872  
 Boyer, Carl 809  
 Boyle, Robert 12, 14, 108, 232, 238, 394, 643, 737, 809, 973, 1118  
 Boynton, William 1153  
 Brackenridge, Hugh Henry 323, 1095  
 Bracker, Milton 1060  
 Bradbury, Ray 27, 519, 700, 930, 1153, 1275, 1477, 1483, 1597, 1626  
 Braddon, Mary Elizabeth 930  
 Bradford, Gamaliel 519  
 Bradley, A. C. 1247  
 Bradley, D. 1736  
 Bradley, Duane 409  
 Bradley, Jr., John Hodgdon 50, 154, 224, 378, 436, 454, 606, 761, 793, 974, 1060, 1144, 1204, 1263, 1275, 1453, 1478, 1551, 1597, 1674, 1711, 1715  
 Bradley, Mary Hastings 70  
 Bradley, Omar 129, 1360  
 Bradley, W. H. 593  
 Bradshaw, A. D. 383  
 Brady, Nicholas 883  
 Bragdon, Claude 97, 810  
 Bragg, Sir William Henry 389, 774, 1119  
 Bragg, Sir William Lawrence 9, 654, 1189  
 Brahe, Tycho 1265, 1471  
 Brahmagupta 14  
 Brain, Lord Walter Russell 1431  
 Brainard, John 285  
 Braithwaite, Richard B. 487  
 Braithwaite, William Stanley 373  
 Bramah, Ernest 275, 700  
 Bramley, William 1664  
 Brand, Stewart 692  
 Brandeis, Louis D. 101, 148, 409  
 Brandt, John C. 1471  
 Braudel, Fernand 680  
 Brautigan, Richard 301  
 Breathed, Guy Berkeley 45  
 Brecht, Bertolt 610, 665, 704, 714, 1109, 1275, 1369, 1503, 1587  
 Bredwell, Stephen 238  
 Bremer, J. 1275  
 Brennan, Richard P. 1119  
 Brenner, Sydney 454  
 Brett-Surman, Michael 1060  
 Bretz, J Harlen 581  
 Brew, John O. 1574  
 Brewster, David 117, 1503  
 Brewster, Edwin Tenney 581, 950, 1275, 1431  
 Brewster, G. W. 377  
 Bridges, Robert Seymour 157, 232, 238, 810  
 Bridgman, F. W. 1727  
 Bridgman, Helen Bartlett 974  
 Bridgman, Percy Williams 214, 277, 296, 385, 519, 697, 810, 974, 1014, 1208, 1275, 1412, 1468, 1597, 1618, 1626  
 Brillouin, Léon 503, 671, 1109, 1626  
 Brin, David 1397  
 British Admiralty 327  
 British Association for the Advancement of Science 1597  
 British Engineer to the Royal Aeronautical Society 422  
 Broad, William 1145, 1239, 1275, 1426  
 Broca, Paul 66  
 Broch, Hermann 1453  
 Brodie, Sir Benjamin Collins 671, 1565  
 Brody, Elaine M. 11  
 Brögger, A. W. 1663  
 Bromberger, Sylvain 579  
 Brome, Alexander 409  
 Bronk, Detlev W. 256  
 Bronk, William 1727  
 Bronowski, Jacob 117, 152, 257, 271, 397, 437, 487, 559, 625, 714, 789, 793, 810, 931, 974, 1085, 1119, 1226, 1276, 1365, 1375, 1431, 1580, 1650, 1706  
 Bronte, Charlotte 942, 974  
 Bronte, Emily 1641  
 Brood, William J. 1503  
 Brooks, Daniel R. 1067  
 Brooks, Edward 810  
 Brooks, Harvey 1226  
 Brooks, W. K. 546, 761  
 Brophy, Brigid 27, 1231  
 Brough, J. C. 1011

- Brougham, Henry 353, 671  
 Broun, Heywood 191  
 Brouwer, L. E. J. 889  
 Browder, Felix E. 810  
 Brower, David 36, 60, 168, 283, 1721  
 Brown, Fredric 598, 1504  
 Brown, Gerald 331  
 Brown, H. 594  
 Brown, Hugh Auchincloss 183, 1548  
 Brown, I. David 231  
 Brown, J. Howard 1247  
 Brown, John 1650  
 Brown, Jr., G. T. 705  
 Brown, Julian R. 1110, 1121  
 Brown, Lloyd 802  
 Brown, Michael S. 1095  
 Brown, Relis B. 454  
 Brown, Thomas 1048  
 Browne, B. P. 394  
 Browne, J. Stark 633, 1504, 1675  
 Browne, Sir Thomas 255, 310, 323, 367, 485, 608, 639, 974, 1046, 1048, 1205, 1231, 1626  
 Browning, Robert 232, 316, 491, 519, 633, 689, 974, 1041, 1247, 1471, 1504  
 Brownlee, Donald 1026, 1160, 1203  
 Bruchac, Joseph 27  
 Bruncken, Herbert Gerhardt 446  
 Bruner, Jerome Seymour 354, 643, 703, 810, 1576  
 Bruno, Giordano 665, 1478, 1675, 1728  
 Brusca, Gary 49  
 Bryan, J. Ingram 157, 974  
 Bryan, Kirk 802  
 Bryan, William Jennings 454, 1276  
 Bryant, Alice Franklin 1641  
 Bryant, William Cullen 549, 975, 1041, 1231, 1504, 1641  
 Bryce, John 895  
 Bryson, Bill 884, 1222, 1276  
 Bryson, Lyman 756  
 Bube, Richard H. 714  
 Buber, Martin 610  
 Buchan, William 1095  
 Buchanan, Robert Williams 97, 238  
 Buchanan, Scott 409, 654, 810, 872, 1015, 1200, 1240, 1432, 1565  
 Bucher, W. H. 562  
 Buchner, Edward 238  
 Büchner, Georg 582  
 Buchner, Ludwig 214, 519, 1276, 1529  
 Buck, Pearl S. 195, 761, 1383, 1432  
 Buck, R. C. 811  
 Buckham, John Wright 1276  
 Buckland, Francis T. 350  
 Buckland, Frank 1597  
 Buckle, Henry Thomas 1422  
 Buckley, Arabella B. 519, 671, 1404, 1715  
 Budworth, D. 1381  
 Buffalo Springfield 1664  
 Bulfinch, Thomas 714  
 Bulgakov, Mikhail 454  
 Bullard, Edward Crisp 790  
 Bullen, Frank T. 76  
 Bullock, J. Lloyd 232  
 Bullock, James 811  
 Bullock, Theodore Holmes 714  
 Bultmann, R. 1383  
 Bulwer, John 1567  
 Bunch, Sterling 1471  
 Bunge, Mario 1247, 1277, 1580  
 Bunsen, Robert Wilhelm Eberhard 1  
 Bunting, Basil 1277, 1504  
 Burbridge, Geoffrey 1119  
 Burdon-Sanderson, J. 706  
 Burgess, Anthony 1095  
 Burgess, Robert W. 1529  
 Burhoe, R. W. 1086  
 Burke, C. J. 374  
 Burke, Edmund 157, 811, 1015, 1504, 1715  
 Burnan, Tom 1529  
 Burnet, Frank Macfarlane 1495  
 Burnet, Thomas 202, 950, 975, 1082, 1145, 1504, 1711  
 Burney, Fanny 975, 1059, 1176  
 Burnham, Jr., Robert Jr. 633  
 Burnham, Robert, Jr. 117  
 Burns, Marilyn 1074  
 Burns, Olive Ann 1022  
 Burns, Robert 144, 222, 285, 520, 606, 1638, 1641  
 Burr, Lehigh 567  
 Burritt, Elijah H. 1504, 1675  
 Burroughs, Edgar Rice 280, 347, 783, 1490, 1597  
 Burroughs, John 58, 186, 454, 520, 591, 954, 975, 1027, 1078, 1140, 1157, 1260, 1263, 1277, 1377, 1383, 1473, 1474, 1647, 1710  
 Burroughs, William S. 1109, 1145, 1432, 1675  
 Burton, Leone 811  
 Burton, Robert 23, 310, 942, 947, 975, 1266, 1462  
 Burton, Sir Richard Francis 129, 942, 1231  
 Burt, B. L. 1574  
 Burt, E. A. 1226  
 Burt, W. A. 744  
 Bury, John Bagnell 85, 1277  
 Busch, Wilhelm 1638  
 Bush, George H. W. 188  
 Bush, Vannevar 11, 302, 714, 1176, 1248, 1277, 1383, 1420, 1651, 1666, 1675, 1723  
 Bushnell, Horace 1085, 1383  
 Butler, Brett 905  
 Butler, James Newton 1565  
 Butler, Joseph 610, 967, 1176



- Butler, Nicholas Murray 811, 1412  
 Butler, Samuel 14, 21, 69, 130, 185, 211, 214, 310,  
 373, 437, 450, 454, 487, 492, 510, 582, 627, 628,  
 654, 668, 715, 895, 908, 920, 942, 975, 1277,  
 1360, 1383, 1504, 1586, 1587, 1662, 1715  
 Butlerov, Aleksandr Mikhailovich 520, 715  
 Butterfield, Herbert 947, 1355  
 Butterworth, Brian 1015  
 Buttimer, Anne 1278  
 Buzzati-Traverso, Adriano 1278  
 Byford, W. H. 1547  
 Byrd, Deborah 118  
 Byrom, Gletcher L. 1580  
 Byron, George Gordon 762  
 Byron, George Gordon, 6th Baron Byron 71, 101, 107,  
 148, 238, 264, 367, 385, 715, 740, 781, 791, 793,  
 906, 951, 975, 1041, 1095, 1145, 1237, 1460,  
 1622, 1641, 1699
- C**
- Cabell, James Branch 1201  
 Cable, George W. 186, 429, 430, 976  
 Cabot, Richard Clarke 447  
 Cady, Varian 238  
 Cage, Jr., John Milton 438  
 Caglioti, Luciano 239  
 Cain, A. J. 1574  
 Caithness, James Balharrie 381, 908  
 Cajori, Florian 715, 811, 1011  
 Calder, Alexander 1432, 1675  
 Calder, Nigel 108  
 Calder, Peter Ritchie 354  
 Calder, Ritchie 1278  
 Caldwell, G. C. 708  
 Caldwell, George W. 1557  
 Callahan, Daniel 577  
 Callaway, Jack M. 562  
 Callen, Charles Lane 227  
 Calvin, Melvin 306, 1278, 1651  
 Calvin, William H. 906, 1208, 1397  
 Calvino, Italo 397, 398, 454  
 Cambridge Conference on School Mathematics 198  
 Camden, William 1095  
 Campbell, Donald T. 1723  
 Campbell, J. H. 454, 577  
 Campbell, Jeremy C. 976  
 Campbell, Norman R. 19, 385, 1086, 1278, 1370, 1412,  
 1597  
 Campbell, Thomas 976, 1278, 1505, 1641  
 Camras, Marvin 354  
 Camus, Albert 211, 487, 655, 685, 754, 912, 1079,  
 1278, 1675  
 Canetti, Elias 27  
 Canning, George 128, 640  
 Cannon, Annie Jump 1404  
 Cannon, Walter Bradford 354, 682, 715  
 Cantor, Georg 812, 1597  
 apek, Josef 54  
 apek, Karel 54  
 Capek, Milic 130, 162, 884  
 Caplan, Arthur 447  
 Capp, Al 422  
 Capra, Fritjof 172, 906, 957, 1248  
 Captain Janeway 1208  
 Captain Kirk 318, 1478  
 Card, Orson Scott 610, 680, 1675  
 Cardano, Girolamo 341  
 Cardenal, Ernesto 163, 179, 1618, 1696  
 Cardozo, Benjamin N. 487, 1176, 1239, 1594  
 Carlson, A. J. 1702  
 Carlton, J. T. 506  
 Carlyle, Thomas 64, 285, 367, 520, 547, 554, 579, 610,  
 685, 812, 976, 1027, 1095, 1278, 1474, 1491,  
 1505, 1529, 1573, 1622, 1626, 1637, 1675  
 Carmichael, Robert Daniel 812, 1651  
 Carnap, Rudolf 715, 1085, 1119  
 Carnochan, John Murray 1557  
 Carnot, Sadi Nicolas Leonhard 631  
 Carpenter, Kenneth 351  
 Carpenter, William B. 520, 554  
 Carr, Archie 30  
 Carr, William H. 951, 1721  
 Carr-Saunders, A. M. (Alexander Morris), Sir 97  
 Carr-Saunders, Sir A. M. (Alexander Morris), 95  
 Carrel, Alexis 148, 607, 1051, 1248, 1279  
 Carroll, J. E. 715  
 Carroll, Lewis (Charles Dodgson) 5, 7, 49, 53, 54, 75,  
 77, 79, 81, 101, 188, 295, 327, 375, 438, 492,  
 515, 520, 640, 643, 680, 709, 711, 783, 802, 912,  
 943, 947, 959, 962, 1529, 1567, 1587, 1627, 1638  
 Carruth, William Herbert 455  
 Carryl, Charles Edward 193, 1409  
 Carson, Hampton 562  
 Carson, Rachel 172, 283, 455, 520, 756, 779, 976,  
 1041, 1162, 1268, 1279, 1453, 1461, 1708  
 Cartwright, Nancy 1119  
 Carus, Paul 689, 812  
 Carver, George Washington 610  
 Casimir, Hendrik B. G. 740, 1351, 1422  
 Cassell, Eric J. 668  
 Cassidy, Harold Gomes 1370  
 Cassiodorus 812  
 Cassirer, Ernst 277, 1086, 1370  
 Cassius Dio 1711  
 Casson, Stanley 812  
 Casti, John L. 744  
 Cather, Willa 39  
 Caullery, Maurice 1248

- Cavendish, Margaret, Duchess of Newcastle 130  
 Cawein, Madison Julius 943, 976  
 Cayley, Arthur 157, 812  
 Cedering, Siv 598, 1587  
 Ceild, J. M. 579  
 Celsus, Aulus Cornelius 1557  
 Cerf, Bennett 1038, 1226  
 Cernan, Eugene 1505  
 Cernan, Gene 107  
 Chadwick, James 1009  
 Chadwick, John 264  
 Chadwick, Owen 1383  
 Chaisson, Eric J. 296, 297, 299, 571, 976  
 Chakrabarti, C. L. 239  
 Chalmers, Thomas 594  
 Chamberlain, Owen 1355  
 Chamberlain, Rollin T. 292, 709, 812, 1145  
 Chamberlin, T. C. 202, 582, 594, 1597  
 Chambers, Robert 1189  
 Chamfort, Nicolas 262, 323  
 Chamfort, Sebastien Roch 214  
 Chandler, Mary 1548  
 Chandler, Raymond Thornton 1651  
 Chandrasekhar, Subrahmanyan 157, 179, 790, 920,  
 1279, 1464  
 Chang, Kwang-Chih 19  
 Chantrenne, H. 165  
 Chapin, Charles V. 8  
 Chapman, C. H. 812  
 Chapman, Clark R. 106, 594, 1140  
 Chapman, Frank M. 32, 334  
 Chapman, Robert D. 1471  
 Chappell, Edwin 438  
 Chaptal, Jean-Antoine-Claude 239  
 Charcot, Jean-Martin 1598  
 Chargaff, Erwin 19, 118, 152, 155, 166, 168, 172, 209,  
 232, 277, 354, 492, 520, 715, 912, 932, 936, 954,  
 977, 1079, 1086, 1216, 1279, 1351, 1410, 1422,  
 1426, 1432, 1651, 1702  
 Charles, John 1702  
 Charles, Prince of Wales 895  
 Charlie Chan 75, 107, 279, 312, 450, 492, 520, 599,  
 715, 895, 1268, 1457, 1597, 1651  
 Chase, Stuart 377  
 Chasles, Michel 599  
 Chatfield, Christopher 271, 318, 1521, 1529  
 Chatton, Milton J. 294  
 Chaucer, Geoffrey 918, 977, 1140, 1266, 1627  
 Chaudhuri, Haridas 884  
 Chedd, Graham 679  
 Cheeseman, Peter 932  
 Chekhov, Anton Pavlovich 254, 323, 354, 367, 668,  
 895, 952, 1022, 1039, 1168, 1280, 1675  
 Chern, Shiing-Shen 599  
 Chernin, Kim 1280  
 Chernoff, H. 1523  
 Chernyshevsky, Nikolai Gavrilovich 354, 1198, 1280  
 Chesterton, G. K. (Gilbert Keith) 9, 182, 214, 255, 299,  
 345, 399, 455, 520, 633, 671, 697, 762, 783, 785,  
 787, 789, 794, 813, 872, 1086, 1189, 1248, 1280,  
 1351, 1361, 1375, 1377, 1432, 1567, 1598, 1648,  
 1724  
 Chestov, Leon 680  
 Chief Engineer Scott 76  
 Chief Seattle 1145  
 Child, Lydia M. 549, 977  
 Childe, V. Gordon 257, 318  
 Chinese ode 381  
 Chiras, Daniel D. 977  
 Chlandni, E. F. F. 911  
 Chomsky, Noam 354  
 Christiansen, Chris 1223  
 Christianson, Gale E. 1627  
 Christie, Agatha 1585  
 Chrysostom, John 1231, 1462  
 Chrystal, George 813  
 Chu, Steven 130, 1666  
 Chuang Tzu 203  
 Chudnovsky, David 1138  
 Church, Peggy Pond 143  
 Churchill, Charles 977  
 Churchill, Lord Randolph 327  
 Churchill, Sir Winston Spencer 101  
 Churchill, Winston Spencer 195, 367, 409, 521, 690,  
 813, 895, 1189, 1280, 1715  
 Ciardi, John 737  
 Cibber, Colley 97  
 Cicero (Marcus Tullius Cicero) 130, 203, 214, 340,  
 367, 438, 557, 633, 977, 1081, 1505  
 Clare, John 43, 46, 54, 78  
 Clark, C. A. 1521  
 Clark, David 92  
 Clark, Gordon H. 1086  
 Clark, Grahame 1167  
 Clark, R. B. 1549  
 Clark, W. C. 1383  
 Clarke, Arthur C. 105, 118, 505, 510, 521, 557, 637,  
 671, 680, 699, 794, 977, 1189, 1203, 1381, 1397,  
 1432, 1474, 1478, 1482, 1483, 1490, 1491, 1505,  
 1580, 1598, 1636, 1651, 1676  
 Clarke, F. W. 394  
 Clarke, J. M. 715  
 Clarke, John 1550  
 Clarke, M'Donald (The Mad Poet) 1505  
 Clarke, Samuel 1082  
 Clasius, Rudolph 431  
 Claude, Albert 209, 214, 762  
 Clawson, Calvin C. 1015

- Cleaver, Eldridge 1189  
Clegg, Johnny 1505  
Clemence, G. M. 1627  
Clemens, William 507  
Clendening, Logan 1560  
Clerke, Agnes Mary 118, 354, 715, 1156, 1198, 1499  
Cleugh, Mary F. 1627  
Cleveland, John 58  
Cleveland, Richard 1460  
Clifford, William Kingdon 15, 297, 554, 599, 937, 1361, 1379, 1425  
Clift, Wallace B. 957  
Cloos, Hans 183, 582, 927, 1145, 1551  
Close, Frank 130, 977  
Cloud, Preston Ercelle 18, 303, 655, 762  
Clough, Arthur Hugh 783  
Clowes, William 1095, 1206  
Clute, Willard N. 1158  
Coates, Florence Earle 1059  
Coates, Robert M. 745, 1570  
Coats, R. H. 1176, 1546  
Cobbe, Frances P. 1281  
Coblentz, Stanton 373  
Cochran, William G. 15, 1267, 1521  
Coggan, Donald 1281  
Cogswell, Theodore R. 1530  
Cohen, I. Bernard 655, 1189, 1281, 1355, 1370, 1729  
Cohen, Jack 1069, 1220  
Cohen, Jacob 1521, 1530  
Cohen, Jerome 521  
Cohen, Joel 172  
Cohen, Joel E. 1433  
Cohen, John 1176, 1224  
Cohen, Martin 1505  
Cohen, Morris Raphael 19, 148, 521, 643, 912, 1027, 1087, 1365  
Cohn, Ferdinand Julius 154  
Colbert, Edwin H. 1060, 1070, 1281  
Colby, Frank Moore 1216  
Colclaser, R. G. 409  
Cole, A. D. 131  
Cole, K. C. 671, 906, 1209, 1491, 1666  
Cole, Thomas 1505  
Cole, William 1651, 1724  
Coleridge, Mary 715  
Coleridge, Samuel Taylor 34, 97, 232, 265, 487, 521, 560, 652, 759, 813, 977, 1146, 1261, 1464, 1505, 1676, 1715  
Coles, Abraham 1281, 1365  
Collard, Patrick 915  
Collingwood, Robin George 239, 329, 521, 716, 745, 977, 1087, 1137, 1189, 1723  
Collins, Billy 1478  
Collins, John 1638  
Collins, Joseph 1095  
Collins, Michael 943  
Collins, Mortimer 455  
Collins, Wilkie 157, 521, 549, 655, 716  
Colman, George (The Younger) 545, 895, 978  
Colman, George (the Younger) 86  
Colton, Charles Caleb 203, 215, 438, 641, 783, 813, 1092, 1095, 1206, 1593, 1598  
Colum, Padraic 34, 73, 813  
Coman, Dale Rex 312, 592, 762, 978, 1146, 1506, 1622, 1624  
Comfort, Alex 215, 1500  
Commentary 1223  
Committee on Guidelines for Paleontological Collecting 562  
Committee on the Conduct of Science 912  
Commoner, Barry 433, 716, 755, 978, 1189, 1238, 1282, 1484, 1580  
Compton, Arthur H. 1374, 1425, 1651  
Compton, Karl Taylor 271, 338, 409, 422, 610, 1119, 1189, 1282, 1350, 1375, 1377, 1383, 1397, 1417, 1420  
Compton-Burnett, Ivy 27  
Comroe, Jr., Julius H. 1422  
Comstock, Anna Botsford 1641  
Comte, Auguste 15, 118, 198, 599, 683, 813, 1015, 1119, 1165, 1506  
Conant, James Bryant 277, 354, 716, 814, 1282, 1355, 1412, 1432  
Condon, Edward Uhler 1120, 1282  
Condorcet, Marie Jean 814, 1190, 1282  
Conduitt, John 622  
Confucius 716, 1261  
Conger, George Perrigo 1676  
Congreve, William 1231  
Conklin, Edwin Grant 254, 385, 1384  
Connell, Joseph 978  
Connolly, Cyril 169, 1370  
Conoley, Gillian 1164  
Conrad, Joseph 118, 215, 522, 943, 978, 1548, 1666, 1722  
Conrad, Pete 107  
Conrad, Timothy 562, 1648  
Conrey, B. 1735  
Conrey, J. Brian 1258  
Constable, George 1006  
Constance, L. 1574  
Constitution of the United States 1282  
Cook, J. Gordon 1551  
Cook, James H. 562  
Cook, Joseph 116, 227  
Cook, Morris L. 410  
Cook, Peter 951, 1676  
Cook, Robin 295

- Cooke, Josiah Parsons 522, 716  
 Cooley, Charles Horton 1706  
 Cooley, Hollis R. 814  
 Coolidge, Julian L. 599, 814  
 Coon, Carleton 801  
 Cooper, Bernard 1282  
 Cooper, Leon 1283, 1426, 1598  
 Cooper, Thomas 716  
 Copeland, Leland S. 1587  
 Copernicus, Nicolaus 118, 157, 633, 814, 872, 978, 1506, 1551, 1676  
 Corbett, Jim 978  
 Corey, E. J. 232  
 Cori, Carl 1397  
 Corner, E. H. J. 186  
 Cornforth, John W. 884, 1433, 1651  
 Cornu, A. 794  
 Cornwall, Barry (Bryan Waller Procter) 32, 1042  
 Cornwall, I. W. 92  
 Cort, David 643  
 Cortázar, Julio 1666  
 Cosmo Kramer 1153  
 Cossons, Sir Neil 1283  
 Couderc, Paul 1598  
 Coues, E. 1237  
 Coulson, Charles Alfred 1384  
 Couper, Archibald Scott 1598  
 Courant, Richard 815, 872, 1087  
 Cournot, Augustin 815  
 Courtney, Leonard Henry 522  
 Cousins, Norman 319, 690, 978, 1077, 1484, 1490  
 Cousteau, Jacques-Yves 455, 762, 1060, 1433, 1453  
 Coveney, Peter 188  
 Coveyou, R. R. 1225  
 Cowan, C. 1009  
 Cowan, George A. 548  
 Cowen, Richard 18, 208  
 Cowper, William 38, 95, 97, 215, 394, 438, 582, 610, 716, 978, 1022, 1708  
 Cox, Gertrude M. 15, 492, 1521  
 Cox, Sir David Roxbee 1521, 1530  
 Coxeter, H. S. M. 815  
 Crabbe, George 49, 310, 1206  
 Cram, Donald J. 239, 308, 1052  
 Cram, Jane M. 1052  
 Cramer, F. 1433  
 Cranch, Christopher Pearse 36, 549  
 Crandall, Robert W. 1169  
 Crane, H. Richard 1008  
 Crane, Hart 690, 1506  
 Crane, Stephen 1552, 1676  
 Crawford, F. Marion 522  
 Crawford, Osbert Guy Stanhope 88, 92, 1061, 1070  
 Crease, Robert P. 1120, 1598  
 Creele, August 1648  
 Crew, Henry 1718  
 Crew of Apollo 11 946  
 Crichton, Michael 259, 276, 355, 410, 620, 778, 816, 1076, 1176, 1283, 1426, 1433, 1530, 1598, 1706  
 Crichton-Browne, Sir James 108, 262, 696, 1139, 1557  
 Crick, Francis Harry Compton 105, 172, 188, 215, 376, 455, 640, 762, 816, 872, 932, 936, 937, 963, 978, 1040, 1109, 1248, 1283, 1370, 1397, 1412, 1420, 1594, 1598, 1620  
 Crimmins, Cathy 905  
 Crofton, M. W. 271, 1177  
 Croll, Oswald 185, 895, 1095, 1558  
 Croly, George 943  
 Cromer, Alan 680, 1226, 1283, 1599, 1620  
 Cromie, William J. 53, 1283, 1453  
 Cromwell, Oliver 816  
 Cronbach, L. J. 295  
 Cronenberg, David 355, 1433  
 Crookes, Sir William 233, 394, 399, 979, 1410, 1499  
 Crookshank, Francis Graham 896  
 Cropper, William N. 1120  
 Crosby, Harry 1552  
 Cross, Hardy 19, 271, 410, 411, 422, 423, 522, 816, 892, 1190, 1581  
 Crosswell, Ken 1676  
 Crothers, Samuel McChord 185, 456, 522, 779, 1283  
 Crow, J. F. 953  
 Crowley, Abraham 1556  
 Crowley, Aleister 1284, 1677  
 Crowson, Roy Albert 59, 263  
 Crowther, Greg 233  
 Crum, H. A. 1046  
 Cudmore, Lorraine Lee 78, 131, 169, 210, 1012, 1065, 1284, 1709  
 Cullen, William 239  
 Cullinane, N. M. 608  
 Culpeper, N. 261  
 Cummings, John 1523, 1527  
 Cummings, Ray 1627  
 Cunningham, Clifford J. 108  
 Cuppy, Will 37, 50, 52, 64, 70, 72, 76, 77, 78, 193, 381, 429, 507, 562, 653, 1709  
 Curie, Eve 233, 1284  
 Curie, Marie Skłodowska 239, 280, 355, 400, 979, 1198, 1284  
 Curie, Marie Skłodowska- 157  
 Cushing, Harvey 183, 1073, 1096  
 Cussler, Clive 1248  
 Cuvier, Georges 85, 182, 222, 562, 665, 762, 1039  
 Cvikota, Clarence 641  
 Cvikota, Raymond J. 26, 1558  
 Cvitanovic, Predrag 1110

- Cyrano Jones 951  
 Czapek, Frederick 762
- D**
- d'Abro, Abraham 816, 1238, 1284, 1599  
 D'Alembert, Jean Le Rond 276, 816, 1651, 1677  
 D'Avenant, Sir William 108  
 D'Israeli, Isaac 109, 704  
 da Costa, J. Chalmers 215, 544, 896, 1558  
 Dagi, Teodoro Forcht 23  
 Dahlberg, Edward 1666  
 Dalton, John 131, 398, 492, 574, 1569  
 Daly, Reginald Aldworth 1263, 1365  
 Dampier-Whetham, William 212, 643, 763, 1177, 1226, 1642  
 Dana, James Dwight 239, 582  
 Dana, Richard Henry 652  
 Dancoff, S. M. 1351  
 Danforth, Charles Haskell 575  
 Daniel, Glyn 89  
 Daniels, Farrington 643  
 Dante, Alighieri 215, 1256  
 Dantzig, Tobias 546, 689, 816, 873, 1015  
 Dark, K. R. 1599  
 Darling, David 166, 297, 510, 884, 1677  
 Darrow, Karl Kelchner 131, 410, 1120  
 Darwin, Charles Galton 817, 873  
 Darwin, Charles Robert 5, 31, 33, 57, 59, 161, 167, 178, 183, 185, 189, 215, 257, 263, 280, 281, 294, 303, 309, 377, 378, 438, 456, 492, 507, 522, 563, 571, 576, 582, 594, 638, 644, 655, 665, 671, 694, 701, 716, 794, 908, 920, 930, 959, 962, 963, 968, 979, 1027, 1049, 1056, 1081, 1166, 1177, 1207, 1231, 1263, 1284, 1356, 1361, 1469, 1496, 1500, 1530, 1564, 1571, 1576, 1599, 1652, 1706, 1727  
 Darwin, Erasmus 131, 289, 397, 399, 400, 457, 763, 908, 928, 943, 979  
 Darwin, G. H. 200, 1599  
 Darwin, Sir Francis 1284  
 Dastre, A. 884  
 Data 1285  
 Date, J. C. B. 15  
 Daumal, Rene 606, 716  
 Davidson, John 394, 925  
 Davidson, Keay 1472  
 Davidson, R. A. 168  
 Davies, John Tasman 1530, 1599  
 Davies, Paul Charles William 131, 167, 210, 403, 431, 599, 693, 701, 817, 932, 1009, 1015, 1049, 1110, 1120, 1121, 1223, 1240, 1285, 1384, 1412, 1464, 1474, 1478, 1599, 1627, 1671, 1677, 1699  
 Davies, Robertson 208, 332, 817, 1096, 1285, 1558, 1723  
 Davies, Sir John 1728  
 da Vinci, Leonardo 33, 146, 157, 203, 337, 438, 487, 492, 628, 685, 716, 816, 872, 892, 979, 1027, 1146, 1248, 1284, 1593, 1715, 1719  
 Davis, Adelle 342, 1024  
 Davis, Chandler 410, 817  
 Davis, George E. 231  
 Davis, Joel 189, 1379  
 Davis, Joseph S. 1530  
 Davis, Kenneth S. 1285  
 Davis, Philip J. 817, 873, 1169, 1201, 1600, 1627  
 Davis, Watson 1285  
 Davis, William Morris 582, 644, 1285  
 Davisson, Clinton 389  
 Davy, John 493  
 Davy, Sir Humphry 4, 11, 20, 87, 158, 227, 233, 239, 284, 329, 355, 438, 523, 569, 583, 638, 644, 665, 697, 717, 740, 745, 906, 979, 1027, 1068, 1087, 1165, 1285, 1465, 1600, 1622, 1652, 1715, 1727  
 Dawkins, Boyd 583  
 Dawkins, Richard 67, 170, 172, 316, 323, 376, 438, 457, 575, 592, 610, 681, 783, 930, 937, 955, 965, 1015, 1025, 1216, 1249, 1286, 1397, 1506, 1530, 1677, 1724  
 Dawson, Sir John William 583, 594, 980, 1082, 1087  
 Day, Clarence 189, 312, 458, 1677  
 Day, David Howard 89  
 Day, R. A. 1249  
 Day, Roger E. 1047  
 Day-Lewis, C. (Cecil) 1379  
 Day-Lewis, Cecil 873  
 Dayton, P. K. 168  
 Dean, Jr., Robert C. 306, 411  
 Deason, Hilary J. 1411  
 DeBakey, L. 900  
 De Bakey, Michael E. 630  
 de Balzac, Honoré 240, 1286  
 de Bary, Anton 1564  
 de Beauregard, Costa 1491  
 de Beauvoir, Simone 410  
 de Bergerac, Cyrano 95, 1140  
 de Bono, Edward 655, 1286, 1580  
 de Botton, Alain 1082  
 de Broglie, Louis 1492  
 de Bruijn, N. G. 818  
 de Bury, Richard 183  
 de Camp, L. Sprague 410  
 de Casseres, Benjamin 1377  
 de Castro, Adolphe 355  
 de Cervantes, Miguel 162, 285, 488, 628, 896, 1177, 1266  
 de Chambaud, J. J. Ménéret 1039  
 de Chauliac, Guy 1558  
 de Cisternay Dufay, Charles Francois 387  
 Decker, Barbara 1712

- Decker, Robert 1712  
 Dedekind, Richard 1015, 1201  
 de Duve, Christian 507  
 Dee, John 599, 790, 818, 947, 1506, 1678  
 Deetz, James 684, 1551  
 Defant, Albert 1624  
 de Fermat, Pierre 545, 1600  
 Defoe, Daniel 411, 1011, 1639  
 de Fontenelle, Bernard le Bovier 15, 109, 118, 265,  
 351, 493, 774, 873, 918, 980, 1140, 1153, 1156,  
 1552, 1652, 1677  
 De Gourmont, Rémy 1370  
 de Gourmont, Rémy 1286  
 de Grasse Tyson, Neil 127, 1587, 1600  
 De Guevara, Antonio 896  
 Dehn, Max 819  
 de Jonnes, Moreau 1530  
 de Jouvenel, Bertrand 557, 745, 818, 1177, 1433  
 Dekker, Thomas 1096  
 Delacroix, Eugene 980  
 de la Mare, Walter 1458, 1506  
 de Lamennais, Félicité Robert 1404  
 de La Mettrie, Julien Offroy 794  
 Delaney, John 763  
 de la Rue, Warren 1500  
 de la Salle, St. Jean Baptiste 1585  
 Delbrick, Max 210, 639, 1287, 1370  
 de Leeuw, A. L. 1177, 1530  
 DeLillo, Don 1678  
 Dell, J. H. 685  
 Deller, Jr., J. R. 385  
 del Rio, A. M. 1286  
 Deluc, Jean-André 523  
 de Lunay, L. 583  
 de Madariaga, Salvador 896, 1073, 1433, 1530  
 de Maistre, J. 355  
 de Maupassant, Guy 1174  
 de Maupertuis, Pierre-Louis Moreau 1381  
 Dembski, William A. 701, 967, 1384  
 de Ment, J. 553  
 Deming, William Edwards 319, 329, 438, 488, 493,  
 684, 745, 889, 1177, 1267, 1521, 1523, 1531,  
 1563  
 Democritus of Abdera 131, 143, 216  
 de Moivre, Abraham 215, 745, 1177  
 de Mondeville, Henri 544, 1558  
 de Montaigne, Michel Eyquem 644, 980, 1096  
 de Morgan, Augustus 15, 109, 198, 329, 355, 599, 644,  
 685, 699, 818, 819, 873, 918, 1065, 1121, 1138,  
 1177, 1201  
 Denckla, W. Donner 638  
 Dennett, Daniel Clement 53, 655, 756, 937, 1087  
 Dennis, F. S. 1560  
 Denton, Michael J. 458, 571  
 de Pavlovsky, G. 819  
 de Pizan, Christine 1404  
 de Queiroz, K. 1571  
 De Quincey, Thomas 1047  
 Derry, Gregory N. 1075  
 Desaguliers, J. T. 980  
 de Saint-Exupéry, Antoine 109, 196, 316, 335, 510,  
 547, 550, 1010, 1263, 1471, 1506, 1581, 1642,  
 1711, 1716  
 de Saussure, Horace-Bénédict 607  
 Descartes, René 310, 312, 315, 327, 599, 685, 819,  
 896, 913, 940, 947, 1088, 1121, 1178, 1231,  
 1287, 1567, 1652, 1723  
 DeSimone, Daniel V. 411, 423, 1581  
 de Sitter, Willem 1678  
 de Spinoza, Baruch 982  
 Dessauer John 1249  
 de Stael, Madame 819  
 de Tabley, Lord 1506  
 Deudney, Daniel 1478, 1484  
 Deuel, Leo 92  
 de Unamuno, Miguel 240, 368, 523, 1087, 1286  
 Deutsch, Armin J. 1552  
 Deutsch, David 1121  
 Deutsch, Karl W. 932, 1678  
 Deutsch, Martin 503  
 Deutsch, Morton 1535  
 Deutscher, I. 1563  
 Deutscher, Murray 166  
 Devaney, James 908  
 Devaney, Robert L. 224  
 de Vega, Lope 410  
 de Vigevano, Guido 23  
 Devine, Betsy 1433  
 Devlin, Keith 2  
 Devons, Ely 1521, 1531, 1546, 1573  
 DeVore, Irvn 459  
 de Voto, Bernard 794  
 de Vries, Peter 1678  
 Dewar, Douglas 39  
 Dewar, James 1287, 1365  
 Dewey, John 9, 101, 272, 523, 542, 655, 745, 763, 884,  
 890, 1082, 1231, 1375, 1408, 1417, 1532, 1620,  
 1627, 1652, 1709  
 DeWitt, Bryce 1209  
 Dexter, William A. 595, 794  
 Deyrup-Olsen, Ingrith 77  
 Diaconis, Persi 1178  
 Diamond, Jared 510  
 Diamond, Marian 189  
 Diamond, Neil 1010  
 Diamond, Solomon 438  
 Diamond, Stanley 83  
 Di Bacco, Babs Z. 1022

- Dibdin, Charles Isaac Mungo 233, 411  
 Dick, Thomas 118, 265, 610, 774, 1507  
 Dicke, R. H. 1110  
 Dickens, Charles 27, 98, 101, 148, 178, 186, 196, 233, 272, 403, 523, 550, 717, 778, 819, 896, 916, 980, 1027, 1224, 1237, 1532, 1558, 1642  
 Dickerson, Richard E. 1618  
 Dickinson, Emily 23, 47, 58, 158, 186, 228, 289, 548, 633, 896, 916, 980, 1059, 1287, 1507, 1558  
 Dickinson, Frances 523  
 Dickinson, G. Lowes 779, 980, 1287  
 Dickson, Frank 119  
 Dickson, Paul 295  
 Diconis, Persi 1268  
 Diderot, Denis 387, 579, 981, 1267, 1375  
 Dietrich, Marlene 510  
 Dieudonné, Jean 264, 411, 600, 818, 819, 873, 1011  
 Digges, Leonard 1047  
 Dijkstra, Edsger Wybe 546  
 Dillard, Anne 381  
 Dillard, Annie 27, 459, 981, 1169, 1628, 1678  
 Dillehay, Thomas D. 89  
 Dillingsley, H. 818  
 Dillmann, E. 819  
 Dilorenzo, Kirk 1121  
 Dimmick, Edgar L. 1558  
 Dimnet, Ernest 98  
 Dingle, Herbert 2, 390, 717, 1240, 1600  
 Diolé, Philippe 1453, 1736  
 Dirac, Paul Adrian Maurice 11, 158, 434, 611, 636, 656, 745, 818, 819, 884, 941, 981, 1110, 1121, 1209  
 Dirgo, Craig 1248  
 Disraeli, Benjamin, 1st Earl of Beaconsfield 203, 459, 550, 787, 1082, 1287, 1507  
 Ditton, Humphry 640  
 Dixon, Malcom 1040  
 Dixon, William MacNeile 1492  
 Djerassi, Carl 1459  
 Doane, R. W. 62  
 Dobie, J. Frank 1287  
 Dobzhansky, Theodosius 173, 302, 376, 459, 577, 656, 788, 936, 953, 981, 1287, 1384  
 Dock, William 355  
 Dodd, Robert 908  
 Dodge, A. Y. 411  
 Dodge, Richard Elwood 740  
 Domagk, Gerhard 253  
 Donaldson, T. B. 915  
 Donghia, Angelo 105  
 Donleavy, James Patrick 628  
 Donne, John 70, 109, 119, 262, 265, 285, 299, 381, 634, 918, 1082, 1096, 1462  
 Donoghue, M. J. 1571  
 Doob, J. L. 818  
 Dorman, Imogen 909  
 Dornan, Christopher 1352  
 Dostoevsky, Fyodor Mikhailovich 7, 449  
 Dott, Jr., Robert H. 1287  
 Douglas, A. Vibert 127, 132, 312, 1190, 1622  
 Douglas, Andrew Ellicott 981, 1642  
 Douglas, James 908  
 Douglas, Mary 1288  
 Douglas, Norman 763  
 Dowdeswell, Wilfrid Hogarth 460  
 Downy, J. C. 670  
 Doxiadis, Apostolos 873, 1170  
 Doyle, Sir Arthur Conan 22, 54, 62, 69, 71, 77, 106, 153, 155, 189, 203, 216, 240, 262, 319, 327, 332, 338, 347, 350, 351, 385, 388, 504, 523, 554, 579, 583, 625, 636, 645, 656, 672, 680, 717, 763, 820, 896, 913, 920, 941, 955, 959, 982, 1027, 1096, 1140, 1178, 1190, 1232, 1288, 1410, 1417, 1507, 1600, 1639, 1672, 1737  
 Dr. Gil 1249  
 Dr. Kemp 1433  
 Dr. Seuss (Theodor Seuss Geisel) 1500  
 Dr. Watson 89  
 Drachmann, A. G. 704  
 Drake, Daniel 737, 897, 1028, 1073, 1096, 1652  
 Drake, Frank 621  
 Draper, John William 982, 1356, 1384, 1499  
 Drees, Willem B. 1227  
 Dresden, Arnold 820  
 Dressler, Alan 1587  
 Dretske, Fred I. 158  
 Drexler, K. Eric 656, 717, 1581  
 Driesch, Hans 173  
 Drinker, Henry 710, 1662  
 Drummond, Jack Cecil 1710  
 Drummond, William, Sir 1232  
 Druyan, Ann 1515, 1554, 1692  
 Dryden, John 38, 109, 132, 203, 216, 233, 340, 368, 439, 690, 791, 897, 909, 982, 1096, 1288, 1365, 1552, 1642  
 du Bartas, Guillaume de Salluste 25, 181, 982  
 DuBois-Reymond, Emil 554  
 Dubos, René Jules 6, 368, 433, 460, 493, 792, 897, 905, 1042, 1146, 1221, 1232, 1288, 1371, 1385, 1412, 1422, 1433, 1581  
 DuBridge, Lee Alvin 411  
 Duchesne, Joseph 400  
 Duck, Stephen 46  
 Duckham, Sir Arthur 230  
 Duckworth, Eleanor 656  
 Duclaux, Pierre Émile 1366  
 Dudley, Underwood 560  
 Dudley Manlove 1140

- Duffin, R. J. 1138  
 Duffy, Carol Ann 240  
 Duffy, John C. 1097  
 du Fresnoy, Nicholas Langlet 240  
 du Hamel, Joannes Baptiste 597  
 Duhem, Pierre-Maurice-Marie 158, 645, 940, 1110, 1121, 1356, 1600  
 Dulbecco, Renato 376, 982  
 Dumas, Alexandre 1097  
 Dumas, Hal S. 411  
 Dumas, Jean Baptiste-Andre 240, 755, 982, 1028, 1222, 1361, 1652  
 Dunbar, Carl O. 1061  
 Dunbar, Paul Laurence 982  
 Duncan, Otis Dudley 439  
 Duncan, Robert 240  
 Duncan, Ronald 665  
 Dunham, William 1735  
 Dunlap, Ellen L. 1146  
 Dunlap, Knight 568  
 Dunlap, William 1462  
 Dunlop, William 1559  
 Dunn, R. A. 168  
 Dunne, Dominick 376  
 Dunne, Finley Peter 109, 544, 702, 915, 1427, 1462  
 Dunnell, Robert C. 1167  
 Dunnette, Marvin D. 1012  
 Dunning, John R. 412  
 du Noüy, Pierre Lecomte 9, 216, 645, 1028, 1080, 1166, 1288, 1385, 1433, 1465  
 Dunsany, Lord Edward John Moreton Drax Plunkett 783  
 Duprée, Hunter 1402  
 du Preez, Peter 1190  
 du Prel, Karl 1678  
 Durack, J. J. 132  
 Durand, David 329, 330  
 Durand, William Frederick 412  
 Durant, William James 107, 168, 403, 789, 1083, 1240, 1371, 1377, 1385  
 Durell, Clement V. 930, 982, 1241  
 Duren, Peter L. 306  
 Durkheim, Emile 1028  
 Durrell, Gerald M. 263  
 Durrell, Lawrence 89  
 Dürrenmatt, Friedrich 372, 622, 930, 1110, 1227  
 du Sautoy, Marcus 1170, 1258  
 Duschl, Richard Alan 1601  
 du Toit, Alex L. 292  
 Dutton, S. T. 820  
 Dwyer, Herbert A. 173  
 Dyer, Betsey Dexter 154  
 Dyer, Frank Lewis 704  
 Dyer, John 378, 1261  
 Dylan, Bob 224  
 Dyson, Freeman J. 60, 81, 403, 412, 444, 460, 511, 611, 625, 763, 780, 820, 874, 884, 920, 1079, 1110, 1122, 1166, 1190, 1204, 1209, 1239, 1288, 1385, 1422, 1434, 1484, 1490, 1492, 1557, 1581, 1678, 1699  
**E**  
 e 377  
 E = mc<sup>2</sup> 377  
 Eakin, Richard M. 1289  
 Earle, Sylvia Alice 1716  
 Easton, Elmer C. 1190  
 Easton, William 656  
 Eastwood, Clint 786  
 Eaton, Burnham 31  
 Eben, Aubrey 1289  
 Ebert, D. 1053  
 Eckert, Allan W. 982  
 Eckstein, Gustav 763  
 Eco, Umberto 299, 690, 1015, 1075, 1667  
 Eddington, Sir Arthur Stanley 132, 142, 179, 203, 216, 276, 279, 302, 345, 356, 390, 403, 431, 446, 460, 486, 488, 493, 515, 524, 542, 566, 571, 577, 595, 670, 690, 718, 745, 754, 774, 782, 794, 803, 821, 874, 890, 892, 909, 921, 932, 940, 947, 963, 983, 1008, 1011, 1028, 1039, 1049, 1054, 1083, 1110, 1122, 1140, 1146, 1163, 1178, 1198, 1209, 1222, 1227, 1241, 1289, 1361, 1385, 1427, 1461, 1474, 1476, 1478, 1492, 1500, 1507, 1550, 1565, 1601, 1618, 1628, 1652, 1679, 1699, 1702, 1718  
 Eddy, Mary Baker 368, 627, 628, 1377  
 Edelman, Gerald M. 1289  
 Edelstein, Ludwig 1122  
 Eden, Sir Anthony 356  
 Edey, Maitland 796  
 Edgeworth, Francis Ysidro 279, 439, 746, 1178, 1232, 1532  
 Edgeworth, Maria 240  
 Edison, Thomas 351, 356, 1621  
 Edison, Thomas Alva 493, 579  
 Editor 774, 789, 1727  
 Editorial 228, 507, 763, 1398, 1581, 1679  
 Editor of the Louisville Journal 181, 265, 342, 1585  
 Edwards, A. W. F. 1532  
 Edwards, Harold M. 821  
 Edwards, Llewellyn Nathaniel 412  
 Edwards, R. Y. 953  
 Edwards, Tyron 821, 1532  
 Efron, Bradley 1532  
 Egerton, E. N. 983  
 Egerton, Sarah 412  
 Egler, Frank E. 277, 579, 697, 718, 913, 1227, 1289, 1434



- Egrafov, M. 874  
 Egyptian Myth 1696  
 Ehlers, Vernon 262  
 Ehrenberg, A. S. C. 319, 1190  
 Ehrenfest, Paul 1122  
 Ehrenreich, Barbara 163, 1146  
 Ehrensvärd, Gosta Carl Henrik 1576  
 Ehrlich, Gretel 27, 740, 1552  
 Ehrlich, Paul 493  
 Ehrmann, Max 1679  
 Eigen, Manfred 932  
 Eilenberger, Gert 821  
 Einstein, Albert 1, 2, 5, 11, 132, 142, 143, 186, 196, 203, 216, 256, 272, 277, 313, 329, 338, 340, 345, 356, 390, 401, 403, 435, 446, 447, 449, 485, 488, 524, 560, 569, 576, 611, 622, 656, 672, 682, 703, 718, 746, 763, 775, 821, 893, 921, 930, 955, 969, 983, 1028, 1083, 1088, 1091, 1111, 1122, 1147, 1191, 1204, 1209, 1226, 1227, 1232, 1241, 1244, 1249, 1258, 1289, 1290, 1350, 1361, 1366, 1371, 1385, 1403, 1427, 1429, 1434, 1459, 1465, 1492, 1500, 1532, 1549, 1550, 1591, 1592, 1601, 1602, 1621, 1622, 1628, 1652, 1667, 1729  
 Einstein, Jacob 15  
 Eiseley, Loren C. 27, 85, 89, 92, 228, 306, 351, 356, 397, 460, 511, 563, 718, 763, 795, 1054, 1140, 1239, 1386, 1716  
 Eisenhart, Churchill 697, 1532  
 Eisenhower, Dwight David 196, 412, 1398  
 Eisenschiml, Otto 339, 637, 656, 1079, 1097, 1290, 1723  
 Eisner, T. 54  
 Ekert, Artur 1210  
 Elder, Joseph 1422  
 Eldredge, Niles 322, 460, 507  
 Eldridge, Paul 216, 340, 371, 493, 524, 690, 861, 1232, 1576  
 Elgerd, Olle I. 423  
 Eliot, George (Mary Ann Evans Cross) 12, 27, 55, 146, 524, 628, 656, 778, 874, 916, 960, 983, 1065, 1163, 1178, 1507, 1603, 1628, 1653  
 Eliot, T. S. (Thomas Stearns) 61, 505, 628, 656, 665, 693, 1073, 1162, 1261, 1559, 1628, 1679, 1699  
 Elliot, Hugh 1679  
 Ellis, Brian 890  
 Ellis, Havelock 822, 960, 1532  
 Elton, Charles S. 80, 383, 433, 1067, 1571, 1737  
 Elton, G. R. 1070  
 Embree, Alice 1581  
 Embury, Emma 550  
 Emelyanov, A. S. 1290, 1434  
 Emerson, Ralph Waldo 20, 33, 55, 57, 85, 88, 98, 101, 106, 107, 109, 119, 132, 158, 186, 196, 200, 204, 222, 228, 233, 241, 255, 258, 263, 302, 340, 378, 395, 404, 412, 461, 493, 524, 550, 560, 574, 576, 583, 598, 600, 622, 628, 657, 672, 685, 700, 704, 706, 718, 746, 779, 789, 795, 820, 913, 983, 1038, 1042, 1059, 1067, 1097, 1123, 1140, 1158, 1191, 1261, 1290, 1361, 1387, 1406, 1418, 1453, 1462, 1465, 1471, 1473, 1474, 1507, 1532, 1587, 1622, 1679, 1716, 1719, 1728  
 Emerson, William 1730  
 Emmeche, Claus 173, 1291  
 Emmerson, G. S. 423  
 Emmet, William LeRoy 412, 423  
 Empedocles of Acragas 395, 943, 1454  
 Empiricus, Sextus 204  
 Empson, William 1478  
 Enarson, Harold L. 319  
 Engard, Charles J. 1680  
 England, Terry 1434  
 English, Thomas Dunn 1642  
 Enriques, Federigo 1366  
 Enzensberger, Hans Magnus 1016  
 Epictetus 1232  
 Epps, John 356  
 Epstein, P. S. 1618  
 Erath, Vinzenz 611  
 Erdős, Paul 611, 822, 1171, 1259  
 Errera, Leo 1653  
 Erzinclioglu, Zakaria 85  
 Esar, Evan 95, 348, 378, 583, 595, 606, 652, 1716  
 Escher, M. C. 822, 874, 1371  
 Esquivel, Laura 1653  
 Estling, Ralph 1680  
 Euclid of Alexandria 746, 1201  
 Eudoxus of Cnidus 1552  
 Euler, Leonhard 1016, 1029, 1172, 1680  
 Euripides 216, 600, 1016, 1022  
 Eustace, R. 113, 997  
 Evanovich, Janet 1178  
 Evans, Bergen 439, 645, 1201  
 Evans, Howard Ensign 55, 430, 984, 1053  
 Evans, Sebastian 412  
 Eve, A. S. 170  
 Everett, Edward 119, 719, 1291, 1588, 1653  
 Everitt, W. L. 423  
 Eves, Howard W. 822  
 Ewing, John 801  
 Eysenck, Hans Jurgen 1434
- F**  
 Faber, Harold 719  
 Fabilli, Mary 1016  
 Fabre, Jean-Henri 47, 397, 600  
 Fagan, Brian 89  
 Fahrenheit, Daniel Gabriel 1620  
 Fairbairn, A. M. 822

- Falconer, William 1552  
 Falk, Donald 1496  
 Falletta, Nicholas 1065  
 Fana, C. 461  
 Faraday, Michael 133, 200, 241, 388, 494, 525, 554,  
 645, 652, 672, 746, 874, 960, 963, 1029, 1081,  
 1562, 1576, 1603  
 Farb, Peter 789  
 Farber, Eduard 241  
 Farber, Eric A. 608  
 Farmer, Philip José 1702  
 Farnes, Patricia 1404  
 Farquhar, George 413  
 Farr, William 1532  
 Farrar, John 822  
 Farrell, Hugh 233  
 Farrington, Benjamin 1410  
 Farris, Jean 178, 791  
 Faul, Carol 583  
 Faul, Henry 583, 1586  
 Faulkner, William 1434  
 Fauset, Jessie Redmon 173  
 Faust 1124  
 Fawcett, Edgar 30  
 Fechner, Gustav 323  
 Feibleman, James K. 747, 1295, 1434  
 Feigl, H. 1291  
 Feinberg, Gerald 763  
 Feinberg, J. G. 133  
 Feinstein, Alvin R. 261  
 Fejer, M. M. 331  
 Feleki, László 704  
 Feller, William 1179  
 Fenger, Carl Emil 1546, 1560  
 Ferguson, Arthlyn 1124  
 Ferguson, Eugene S. 336, 423  
 Ferguson, Kitty 451, 890, 1016, 1532  
 Ferguson, Marilyn 1667  
 Fermi, Enrico 217, 984, 1068  
 Fermi, Laura 548  
 Fernel, Jean 24, 611  
 Ferré, Nels F. S. 1292, 1376  
 Ferrer, Francisco 1244  
 Ferris, G. F. 960  
 Ferris, Timothy 163, 297, 299, 494, 543, 572, 756, 764,  
 932, 1210, 1292, 1478, 1485, 1492, 1549, 1567,  
 1588, 1667, 1680  
 Fersman, A. E. 672, 1232  
 Feuer, Michael J. 291  
 Feuerbach, Ludwig 755, 984, 1500  
 Fevre, R. W. 984  
 Feyerabend, Paul K. 461, 525, 657, 984, 1198,  
 1232, 1266, 1292, 1356, 1398, 1403, 1413,  
 1434, 1577, 1708  
 Feynman, Richard P. 81, 88, 133, 134, 154, 162, 301,  
 313, 339, 356, 372, 390, 402, 404, 435, 494, 505,  
 553, 554, 608, 612, 622, 626, 657, 673, 683, 719,  
 746, 758, 775, 822, 823, 921, 932, 955, 1016, 1029,  
 1068, 1069, 1088, 1092, 1111, 1124, 1141, 1179,  
 1191, 1210, 1216, 1266, 1292, 1352, 1371, 1398,  
 1413, 1427, 1435, 1465, 1490, 1577, 1581, 1591,  
 1593, 1603, 1618, 1653, 1662, 1667, 1680, 1737  
 Fibiger, Johannes 199  
 Ficino, Marsilio 1147  
 Fiedler, Edgar R. 557, 1164, 1239  
 Field, Edward 1680  
 Field, Eugene 65, 339, 1097  
 Fielding, Henry 323, 544, 985, 1097  
 Fieller, E. C. 1706  
 Fienberg, Stephen E. 1533  
 Figenbaum, Mitchell 224  
 Fillery, Frank 332  
 Finch, James Kip 413  
 Findley, Thomas 702, 1559  
 Finlay, Victoria 775  
 Finney, D. J. 1524  
 Finniston, Sir Monty 1435  
 Firsoff, Valdemar Axel 1485  
 Fischbach, Gerald D. 189  
 Fischer, D. H. 1216  
 Fischer, Emil 228, 241, 1293  
 Fischer, Ernst Peter 439  
 Fischer, Martin H. 329, 357, 525, 645, 719, 737, 822,  
 1029, 1352, 1377, 1603, 1637  
 Fischer, Robert B. 719  
 Fish, J. C. L. 423, 425  
 Fishback, Margaret 653  
 Fisher, H. A. L. 755  
 Fisher, Irving 1260  
 Fisher, Sir Ronald Aylmer 4, 23, 217, 319, 331, 439,  
 494, 578, 620, 665, 719, 823, 965, 1012, 1224,  
 1225, 1245, 1356, 1418, 1429, 1522, 1524, 1533,  
 1563, 1573  
 Fiske, John 795, 1240, 1293  
 Fitch, G. D. 823  
 Fittag, R. 275  
 Fitz-Randolph, Jane 1091  
 FitzGerald, Edward 196  
 Fitzgerald, F. Scott 579, 1533  
 Fitzgerald, Penelope 1435  
 Flammarion, Camille 120, 265, 381, 764, 874, 943,  
 985, 1006, 1471, 1474, 1552, 1680  
 Flanders, Michael 50, 507, 631  
 Flanders, Ralph E. 413  
 Flannery, Kent V. 83, 92  
 Flannery, Maura C. 9, 170  
 Flaubert, Gustave 49, 79, 182, 254, 302, 332, 351, 373,  
 377, 399, 791, 906, 924, 1294, 1387, 1696

- Fleck, Ludwik 719  
 Flecker, James Elroy 1454, 1508  
 Fleiss, Joseph L. 743, 1524  
 Fleming, Alexander 84  
 Fleming, Donald 962  
 Fleming, Ian 926  
 Fleming, J. A. 1191  
 Fleming, Sir Alexander 357, 1076  
 Fletcher, Colin 921  
 Fletcher, John 310, 972  
 Fletcher, Joseph 1245  
 Flexner, Abraham 146, 697, 897, 1080, 1191, 1413  
 Flinn, Alfred D. 423  
 Florian, Douglas 47, 48, 62, 65, 66  
 Florio, John 985, 1097  
 Florman, Samuel C. 413, 423, 447, 787, 1260  
 Flory, Paul J. 241  
 Flower, Sir William Henry 953  
 Fock, Vladimir Alexandrovich 345  
 Fontenelle, Bernard Le Bovier 600  
 Forbes, A. 915  
 Forbes, Edward 308, 592, 764, 781, 969, 1042, 1204, 1294, 1497  
 Forbes, J. D. 1179  
 Ford, E. B. 966  
 Ford, Henry 637  
 Ford, John 1097  
 Ford, Joseph 224  
 Ford, Kenneth W. 985  
 Forder, Henry G. 823  
 Foreman, Dave 383  
 Forrester, Jay Wright 275  
 Forssmann, Werner 628  
 Forster, E. M. (Edward Morgan) 1524, 1642  
 Forsyth, A. R. 719, 823  
 Fort, Charles 109, 319, 1263, 1294  
 Fosdick, Harry Emerson 956, 1387  
 Foss, Sam Walter 148  
 Fossey, Dian 70  
 Foster, Alan Dean 1435  
 Foster, Bishop 697  
 Foster, G. C. 1111  
 Foster, Hannah W. 1083  
 Foster, Sir Michael 342, 526, 719, 985, 1356, 1366, 1418  
 Foucault, Michel 764  
 Fourcroy, Antoine-François 128, 1653  
 Fourier, (Jean Baptiste-) Joseph 204, 343, 357, 631  
 Fournier d'Albe, E. E. 390  
 Fowler, Peter J. 92  
 Fownes, George 241  
 Fox, Robin 1294, 1435  
 Fox, Russell 319, 890  
 Fox, Sir Theodore 1098  
 Fraenkel, Aviezri S. 985  
 France, Anatole (Jean Jacques Brousson) 86, 526, 1366, 1413, 1681  
 France, M. Mendés 1173  
 Francis, Peter 1712  
 Franck, Georg 1294  
 Frank, Julia Bess 334  
 Frankel, Felice 390, 775, 937, 1049, 1227  
 Frankland, A. 823, 1567  
 Franklin, Alfred 665  
 Franklin, Benjamin 34, 388, 494, 693, 747, 823, 1294, 1425, 1585  
 Franklin, W. S. 823, 1125  
 Franks, Felix 1716  
 Fraser, Julius Thomas 1125, 1628  
 Fraunhofer, Joseph von 1508  
 Frayn, Michael 153, 1011, 1681  
 Frazer, Sir James George 747, 921  
 Frazier, A. W. 1191  
 Frederick the Great 228, 1653  
 Fredrickson, A. G. 608, 1191  
 Fredrickson, G. 694  
 Fredrickson, Hal 198  
 Free, E. E. 407, 1366  
 Freeland, E. Harding 255  
 Freeman, Ira M. 134  
 Freeman, Linton C. 1533  
 Freeman, R. Austin 24, 320, 526, 747, 1097, 1179, 1249  
 Frege, Friedrich Ludwig Gottlob 102, 329, 385, 526, 783, 824  
 Freke, John 388  
 French, John 183  
 French Apothegm 1295  
 Frere, John Hookam 128, 640  
 Frere, John Hookham 1063, 1237  
 Fresenius, C. R. 5  
 Freud, Sigmund 173, 645, 700, 1294, 1387, 1399, 1435  
 Freudenthal, Hans 329  
 Freund, C. J. 306, 413  
 Freund, Ida 1294  
 Frey, Robert W. 653  
 Freyssinet, E. 413  
 Fridovitch, Irwin 399  
 Friedel, Robert 424  
 Friedenberg, Edgar Z. 1376  
 Friedman, Herbert 109, 1471  
 Friedman, Milton 148, 645  
 Friend, Julius W. 747, 1295  
 Frisch, Max 1581  
 Frisch, Otto 134, 313  
 Fritzschn, Harald 1681  
 Fromm, Erich 1295

- Frost, Robert 47, 62, 110, 120, 224, 234, 285, 289,  
631, 884, 909, 911, 943, 1067, 1227, 1295, 1479,  
1508, 1588, 1603, 1681, 1699
- Froude, James Anthony 148, 204, 212, 439, 526, 690,  
747, 1179, 1362, 1387, 1628
- Fruton, Joseph S. 166
- Fry, Christopher 943
- Fry, Harold Shipley 234
- Fry, Thornton C. 1179
- Frye, Northrop 673
- Fuertes, Louis Agassiz 1223
- Fulbright, James William 1295
- Fulford, Robert 907
- Fuller, R. Buckminster 234, 296, 336, 357, 511, 795,  
985, 1435
- Fuller, Sarah Margaret 433
- Fuller, Thomas 85, 324, 368, 622, 720, 1098, 1139,  
1462, 1465, 1638
- Fuller, Wallace H. 1473
- Fung, Y. C. B. 424
- Furth, Harold P. 84
- Futuyma, Douglas J. 462
- G**
- Gäbor, Dennis 178, 413, 1295, 1582
- Gage, Simon Henry 526
- Gahan, A. B. 960
- Gaiman, Neil 617
- Galbraith, John Kenneth 414, 704, 1295, 1582
- Gale, Barry 462
- Gale, Richard M. 1629
- Galilei, Galileo 120, 280, 294, 526, 600, 612, 947,  
1029, 1064, 1147, 1153, 1233, 1552, 1556, 1588,  
1654, 1667, 1681
- Galilei, Vincenzo 1654
- Galison, Peter 697
- Gallup, George 1533
- Galston, Arthur William 1436
- Galsworthy, John 212, 217, 897, 1266
- Galton, Sir Francis 374, 450, 462, 747, 764, 795, 1198,  
1436, 1533, 1629
- Gamow, George 163, 313, 390, 404, 431, 462, 690,  
747, 795, 941, 1008, 1009, 1075, 1111, 1125,  
1222, 1238, 1508, 1588, 1697, 1700, 1718
- Gann, Ernest K. 1533
- Gaposchkin, Sergei 1012
- Gardner, Earl Stanley 527, 1629
- Gardner, John 27, 51, 79
- Gardner, John W. 695
- Gardner, Martin 179, 824, 1075, 1125, 1172, 1266,  
1296, 1436, 1725
- Garfield, James A. 1454
- Garman, Charles E. 1387
- Garrels, Robert M. 583
- Garrett, A. B. 757
- Garrison, W. M. 764
- Garrod, Archibald 1296, 1366, 1413, 1425
- Garstang, Walter 31, 43, 48, 50, 64, 278, 636
- Garth, Sir Samuel 897, 985
- Garwin, R. L. 337
- Gass, Fredrick 1016
- Gassendi, Pierre 134, 824
- Gastel, Barbara 1422
- Gatty, M. S. 1158
- Gaudry, Jean-Albert 1060
- Gauss, Johann Carl Friedrich 567, 600, 690, 720, 824,  
874, 893, 921, 1172, 1256, 1436, 1479, 1577,  
1654
- Gay, John 36, 58, 60, 65, 72, 985, 1179
- Gay-Lussac, Joseph Louis 18, 196, 357, 494, 527, 577,  
747, 913, 1125, 1233, 1257, 1603
- Geary, R. C. 374
- Geddes, Patrick 462
- Gee, Samuel 1137
- Geertz, Clifford 83
- Geikie, Sir Archibald 445, 637, 1356, 1427, 1457
- Gelernter, David 1422
- Gell, Alfred 720
- Gell-Mann, Murray 1, 201, 435, 1210, 1436, 1556
- Geminus of Rhodes 110
- General Motors 1169
- Geoffroy the Elder 398
- Geordi 1125
- George, T. N. 563
- George, William H. 224, 527, 1249, 1603
- Gerard, John 1158
- Gerhardt, C. 1466
- Germain, Sophie 824
- Gerould, Katherine Fullerton 584, 1296, 1721
- Gesenius, Wilhelm 1427
- Gettings, Fred 1040
- Ghalioungui, Paul 1080
- Gibbon, Edward 747, 824, 1179
- Gibbs, J. Willard 645, 1112, 1249, 1352, 1708
- Gibran, Kahlil 110, 324, 720, 890, 926, 928, 1016,  
1436, 1466, 1479
- Gibson, Charles R. 390
- Gibson, William Hamilton 194
- Gibson, William Sidney 584
- Giddings, Franklin H. 494, 527
- Gideonse, H. D. 1296
- Giere, Ronald 697
- Gilbert, G. K. 595, 646, 665, 720
- Gilbert, Sir William Schwenck 439, 463, 527, 790, 824,  
1065, 1179, 1268, 1553, 1603, 1638
- Gilbert, William 357, 791, 927, 1179
- Gilbertus, Anglicus 1559
- Gildersleeve, Virginia Crocheron 1404

- Giles, Roscoe C. 146, 1561  
 Gilkey, Langdon 152, 1387  
 Gill, Eric 1296  
 Gillette, H. P. 424  
 Gillilan, Strickland 915  
 Gillispie, Charles Coulston 986, 1387  
 Gillmor, R. E. 414  
 Gilman, Charlotte Perkins 31, 332, 527  
 Gilman, Peter A. 1555  
 Gilmer, Ben S. 306  
 Ginger, Ray 1296  
 Gingerich, Owen 1223  
 Ginsey, Gurney 1016  
 Giraudoux, Jean 511, 1682  
 Girtanner, Christopher 234, 439  
 Gisbourne, Thomas 1098  
 Gish, D. T. 463  
 Gissing, George 86, 1180, 1268, 1533  
 Gladilin, V. N. 258  
 Glaessner, M. F. 1461  
 Glaisher, James Whitbread Lee 874, 1011, 1422  
 Glanvill, Joseph 824  
 Glaser, Christophe 241, 253, 608  
 Glasgow, Ellen 285  
 Glashow, Sheldon L. 338, 390, 400, 623, 775, 1069,  
 1090, 1436, 1604, 1718  
 Glasow, Arnold 668  
 Glass, H. Bentley 357, 1296  
 Glasser, Allen 294  
 Glazkov, Yuri 764  
 Gleason, Andrew M. 824, 1201  
 Gleason, Henry Allan 1158  
 Glegg, Gordon L. 306, 414  
 Gleick, James 224, 495, 505, 691, 802, 1069, 1399,  
 1436  
 Gleiser, Marcello 1682  
 Glenn, Jr., John 1479  
 Gloag, John 194  
 Glob, Peter Vilhelm 92  
 Glover, Townend 193  
 Gluckman, Max 1296  
 Goddard, Robert H. 104, 439, 543, 680, 1198, 1264,  
 1297, 1508, 1604  
 Godwin, William 825  
 Goeppert-Mayer, Maria 134, 1125  
 Gogarty, Oliver St. John 698, 1559  
 Gold, Thomas 433, 527  
 Goldanskii, Vitalii 1055  
 Goldenweiser, Alexander 272, 646, 1436  
 Golder, H. Q. 414  
 Goldhaber, Maurice 1604  
 Goldsmith, Oliver 344  
 Goldstein, A. 1437  
 Goldstein, Herbert 1565  
 Goldwyn, Samuel 680  
 Goleman, Daniel 907  
 Gombrich, Ernst Hans 5, 931  
 Gonek, S. 1172  
 Gonseth, Ferdinand 495  
 Good, I. J. 1180, 1524  
 Good, John Mason 485, 584  
 Goodale, Dora Read 550  
 Goodale, Elaine 550  
 Gooday, Graeme 527  
 Goode, George Brown 953  
 Goodenough, Ursula 1508  
 Goodfield, June 662, 1072, 1729  
 Goodman, Ellen 787  
 Goodman, Nelson 1466  
 Goodman, Nicholas P. 1604  
 Goodspeed, Edgar J. 612, 1387  
 Goodstein, Reuben L. 825  
 Goodwin, Brian Carey 173, 789, 907  
 Gorbunov, Max 319, 890  
 Gordon, Alexander 92  
 Gore, Al 260, 1582  
 Gore, George 495, 528, 720, 1217, 1233, 1466, 1654  
 Gore, Rick 173  
 Gorky, Maxim 1070, 1297  
 Gornick, Vivian 1378, 1437  
 Gortner, Ross Aiken 1297  
 Görtznitz, Thomas 298  
 Goudsmit, Samuel A. 1501  
 Gould, Donald 463  
 Gould, Hannah Flagg 1042  
 Gould, Laurence M. 789, 1297  
 Gould, Stephen Jay 29, 105, 200, 225, 303, 305, 306,  
 337, 357, 375, 429, 440, 463, 478, 508, 528, 592,  
 595, 612, 626, 637, 657, 664, 673, 764, 885, 894,  
 907, 921, 931, 933, 966, 986, 1017, 1025, 1191,  
 1217, 1244, 1297, 1376, 1399, 1413, 1420, 1423,  
 1470, 1574, 1604, 1672, 1721  
 Gowers, Timothy 874, 1172  
 Goya, Francisco Jose 673  
 Grace, Eugene G. 414  
 Gracian, Baltasar 1098, 1180  
 Graham, Aelred 612  
 Graham, L. A. 196, 555, 759, 782, 825, 875, 1076,  
 1138  
 Graham, Loren R. 447  
 Graham, Neill 1209  
 Graham, Ronald L. 825  
 Grainger, Elena 223  
 Granick, Samuel 357  
 Grant, Claud 342  
 Grant, Robert 120  
 Granville, Peter 584  
 Grassé, Pierre P. 154, 173, 225, 466, 700, 1061, 1298

- Grassi, Horatio 265  
 Grassmann, Hermann 825  
 Graton, L. C. 258  
 Gratzler, Walter Bruno 1604  
 Graves, Richard 544, 1206  
 Gray, Asa 584  
 Gray, George W. 337, 986, 1147, 1238, 1437, 1654  
 Gray, Thomas 55, 98, 986, 1042, 1298  
 Greedman, D. A. 933  
 Green, Celia 86, 329, 495, 1058, 1112, 1249, 1533  
 Greenberg, J. Mayo 764  
 Greene, Brian 691, 986, 1112, 1125, 1217, 1241, 1366  
 Greene, Edward L. 624  
 Greene, Graham 466  
 Greenspoon, David Harry 274  
 Greenstein, George 320, 612, 913, 1508  
 Greenstein, Jesse L. 127, 528  
 Greenwood, H. J. 933  
 Greenwood, M. 1533  
 Greer, Scott 1029  
 Gregg, Alan 4, 368, 495, 528, 646, 1029, 1098, 1249  
 Gregory, Dick 986  
 Gregory, J. W. 584  
 Gregory, John 897, 1098, 1533  
 Gregory, Olinthus 893  
 Gregory, Sir Richard Arman 279, 357, 528, 646, 707,  
 720, 922, 986, 1029, 1207, 1298, 1362, 1420,  
 1427, 1485, 1497, 1592, 1654, 1723  
 Grew, Nehemiah 608, 1030, 1233  
 Gribbin, John 4, 1112, 1228, 1240, 1604, 1700  
 Griffin Jay 1080  
 Griffiths, Trevor 300  
 Grimaux, L. E. 1466  
 Grindal, Bruce 82, 291  
 Grinnel, Frederick 1387  
 Grinnell, George Bird 584  
 Grinter, L. E. 424  
 Groen, Janny 1495  
 Grondal, Florence Armstrong 110, 634, 1509  
 Gross, David 158, 555, 1126  
 Gross, S. D. 1559  
 Grosseteste, Robert 1048  
 Grove, Sir William 1237, 1298  
 Grover Snood 148  
 Gruber, Howard E. 1298  
 Gruenberg, Benjamin C. 414, 1298  
 Gübelin, Eduard 929  
 Guest, Judith 217  
 Guiducci, Mario 1725  
 Guillen, Michael 825, 875  
 Guinzelli, Guido 33  
 Guiterman, Arthur 466, 1147, 1509  
 Gull, Sir William Withey 897, 1098, 1388  
 Gumperson, R. F. 1180  
 Guruprasad, Venkata 825  
 Gutenberg, Beno 183, 309  
 Guterson, David 1712  
 Guth, Alan 163, 297, 404, 1298, 1682  
 Gutzwiller, M. C. 1735  
 Guy, Richard K. 825  
 Guyau, Jean-Marie 560  
 Guye, Charles Eugene 1298
- H**
- Haag, Joel 1008  
 Haas, W. H. 1080  
 Haber, Fritz 3, 242  
 Haber, Heinz 313, 511, 1490  
 Habera, Audrey 1533  
 Habington, William 1509  
 Hachamovitch, Moshe 1  
 Hackett, L. W. 485  
 Hacking, Ian 502, 1163, 1166, 1501  
 Hadamard, Jacques 351, 657, 825  
 Haeckel, Ernst 383, 467, 986, 1091  
 Hafemeister, David 260  
 Hafiz, Mohammed Shems-ed-Deen 234  
 Hageman, Samuel M. 1147  
 Haggard, H. Rider 943  
 Haggard, Howard W. 897, 1298  
 Hagstrom, Warren O. 1423  
 Hailey, Arthur 1534  
 Halacy, Jr., D. S. 1682  
 Halbach, Mary Jayne 242  
 Haldane, John Burdon Sanderson 59, 173, 199, 228,  
 242, 343, 528, 673, 765, 826, 1158, 1388, 1423,  
 1466, 1604, 1682  
 Haldane, John Scott 612, 930, 1622  
 Haldane, R. B. 1241  
 Hale, George Ellery 120, 698, 775, 791, 1485, 1520,  
 1682  
 Hale, Susan 332  
 Hales, Stephen 890, 986, 1017, 1030  
 Half, Robert 352  
 Haliburton, Thomas C. 144  
 Hall, A. D. 1299  
 Hall, Alfred Rupert 721, 1299, 1356, 1410  
 Hall, Asaph 1362, 1406  
 Hall, G. Stanley 826  
 Hall, J. 584  
 Hall, John 134  
 Hall, Marie Boas 1299, 1356  
 Halle, John 24, 291  
 Halle, Louis J. 46  
 Halley, Edmond 110, 266  
 Halmos, Paul R. 484, 826, 1191, 1654  
 Halsted, Anna Roosevelt 1462  
 Halsted, George Bruce 600, 826

- Hamerton, Philip Gilbert 414  
Hamilton, Edith 1605  
Hamilton, L. L. 424  
Hamilton, Sir William Rowan 16, 345, 358, 600  
Hamilton, W. 911  
Hamilton, Walton 704  
Hamilton, William D. 966  
Hammer, P. C. 88, 280  
Hammersley, J. 875  
Hamming, Richard W. 277, 374, 1180, 1201  
Hammond, Allen Lee 404, 1141  
Hammond, H. P. 424  
Hammond, Henry 1180  
Hammond, John Hays 424  
Hammond, Kenneth R. 1164  
Hancock, William Keith 1534  
Hand, D. J. 1534  
Handler, Philip 168, 1299  
Hanham, H. J. 1582  
Hankel, Hermann 826  
Hankins, Arthur Preston 1588  
Hankla, Susan 1161  
Hanson, Elayne Clipper 1022  
Hanson, Norwood Russell 529, 1030, 1112, 1126  
Hans Solo 641  
Harari, Haim 1008  
Harari, Josué V. 1299  
Hardenberg, Friedrich von 875  
Hardin, Garrett 506, 613, 1388  
Harding, Rosamund E. M. 674, 1437  
Hardy, G. H. (Godfrey Harold) 506, 827, 875, 1017, 1021, 1046, 1172, 1399, 1682, 1727  
Hardy, Thomas 7, 44, 310, 1147, 1299, 1454, 1469, 1509, 1642, 1725  
Hare, Hobart Amory 529, 1569  
Harington, John 1704  
Harishchandra 674  
Harjo, Joy 1509  
Harker, Alfred 748  
Harkness, William 987, 1708  
Harman, Willis 1299  
Harnwell, G. P. 1437  
Harré, Rom 907  
Harrington, Eldred 827  
Harrington, John W. 595, 1299, 1621  
Harrington, Sir John 110  
Harrington, Thomas 121, 208, 739, 1624  
Harris, A. J. 424  
Harris, Anita 585  
Harris, Errol E. 1180, 1299  
Harris, Joel Chandler 1462  
Harris, John 266, 1556  
Harris, Ralph 558  
Harris, Sidney 374  
Harris, Sydney J. 721  
Harris, William Torrey 827  
Harrison, B. 1241  
Harrison, Edward Robert 225, 391, 445, 657, 666, 691, 721, 1180, 1211, 1682, 1700  
Harrison, George R. 938  
Harrison, Harry 529  
Harrison, Jane 368, 1299  
Harrison, R. J. 905  
Harrison, Tinsley R. 1098  
Harrison, Will 607  
Harrow, Benjamin 134  
Hart, Charles William 309  
Hart, Joseph 76  
Harte, Francis Bret 148, 563  
Harth, Erich 721  
Hartley, David 20  
Hartley, H. Q. 1539  
Hartley, L. P. 1070  
Hartwell, Leland H. 987  
Harvey, William 24, 181, 255, 387, 630, 721, 987, 1030, 1299, 1371, 1707  
Harwit, Martin 358  
Haskins, C. P. 1399  
Hasselberg, K. B. 1126  
Hastings, C. S. 1588  
Hauffman, Paul 698, 827  
Hauge, Bernt K. 1221  
Hauge, Philip 1299  
Haught, James A. 1683  
Haughton, Samuel 1629  
Hauy, Abbé René Just 926  
Havel, Václav 1300  
Havemann, Joel 189  
Hawkes, Christopher 89  
Hawkes, Jacquetta 89  
Hawking, Stephen William 81, 179, 276, 298, 340, 404, 435, 450, 613, 640, 674, 686, 755, 885, 1070, 1211, 1300, 1407, 1468, 1485, 1492, 1605, 1629, 1668, 1672, 1683, 1700  
Hawkins, D. 1191  
Hawkins, Francis Bisset 1534  
Hawkins, Gerald S. 467, 1697  
Hawkins, Michael 1427, 1683  
Hawksworth, D. L. 1663  
Hawthorne, Nathaniel 388, 433, 629, 792, 1643  
Hay, John 639, 1643  
Hayes, Brian 657, 827, 876  
Hayflick, Leonard 1683  
Hayford, F. Leslie 1534  
Hayne, Paul H. 1643  
Haynes, Margaret 1683  
Hays, Carl V. 408, 1188, 1498  
Hayward, Jeremy 1300

- Hazlitt, William Carew 87, 544, 579, 987, 1098, 1300, 1454, 1559, 1638, 1668, 1728
- Heaney, Robert P. 182
- Hearn, Lafcadio 918, 926, 1509
- Heath-Brown, R. 1259
- Heath-Stubbs, John 1638
- Heaviside, Oliver 330, 623, 783, 827, 876, 885, 1605, 1654
- Heberden, William 1099
- Hediger, Heini 1736
- Hegel, Georg Wilhelm Friedrich 1509
- Heidegger, Martin 1126, 1582
- Heidel, W. A. 1300
- Heidmann, Jean 373
- Heilbronner, Robert 558
- Heiles, Carl 620
- Heim, F. 225
- Hein, Piet 1069
- Hein, Robert 1509, 1697
- Heine, Heinrich 987, 1509, 1643
- Heinlein, Robert A. 20, 55, 60, 70, 102, 147, 161, 272, 301, 342, 440, 503, 529, 575, 748, 796, 827, 953, 987, 1046, 1126, 1300, 1408, 1437, 1460, 1485, 1495, 1534, 1563, 1605, 1654, 1683
- Heise, David R. 204
- Heisenberg, Werner Karl 84, 134, 159, 196, 204, 278, 342, 395, 448, 495, 657, 741, 748, 765, 987, 1009, 1030, 1069, 1112, 1126, 1192, 1211, 1214, 1217, 1228, 1249, 1300, 1367, 1371, 1388, 1429, 1466, 1476, 1479, 1621, 1622, 1664, 1668, 1726
- Heiss, E. D. 1577
- Heitler, W. 1605
- Heizer, Robert F. 93
- Hele-Shaw, H. S. 721
- Heller, Joseph 12, 368, 827, 1192
- Heller, Walter 148
- Hellerstein, Herman 630
- Hellman, C. Doris 266, 666
- Hellmund, R. E. 425
- Helmuth, William Tod 25, 154, 1073, 1168, 1559, 1561
- Helvetius, Claude Adrien 217
- Hemans, Felicia D. 289, 1159, 1643
- Hemingway, Ernest 50, 757
- Hempel, Carl G. 827
- Henderson, Archibald 1684
- Henderson, John R. 657
- Henderson, Lawrence 272, 1042, 1301
- Hendrick, Ellwood 708
- Henkel, R. E. 1522
- Henle, Jacob 640
- Henle, James M. 1017
- Henley, William Ernest 987
- Hennig, W. 1571
- Henry, John 555
- Henry, Joseph 358, 1301
- Henry, Patrick 558
- Henry, William 737, 906
- Henslow, John Stevens 186
- Heppenheimer, T. A. 1485, 1510
- Heraclitus 987, 1553, 1629, 1671
- Herbart, Johann Friedrich 674, 827
- Herbert, Frank 383, 721
- Herbert, George 110, 234, 414, 1567, 1577, 1643
- Herbert, Nick 885, 1180, 1573
- Herbert, Sir Alan 1716
- Herford, Oliver 42, 467
- Hering, Constantine 1046
- Hermes, Hans 828
- Hermite, Charles 601
- Herodotus 217, 601
- Herold, Don 545, 641
- Herophilus 629, 897, 1099
- Herrick, Robert 311, 613, 708, 924, 1139, 1510, 1585
- Herschel, Friedrich Wilhelm 316, 634, 674, 988, 1007, 1141, 1156, 1510, 1588
- Herschel, Sir John Frederick William 22, 121, 266, 313, 488, 555, 585, 693, 721, 748, 755, 765, 796, 829, 918, 922, 987, 1030, 1081, 1165, 1192, 1256, 1301, 1408, 1510, 1605, 1654, 1725
- Hersh, Reuben 817, 873, 1169, 1201, 1600, 1627
- Hershko, Avram 368
- Hersh Reuben 829
- Herskovits, Melville Jean 83
- Herstein, I. N. 829, 1192
- Hertz, Heinrich 435, 488, 693, 829, 889, 893, 913, 1301, 1410
- Hertz, Rabbi Richard 1388
- Herwitz, Daniel 1408
- Herzen, Aleksandr 1062, 1301
- Heschel, Abraham J. 182, 898, 1073, 1099, 1250
- Hesiod 196, 212
- Hess, Elmer 448, 898
- Hess, Harry 1043
- Hess, Walter 1053
- Hesse, Hermann 829
- Hesse, Mary B. 20, 741
- Hester, Thomas R. 93
- Heurnius 1092
- Hewish, Antony 796
- Hewitt, Barnard 898
- Hewitt, Philip C. 585
- Hey, Nigel S. 511, 922, 1057, 1141, 1262, 1474, 1479, 1486
- Heyerdahl, Thor 1043
- Heyl, Paul R. 623, 765, 1127
- Heyward, DuBose 217
- Heywood, V. H. 1574
- Heyworth, Sir Geoffrey 529



- Hicks, Beatrice Alice 425  
Higgins, Bryan 135  
Highet, Gilbert 1437  
High school chemistry student 199  
Hilbert, David 159, 485, 569, 601, 666, 686, 789, 803, 829, 913, 1021, 1064, 1127, 1192, 1201, 1228, 1239, 1565  
Hildebrand, Wolfgang 266  
Hilger, Adam 737  
Hill, Archibald V. 358, 448, 721  
Hill, Thomas 613, 830  
Hillaby, John 585  
Hillel, Daniel 1147  
Hillery, Herbert 1061  
Hillis, W. Daniel 1388  
Hilton, James 1605  
Hilton, John 1059  
Hilts, Philip 1302  
Hinds, Norman E. A. 796  
Hine, Reginald Leslie 488  
Hinkley, D. V. 1530  
Hinschelwood, Sir Cyril 228, 242, 741, 1031, 1302, 1684, 1702  
Hippocrates 1, 187, 200, 253, 331, 434, 440, 567, 898, 1099, 1302, 1561  
Hirsch, Nathaniel David 606  
Hitchcock, Alfred 311  
Hitchcock, Edward 554, 563  
Hitching, Francis 358, 564  
Hitler, Adolf 1302  
Hoagland, Hudson 567, 1302, 1427  
Hoagland, Mahlon 1466  
Hoban, Russell 264  
Hobbes, Thomas 330, 440, 529, 601, 613, 686, 1623  
Hobson, E. W. 830  
Hocking, R. 1302  
Hocking, W. E. 1425  
Hodge, Paul W. 506  
Hodges, Wilfrid 830  
Hodgkin, Alan L. 1007  
Hodgson, Leonard 1302  
Hodgson, Ralph 110, 1510  
Hodnett, Edward 20, 81, 320, 529, 560, 1192  
Hoefler, Don C. 657  
Høeg, Peter 1629  
Hoel, P. G. 1534  
Hoffer, Eric 212, 242, 530, 946, 1217, 1466, 1582  
Hoffman, Jeffrey 909  
Hoffman, Paul 830, 1414  
Hoffman, Roald 1668  
Hoffmann, Banesh 391, 446, 485, 757, 1112, 1492  
Hoffmann, Friedrich 339, 488, 898, 1099  
Hoffmann, Hans 1466  
Hoffmann, Roald 228, 234, 242, 938, 1225, 1400, 1618  
Hofmann, A. W. 242, 560  
Hofstadter, Douglas 225, 272, 1017, 1075  
Hofstadter, Douglas R. 1593  
Hogan, Graig J. 1619  
Hogan, James P. 1437  
Hogan, John 1684  
Hogben, Lancelot 414, 830, 1534  
Holgate, Thomas F. 831  
Holland, John 402, 1012  
Holland, W. J. 193, 1011  
Hölldobler, Bert 57, 954  
Holloman, J. Herbert 425  
Holmes, Arthur 10  
Holmes, Bob 765  
Holmes, Charles N. 909  
Holmes, Harry N. 234, 242  
Holmes, John Haynes 1684  
Holmes, Jr., Oliver Wendell 212, 467, 831, 1534  
Holmes, Oliver Wendell 12, 24, 25, 52, 63, 101, 102, 148, 189, 204, 267, 272, 276, 292, 324, 339, 430, 484, 485, 530, 568, 629, 638, 666, 668, 722, 757, 765, 783, 831, 899, 916, 922, 960, 1017, 1052, 1073, 1092, 1099, 1168, 1180, 1302, 1400, 1464, 1510, 1588, 1623, 1655, 1668  
Holt, Michael 1605  
Holton, Gerald 358, 435, 722, 748, 988, 1031, 1242, 1303, 1357, 1380, 1400  
Holz, Daniel E. 298  
Homer (Smyrns of Chios) 286, 944, 1141  
Honsberger, Ross 831  
Hood, Thomas 332, 340, 414, 544, 550, 944, 1059, 1206, 1463, 1585, 1638  
Hooke, Robert 47, 149, 320, 495, 801, 916, 988, 1031, 1461, 1477, 1524, 1535  
Hooker, Richard 1180  
Hooker, Worthington 530  
Hooper, Judith 64, 190, 467  
Hoover, Herbert 414, 425, 1498  
Hoover, T. J. 425  
Hooykaas, Reijer 1388  
Hopfield, John 1718  
Hopkins, Frederick Gowland 166, 286, 1052, 1721  
Hopkins, Gerard Manley 267, 302, 1510  
Hopkins, Harry 547, 1524, 1535  
Hopkinson, John 722, 831  
Hopper, Grace Murray 748  
Hopwood, Arthur Tindell 258  
Horace (Quintus Horatius Flaccus) 149, 988, 1510, 1535, 1726  
Horgan, J. 1303  
Horn, Alfred Aloysius 1070  
Hornaday, William Temple 28, 508, 1722  
Horne, R. A. 243  
Horowitz, Norman H. 512, 1475

- Horrobin, David F. 1217  
 Horsfield, Brenda 1043  
 Horton, F. 400  
 Horton, Robin 1605  
 Hosmer, William 1039  
 Hospers, John 748  
 Hotelling, Harold 1535  
 Houot, Georges 1454  
 Housman, A. E. (Alfred Edward) 7, 1629  
 Housman, Alfred Edward 988  
 Hovey, Richard 1510  
 Howard, Leland O. 430  
 Howard, Neale E. 110  
 Howard, Robert West 1062  
 Howe, E. W. 272, 1164, 1181  
 Howe, Roger 1593  
 Howell, G. K. 1648  
 Howell, Scott 1648  
 Howells, William Dean 1100  
 Howison, G. H. 831  
 Howland, W. E. 415  
 Hoyle, Geoffrey 631, 1127, 1303, 1606  
 Hoyle, Sir Fred 88, 110, 116, 121, 163, 174, 263, 306, 320, 358, 387, 467, 488, 512, 572, 631, 635, 658, 722, 748, 776, 796, 885, 890, 1031, 1058, 1083, 1112, 1127, 1147, 1192, 1201, 1217, 1303, 1486, 1510, 1582, 1605, 1606, 1629, 1664, 1668, 1684, 1697  
 Hoyt, William Graves 376  
 Hsi, Chu (Zhu Xi) 1461  
 Hsu, Francis L. K. 789  
 Hubbard, Elbert 149, 154, 705, 783, 1233, 1303, 1438, 1561  
 Hubbard, Gardiner G. 1303  
 Hubbard, John 831  
 Hubbard, Kin 576, 1074  
 Hubbard, Ruth 958, 1303  
 Hubble, Edwin Powell 121, 722, 913, 1007, 1031, 1228, 1250, 1303, 1438, 1479, 1486, 1589, 1606, 1684  
 Hudson, Hilda Phoebe 831  
 Hudson, Jeffrey 1423  
 Hudson, Robert P. 369  
 Hudson, William Henry 283, 988  
 Huebner, Jay S. 1127  
 Hufeland, Christoph Wilhelm 1100  
 Huff, Darrell 330, 342, 1535  
 Huggins, Charles 1438  
 Huggins, Sir William 358, 674, 988, 1007, 1499, 1520, 1606  
 Hughes, Richard 876  
 Hugo, Victor 28, 77, 102, 194, 197, 217, 225, 302, 530, 564, 601, 658, 682, 696, 701, 776, 791, 876, 916, 922, 988, 1007, 1079, 1080, 1303, 1454, 1511, 1668, 1716, 1735, 1737  
 Huheey, James E. 6  
 Huizinga, Johan 1303  
 Hull, David L. 170, 258, 1438  
 Hulme, Keri 899  
 Hume, David 5, 204, 217, 279, 495, 1017, 1181, 1304, 1707  
 Humphrey, Hubert H. 1147  
 Humphries, W. J. 1065  
 Hungerford, H. B. 61  
 Hunt, Leigh 50  
 Hunter, Evan 1181  
 Hunter, John 495  
 Hunter, Mark 505  
 Hunter, Robert 1157  
 Huntington, Edward V. 1049  
 Huntington, Ellsworth 1222  
 Huntley, Henry Edwards 159  
 Huntley, Henry Edwin 832  
 Hurdis, James 63  
 Hurley, Patrick M. 592, 1629  
 Hurston, Zora Neale 899, 1250  
 Husserl, Edmund 530, 1438  
 Hussey, Russell C. 223  
 Hutchison, Sir Robert Grieve 899, 1100, 1577, 1708  
 Huth, Edward Janavel 899, 1423  
 Hutton, James 223, 280, 326, 592, 1147, 1233, 1572, 1606, 1630, 1712  
 Hutton, W. 948, 988  
 Huxley, Aldous 3, 135, 149, 174, 197, 330, 467, 530, 547, 598, 601, 614, 681, 703, 722, 741, 832, 915, 1017, 1075, 1181, 1304, 1351, 1371, 1566, 1577, 1582, 1593, 1655, 1702  
 Huxley, Elspeth 1218  
 Huxley, Julian 33, 74, 78, 121, 170, 190, 341, 352, 405, 468, 530, 578, 674, 885, 944, 953, 1193, 1245, 1304, 1374, 1378, 1388, 1511  
 Huxley, Thomas Henry 5, 28, 83, 121, 161, 170, 174, 182, 183, 205, 243, 272, 282, 315, 327, 385, 395, 405, 415, 440, 469, 484, 495, 531, 542, 543, 560, 585, 646, 658, 666, 674, 686, 722, 738, 739, 749, 755, 758, 777, 780, 796, 832, 876, 885, 899, 922, 925, 931, 962, 988, 1007, 1031, 1049, 1054, 1062, 1093, 1127, 1137, 1181, 1225, 1305, 1351, 1352, 1357, 1362, 1389, 1406, 1410, 1414, 1425, 1429, 1577, 1606, 1630, 1655, 1702, 1707, 1716  
 Huygens, Christiaan 190, 267, 512, 601, 723, 948, 989, 1048, 1141, 1148, 1153, 1156, 1181, 1511, 1668, 1684, 1705  
 Hyerdahl, Thor 1157  
 Hynek, J. Allen 1673  
**I**  
 Ian 1438  
 Ibn Khaldun 601

- Ice-T 7  
 Icke, Vincent 1127  
 Ihde, Aaron J. 234  
 Imhof, Peter 1438  
 Indiana Jones 93  
 Infeld, Leopold 277, 403, 560, 614, 656, 672, 1191, 1227, 1290, 1366, 1532, 1602, 1667  
 Inge, William Ralph 1655  
 Inge, William Ralph 149, 254, 876, 1083, 1389, 1684  
 Ingelow, Jean 944, 1043, 1643  
 Ingemann, Bernhard S. 1643  
 Ingersoll, Robert G. 682, 1307  
 Ingle, Dwight J. 658, 723, 1193, 1423  
 Ingram, Jay 1438  
 Inose, Hiroshi 320  
 Inscription 350, 1071, 1427  
 Intergovernmental Panel on Climate Change (IPCC) 260  
 Ionesco, Eugene 691, 1684  
 Irving, Washington 1643  
 Irwin, James 1148  
 Irwin, Keith Gordon 990  
 Isaac, Gylan Llwylyn 93  
 Isaacs, Bernard 12  
 Isidorus 960  
 Israel, Werner 179  
 Issigonis, Sir Alec 832  
 Ivic, A. 1259
- J**  
 Jacks, L. P. 531, 1307  
 Jackson, Helen Hunt 1057  
 Jackson, Hughlings 205  
 Jackson, James 1100  
 Jacob, François 469, 958, 1053, 1307, 1420  
 Jacobi, Abraham 1228  
 Jacobi, Karl Gustav Jacob 614, 832, 1017, 1307  
 Jacobs, Joseph 149  
 Jacobson, Ethel 1511  
 Jacoby, Harold 111  
 Jaffe, Bernard 1250, 1577  
 Jahoda, Marie 1535  
 James, Henry 369, 531, 1638  
 James, P. D. 495, 1181  
 James, William 49, 68, 205, 258, 272, 320, 440, 488, 531, 585, 614, 646, 658, 666, 723, 749, 780, 990, 1031, 1167, 1224, 1307, 1606, 1685, 1700  
 Jamin, E. V. 893  
 Jammer, Max 1479  
 Janssen, Johannes 243  
 Jaspers, Karl 668  
 Jastrow, Joseph 1198, 1307, 1606  
 Jastrow, Robert 299, 469, 614, 944, 1389, 1685, 1700  
 Jauncey, G. E. M. 1732  
 Jeans, Sir James Hopwood 111, 116, 121, 135, 296, 302, 391, 397, 425, 431, 675, 723, 765, 796, 832, 933, 938, 940, 948, 1007, 1032, 1040, 1045, 1076, 1088, 1112, 1127, 1148, 1228, 1238, 1308, 1378, 1479, 1511, 1550, 1630, 1685, 1700  
 Jeffers, Robinson 8, 18, 111, 122, 135, 164, 373, 470, 572, 578, 833, 909, 1148, 1308, 1427, 1511, 1655, 1685, 1700, 1705  
 Jefferson, Thomas 187, 243, 441, 496, 629, 723, 909, 1181, 1308, 1376  
 Jefferys, William H. 160  
 Jeffrey, C. 1574  
 Jeffreys, Sir Harold 531, 778, 833, 1032, 1475, 1501  
 Jekyll, Joseph 1100  
 Jenkin, Fleeming 135  
 Jenkins, Edward B. 334  
 Jenner, Edward 1207  
 Jennings, Elizabeth 28  
 Jennings, Herbert Spencer 320, 765, 796, 1685  
 Jensen, Elwood V. 1438  
 Jerome, Fred 504  
 Jerome, Jerome K. 28, 369, 899, 1457  
 Jerrold, Douglas William 1139  
 Jespen, G. L. 1623  
 Jespersen, James 1091  
 Jesus Christ 1100  
 Jevons, William Stanley 5, 217, 260, 327, 441, 496, 646, 724, 749, 832, 922, 1018, 1080, 1250, 1308, 1466  
 Jewett, Frank B. 415  
 Jewett, Sarah Orne 1023  
 Jhabvala, Ruth Praver 369  
 Jinchu, Hu 73  
 Joad, Cyril Edwin Mitchinson 1088, 1308, 1686  
 Joffe, A. F. 1308  
 Johanson, Donald 796  
 John of Salisbury 217, 1100, 1233  
 John Shade 1492  
 Johnson, Athol A. W. 256  
 Johnson, Eric 415  
 Johnson, Ernest 1561  
 Johnson, George 315, 405, 749, 1069, 1112  
 Johnson, Harry G. 1250, 1381  
 Johnson, James Weldon 415  
 Johnson, Lyndon B. 1148, 1486, 1535  
 Johnson, Matthew 93  
 Johnson, Palmer O. 1535  
 Johnson, Philip 98, 470, 968  
 Johnson, Samuel 6, 16, 185, 197, 218, 311, 313, 694, 724, 741, 758, 833, 1018, 1059, 1100, 1233, 1308, 1463  
 Johnson, Severance 107  
 Johnson-Laird, P. N. 20  
 Johnston, Eric 348  
 Johnston, Francis E. 833

- Johnston, Helen 743  
 Johnston, James Finlay Weir 155  
 Joint Statement of Religious Leaders 1389  
 Joly, John 358, 405  
 Jones, Barry 1582  
 Jones, F. Wood 317  
 Jones, Franklin P. 1536  
 Jones, Frederick Wood 1380  
 Jones, J. S. 1053  
 Jones, Raymond F. 783, 1655  
 Jones, Richard G. 264  
 Jones, Rufus M. 1308  
 Jones, Sir Harold Spencer 111, 512  
 Jones, Steve 1032, 1308, 1378  
 Jones, Thomas P. 738  
 Jones, Thomas Rymer 156  
 Jones, William 653  
 Jones J. 1559, 1561  
 Jonsen, Albert 1100  
 Jonson, Ben 398, 635, 781, 944, 1032, 1463, 1655  
 Joos, Georg 1233, 1606  
 Jordan, David Starr 724, 1309  
 Joseph, George Gheverghese 17  
 Joseph, Lawrence E. 571  
 Joslin, Rebecca R. 382  
 Josselyn, John 1639  
 Joubert, Joseph 2, 85, 783, 1046, 1493  
 Joule, James Prescott 405  
 Jowett, Benjamin 784  
 Joyce, James 17, 267, 286, 579, 631, 918, 1048, 1113, 1211, 1215, 1511, 1568, 1701  
 Judson, Horace 174  
 Jukes, Thomas Hughes 376  
 Jung, Carl G. 7, 149, 212, 282, 306, 328, 451, 691, 695, 700, 710, 786, 1309, 1460, 1467, 1490, 1566  
 Jungck, J. R. 431  
 Juster, Norton 149, 254, 681, 960, 1018, 1239, 1669  
 Jutila, M. 1172  
 Juvenal (Decimus Junius Juvenal) 990
- K**
- Kac, Mark 833, 1138, 1181  
 Kaczynski, Theodore 1309  
 Kadane, Joseph 155  
 Kadanoff, Leo P. 749  
 Kaempffert, Waldemar 1389  
 Kafka, Franz 1309, 1559  
 Kahn, Fritz 1148  
 Kahn, S. J. 1536  
 Kaku, Michio 641, 1211, 1568, 1637, 1672, 1686  
 Kaminsky, Kenneth 165, 1018  
 Kanigel, Robert 264, 833  
 Kant, Immanuel 205, 243, 489, 496, 686, 833, 885, 990, 1233, 1404, 1479, 1630
- Kapitza, Pyetr Leonidovich 496, 569, 1309  
 Kaplan, Abraham 749, 834, 890, 933, 1166, 1193, 1536  
 Kaplan, Ellen 691  
 Kaplan, Robert 691  
 Karanikas, Alexander 1372  
 Karch, Carroll S. 641, 1458  
 Karlin, Samuel 933  
 Karpansky, L. 6  
 Karpinski, L. C. 834  
 Kasner, Edward 315, 560, 573, 686, 691, 834, 876, 1065, 1181, 1234  
 Kass-Simon, G. 1404  
 Katsaros, Kristina 320  
 Katscher, F. 1439  
 Kauffman, Stuart A. 17, 174, 766  
 Kaufmann, William J., III 1228, 1669  
 Kay, Marshall 627  
 Kaysen, Carl 1582  
 Keane, Bill Joseph 632  
 Keate, George 95  
 Keating, J. P. 1258  
 Keats, John 111, 181, 225, 288, 395, 550, 944, 1378, 1512  
 Keegan, John 149  
 Keel, William C. 572  
 Keeler, Charles 607  
 Keeney, Ralph 23  
 Kehoe, Alice Beck 93  
 Keill, John 122, 382, 614, 1156, 1512  
 Keillor, Garrison 614  
 Keith, Arthur 470  
 Kekulé, Friedrich August 136, 359, 658, 1052  
 Keller, Evelyn Fox 1309  
 Keller, Helen 601, 834, 1309  
 Kellogg, Vernon 170  
 Kellogg, Vernon L. 55, 1309  
 Kelly, J. L. 670  
 Kelvin, Lord William Thomson 87, 136, 159, 187, 682, 686, 701, 710, 738, 756, 766, 767, 776, 834, 876, 885, 891, 911, 933, 936, 956, 1018, 1063, 1066, 1148, 1218, 1309, 1553, 1606, 1619, 1624, 1669, 1708  
 Kemble, William H. 375  
 Kemeny, John 2  
 Kendall, Maurice G. 743, 1536  
 Kendall, May (Emma Goldworth) 49  
 Kendrew, John 1166  
 Kennedy, Donald 1423  
 Kennedy, Florynce 1  
 Kennedy, John F. 1043, 1310, 1486  
 Keosian, J. 243  
 Kepes, Gyorgy 1372  
 Kepler, Johannes 111, 122, 205, 359, 434, 601, 614, 627, 634, 658, 796, 835, 922, 990, 1048, 1153, 1486, 1490, 1589, 1656, 1686, 1730

- Kernan, F. C. 642  
 Kerr, Jean 639  
 Kerridge, D. F. 1524  
 Kerry, John 724  
 Kettering, Charles Franklin 225, 531, 658, 699, 705, 724, 1193, 1245, 1250, 1310  
 Kevan, D. Keith McE. 1575  
 Keynes, John Maynard 22, 273, 532, 658, 1182, 1623  
 Keyser, Cassius Jackson 415, 449, 567, 641, 705, 835, 876, 1203, 1225, 1240, 1310, 1607, 1617, 1686  
 Khayyam, Omar 16  
 Kiddle, Alfred W. 425  
 Kielan-Jaworowska, Zofia 1062  
 Kiepenheuer, Karl 1193  
 Killian, Jr., James R. 415, 1439  
 Kilmer, Joyce 918  
 King, Alexander 623  
 King, B. C. 1160  
 King, Ben 378, 471  
 King, Blake 307, 705  
 King, G. C. P. 1160  
 King, Jerry P. 9, 835, 877  
 King, Jr., Martin Luther 1310, 1389, 1400  
 King, Lester C. 293  
 King, W. J. 445  
 King, Willford 1536  
 King, William H. 1101  
 Kingdon, Clifford W. 666  
 Kingsley, Charles 98, 145, 288, 350, 415, 532, 585, 635, 749, 757, 990, 1310, 1418, 1439, 1724, 1731  
 Kington, Miles 185  
 Kipling, Lockwood 34  
 Kipling, Rudyard 70, 102, 254, 291, 311, 415, 425, 471, 532, 545, 561, 899, 1023, 1205, 1310, 1457, 1697  
 Kirby, William 430, 1310  
 Kirby, William F. 55, 60  
 Kircher, Athanasius 13  
 Kirchmayer, George Caspard 42  
 Kirchoff, Gustav Robert 893  
 Kirklin, John 1561  
 Kirkpatrick, Clifford 395, 1311  
 Kirkpatrick, Sidney D. 425  
 Kirkup, James 286  
 Kirshner, Robert P. 111, 316, 1686  
 Kistiakowsky, George B. 741  
 Kitaigorodski, Aleksandr Isaakovich 1607  
 Kitcher, Philip 318  
 Kitchiner, William 1589  
 Kitts, David B. 1062  
 Klaproth, Martin Heinrich 243, 401  
 Klarreich, E. 907, 1259  
 Klee, Paul 33, 703, 1372  
 Klein, Felix 199, 276, 315, 377, 602, 835  
 Klein, William 1018  
 Kleiner, Israel 1549  
 Kline, Morris 9, 602, 836, 877, 886, 1018, 1049, 1250, 1311, 1546  
 Kliuchevsky, V. O. 1311  
 Kluckhohn, Clyde 84, 496, 1166  
 Kneale, W. 374  
 Knickerbocker, William Skinkle 1357, 1418  
 Knight, David 243, 1311  
 Knight, Norman L. 1454  
 Knopf, Alfred A. 585, 592  
 Knopoff, L. 586  
 Knuth, Donald E. 658, 825, 1311, 1372  
 Koch, Howard 18  
 Koerner, Jon 682  
 Koestler, Arthur 179, 307, 320, 471, 532, 578, 693, 797, 941, 946, 1071, 1372, 1381, 1439, 1607, 1686  
 Kofahl, R. E. 1311  
 Kohl, Philip L. 1071  
 Köhler, Wolfgang 1311  
 Kolb, Edward W. (Rocky) 104, 112, 159, 572, 675, 933, 990, 1032, 1311, 1439, 1686  
 Kolmogorov, Andrei N. 1182  
 Kolthoff, I. M. 6  
 Kornberg, Arthur 229, 244, 936, 1439  
 Körner, T. W. 359  
 Koshland, Jr., Daniel E. 1312, 1536  
 Kosko, Bart 1182, 1476  
 Kough, A. 532  
 Kovalevskii, V. O. 1738  
 Kowal, Charles T. 106  
 Koyré, Alexandre 441, 837, 1128  
 Krafft, Katia 1712  
 Kragh, Helge 159  
 Kramers, Hendrick Anthony 1211  
 Krantz, David L. 659  
 Krantz, Steven 566, 877  
 Krass, F. 749  
 Kratovil, Robert 532  
 Kraus, Arthur Lawrence 136  
 Kraus, Jack 52, 389, 639  
 Kraus, John 1223  
 Kraus, Karl 25, 267, 339, 899, 1372  
 Krauss, Lawrence M. 136, 797, 1113, 1211, 1242, 1257, 1312, 1630, 1637, 1686, 1725  
 Krebs, Hans Adolf 766  
 Kreutzberg, E. C. 1266  
 Kreymborg, Alfred 1471  
 Krieger, A. 1663  
 Kroeber, Alfred Louis 84, 1312  
 Kronecker, Leopold 1018  
 Kronenberger, Louis 1350  
 Kropotkin, Peter Alekseyevich 724, 938, 1251, 1414

- Kruger, Otto 1418  
 Krumbein, W. C. 321  
 Kruskal, William 1525, 1536  
 Krutch, Joseph Wood 28, 56, 61, 68, 83, 149, 766, 990,  
 1113, 1414, 1512, 1582, 1721  
 Kruyt, Hugo Rudolph 1376  
 Kubie, L. S. 1312  
 Kubler, George 1071  
 Kubler-Ross, Elisabeth 899  
 Kuhn, Thomas S. 9, 307, 359, 532, 698, 1032, 1064,  
 1113, 1312, 1357, 1367, 1439, 1607  
 Kühnert, Franz 112, 384  
 Kuiper, Gerard P. 1154  
 Kunckel, Johann 244  
 Kundera, Milan 1218  
 Kunin, Robert 708  
 Kunitz, Stanley 1687  
 Kunz, F. L. 1687  
 Kurten, Bjorn 348  
 Kusch, Polykarp 724, 1113, 1312  
 Kyburg, Jr., H. E. 1182  
 Kyte, Frank 348
- L**
- L. L. Cool J. 1242  
 L'Amour, Louis 336  
 La Bruyère, Jean 1101  
 Ladenburg, Rudolf 1113  
 Laennec, René-Théophile-Hyacinthe 1547  
 Lagen, Doug 738  
 LaGuardia, Fiorello 1536  
 Laitinen, H. A. 234  
 Lakatos, Imre 837, 877, 1357, 1607  
 Lake, Philip 293  
 Lalande, Jérôme 614  
 Lamarck, Jean-Baptiste Pierre Antoine 10, 136, 174,  
 258, 359, 441, 508, 614, 675, 724, 990, 1234,  
 1497, 1630, 1656, 1709  
 Lamb, Charles 254, 294, 1313, 1463, 1493, 1585  
 Lamb, J. C. 738  
 Lamb, Sir Horace 553, 837, 1662  
 Lamb, William 1101  
 Lambert, Johann Heinrich 572, 593, 615, 646, 797,  
 916, 919, 1234, 1475, 1512, 1687  
 Lamy, Étienne 1404  
 Land, Edwin 922  
 Landau, Edmund 757  
 Landau, Lev 797, 1218  
 Landauer, Rolf 1640  
 Landé, Alfred 351  
 Landes, K. K. 929  
 Landor, Walter Savage 1043  
 Landsberg, Peter Theodore 1313  
 Lang, Andrew 340, 1313, 1536  
 Langer, R. E. 837  
 Langer, Susanne Knauth 16, 532, 659, 877, 1032  
 Langley, John Newport 146, 780  
 Langley, Samuel Pierpoint 595, 1553, 1709  
 Lanier, Sidney 1719  
 Lao Tzu 150, 1687  
 Lapin, Lawrence 1537  
 Laplace, Pierre Simon 22, 122, 180, 205, 218, 273,  
 359, 387, 532, 623, 675, 683, 724, 750, 837, 991,  
 1080, 1182, 1362, 1556, 1656  
 Lapp, Ralph E. 1313  
 Lappe, Marc 431  
 Lapworth, Charles 174, 586, 1630, 1672  
 Larcom, Lucy 1043, 1719  
 Large, E. C. 766, 1352, 1418  
 Larrabee, Eric 123, 1128, 1313, 1439  
 Larrabee, Harold A. 724  
 Lasker, Albert D. 1251  
 Lasota, Jean-Pierre 180  
 Lasserre, Francois 838  
 Laszlo, E. 1607  
 Latham, Peter Mere 20, 244, 273, 311, 339, 369, 489,  
 496, 532, 724, 938, 1059, 1101, 1168, 1569  
 La Touche, Mrs. 102  
 Latour, Bruno 532, 1407  
 Laudan, Larry 304, 708, 1313  
 Lauden, Larry 313, 1607  
 Laurence, William Leonard 143  
 Laut, Agnes C. 533  
 Lavoisier, Antoine Laurent 229, 234, 244, 395, 441,  
 496, 533, 659, 675, 698, 741, 776, 877, 906, 960,  
 1256, 1313, 1357, 1467, 1571  
 Lavrov, Pyotr 1198  
 Lawrence, D. H. (David Herbert) 33, 50, 75, 79, 192,  
 299, 489, 615, 797, 1211, 1716  
 Lawrence, Ernest 1199  
 Lawrence, Jerome 40  
 Lawrence, Louise de Kiriline 991  
 Lawrence Ernest O. 569  
 Lawson, Alfred William 1656  
 Lawson, Andrew C. 436, 595  
 Layton, Jr., Edwin T. 336, 416  
 Leach, Edmund Ronald 84  
 Leacock, Stephen 102, 123, 136, 150, 432, 948, 1537  
 Leakey, Mary 93, 344, 702, 797, 1071  
 Leakey, Richard Erskine 564, 802, 1167, 1497  
 Lear, Edward 67, 944  
 Leary, Timothy 1314  
 Lebesgue, Henri 877, 878  
 Le Bon, Gustave 1656  
 Lebowitz, Fran 16, 512, 1314, 1440  
 Lec, Stanislaw 838, 1669, 1728  
 LeCam, Lucien 838  
 Leclerc, George-Louis, Comte de Buffon 87

- Leclerc, Georges-Louis, Comte de Buffon 627, 991,  
 1079, 1314  
 LeConte, John 725, 1263  
 Le Conte, Joseph 797  
 Le Corbusier (Charles-Edouard Jeanneret) 95, 98, 416  
 Ledbetter, B. G. 1454  
 Lederer, Charles 1080  
 Lederman, Leon 4, 136, 245, 391, 497, 659, 914, 991,  
 1113, 1400, 1440, 1595, 1608, 1687  
 Lee, Gerald Stanley 787  
 Lee, Hannah Farnham 206  
 Lee, Nathaniel 1512  
 Lee, Oliver Justin 267, 1032, 1428  
 Lee, Robert Edwin 40  
 Lee, Stan 693  
 Lee, Tsung Dao 1367  
 Lee-Hamilton, Eugene J. 1043  
 Le Févre, Nicaise 547  
 Le Févre, Nicholas 244, 960, 1716  
 Leggett, A. J. 1218  
 Legrain, G. 631  
 Le Guin, Ursula K. 436, 1263, 1313, 1669  
 Lehman, Robert C. 623  
 Lehmer, Derrick Henry 878  
 Lehn, Jean-Marie 229, 235, 245  
 Lehrer, Keith 273  
 Lehrer, Tom 334  
 Leiber, Jr., Fritz 1703  
 Leibniz, Gottfried Wilhelm 102, 136, 159, 212, 359,  
 497, 602, 615, 683, 759, 838, 1018, 1182, 1707  
 Leidy, Joseph 508  
 Leighton, Robert B. 88, 134, 372, 390, 404, 435, 555,  
 612, 673, 683, 719, 746, 775, 823, 1069, 1124,  
 1210, 1413, 1618, 1662, 1680  
 Leland, Charles G. 34, 41, 551  
 Lemaire, Eugene 245  
 Lemaître, Abbé Georges 136, 296, 405, 1687  
 Lemelson, Jerome 705  
 Lemery, Nicolas 183, 245  
 Lemke, J. 1352  
 Lemoine, Emile 838  
 Lemon, Harvey Brace 700, 725, 838  
 Le Noble, William J. 244  
 Lenstra, Jr., H. W. 1202  
 Leon, Mark 1440  
 Leonard, Jonathan Norton 235, 512, 1440  
 Leonov, Aleksei 1480  
 Leopold, Aldo 283, 284, 471, 1647  
 Leovy, Conway B. 1154  
 Lerner, Max 1314, 1376, 1582  
 Le Sage, Alan Rene 532  
 LeShan, Lawrence 1406  
 Leslie, John 838  
 Leslie, Sir John 675  
 Lessing, Gotthold Ephraim 4  
 Lester, B. L. 348  
 Lettsom, J. C. 1092  
 Leucippus 1224  
 Levenson, Thomas 1263  
 Levi, Primo 59, 60, 164, 180, 235, 245, 373, 401, 647,  
 725, 1440, 1470, 1550  
 Levi-Setti, Riccardo 1648  
 Lévi-Strauss, Claude 512, 1357, 1418  
 Levine, George 780  
 Levins, Richard 206  
 Levinson, Leonard Louis 607  
 Levinson-Lessing, F. Y. 1440  
 Levitt, Norman 838  
 Levy, David H. 267, 1512  
 Levy, Hyman 1656  
 Levy, Matthys 275  
 Lewes, G. H. 246  
 Lewin, Roger Amos 105, 471, 564, 802, 1053, 1222  
 Lewis, C. S. (Clive Staples) 324, 472, 683, 933, 991,  
 1049, 1128, 1183, 1380, 1389, 1566  
 Lewis, Clarence Irving 489, 725, 1183, 1537  
 Lewis, Denslow 900  
 Lewis, Don 374  
 Lewis, Edwin Herbert 137, 391, 395, 398, 399, 1128,  
 1624, 1732  
 Lewis, Gilbert Newton 246, 391, 891, 934, 1033,  
 1083, 1193, 1314, 1389, 1440, 1480, 1619, 1656,  
 1726  
 Lewis, John S. 766, 1486  
 Lewis, Lucille 1023  
 Lewis, Sinclair 246, 308, 878, 1441  
 Lewis, Wyndham 767, 1314  
 Lewontin, Richard C. 206, 472, 1608  
 Ley, Willy 659  
 Leyden, John 1643  
 Libby, Walter 1357  
 Libby, Willard F. 246  
 Libchaber, Albert 838  
 Libes, Antoine 1608  
 Lichtenberg, Georg Christoph 20, 123, 206, 246, 725,  
 839, 891, 917, 1018, 1113, 1314, 1608  
 Lieber, Lillian R. 102, 150, 839  
 Liebling, A. J. 693  
 Liebson, Morris 1128  
 Lightman, Alan 956, 1441, 1630  
 Lightner, Alice 944  
 Lilienthal, David E. 405, 1583  
 Lillich, Robert 375  
 Lilly, John 701  
 Lincoln, Abraham 324, 1183  
 Lindbergh, Anne Marrow 1454  
 Lindbergh, Anne Morrow 508, 956  
 Lindbergh, Charles A. 1721

- Lindbergh, Charles H. 1703  
 Lindley, David 391, 839, 934, 1081, 1113, 1128, 1212, 1242, 1314, 1367, 1608  
 Lindley, Dennis V. 1183, 1467  
 Lindon, J. A. 1021, 1242  
 Lindsay, R. Bruce 405, 839  
 Lindsay, S. E. 426  
 Lindsay, Vachel 63, 449  
 Linnaeus, Carl (von Linné) 185, 187, 497, 576, 960, 969, 991, 1159, 1169, 1263, 1460, 1547  
 Lipe, William D. 1071  
 Lipmann, Fritz 505  
 Lippmann, Walter 787, 1046, 1225, 1537, 1547  
 Lipps, Jere 916  
 Lipscombe, William N. 307  
 Litin, Edward M. 1097  
 Little, Arthur D. 246, 426  
 Little, T. M. 1218  
 Littlewood, John E. 1727  
 Lloyd, C. G. 961  
 Lloyd, David 934  
 Lloyd, Seth 137, 1687  
 Lloyd George, David, 1st Earl of Dwfors 1537  
 Lobachevskii, Nikolai Ivanovich 839  
 Locke, John 16, 137, 212, 632, 659, 691, 839, 948, 1019, 1046, 1183, 1267, 1314, 1497, 1703, 1730  
 Locke, William John 878  
 Lockyer, Joseph Norman 623, 1141, 1500  
 Lodge, Sir Oliver 137, 391, 445, 446, 666, 878, 1113, 1129, 1199, 1608, 1656, 1672  
 Loeb, Jacques 170, 767  
 Loehle, Craig 568, 725  
 Loewy, A. G. 168  
 Loftus, Elizabeth 497  
 Lomonosov, Mikhail 497  
 London, Jack 435, 767, 910  
 Lonergan, Bernard J. F. 359, 913  
 Long, Roger 123  
 Longacre, William A. 1537  
 Longair, Malcolm 180, 1033, 1589  
 Longfellow, Henry Wadsworth 33, 35, 36, 40, 42, 43, 53, 95, 98, 193, 218, 286, 288, 289, 290, 311, 551, 625, 919, 944, 991, 1019, 1043, 1071, 1101, 1154, 1455, 1473, 1512, 1553, 1644, 1687, 1722  
 Lonsdale, Dame Kathleen 309, 1033  
 Loomis, Elisha S. 686  
 Loomis, Frederic Brewster 1352  
 Loos, Anita 246  
 Lorand, Arnold 1429  
 Lorentz, Hendrik Antoon 922  
 Lorenz, Konrad 174, 647, 767, 992, 1315  
 Lote, Christopher J. 575  
 Louderback, G. D. 586  
 Louis, Pierre-Charles-Alexandre 1033, 1537  
 Lovecraft, H. P. (Howard Phillips) 923, 1403, 1461  
 Lovejoy, Thomas E. 284, 416  
 Lovelace, Richard 63  
 Lovell, James A. 945  
 Lovell, Sir Alfred Charles Bernard 1375, 1589  
 Lovelock, James Ephraim 174, 324, 548, 571, 767, 1162  
 Lovins, Amory B. 1583  
 Lowell, Amy 1471  
 Lowell, James Russell 37, 190, 307, 1455, 1644  
 Lowell, Percival 321, 360, 513, 659, 675, 757, 797, 803, 840, 956, 1038, 1154, 1202, 1315, 1475, 1487, 1512, 1727, 1730  
 Lower, Lennie 332, 426  
 Lowie, Robert H. 1367  
 Lowry, Malcolm 1712  
 Lubbock, Sir John 57, 267, 992, 1033, 1261, 1315, 1455  
 Lubchenco, Harold A. 1152  
 Lucas, William F. 840  
 Luciano, Giano 13, 489  
 Lucretius 144, 209, 326, 687, 791, 923, 948, 992, 1050, 1487, 1687, 1701  
 Ludlum, Robert 1183, 1537  
 Ludmerer, Kenneth M. 1101, 1623  
 Ludwig, Carl Friedrich Wilhelm 936  
 Lugosi, Bela 76  
 Lukasiewicz, J. 533  
 Lull, Richard Swann 473  
 Luminet, Jean-Pierre 127  
 Lundberg, G. A. 1315  
 Lunn, Arnold 473  
 Luria, Salvador Edward 273, 936  
 Luther, Martin 1101  
 Luther Standing Bear 992  
 Luttrell, Henry 1463  
 Lydston, George Frank 1023, 1207  
 Lyell, Sir Charles 206, 304, 379, 473, 509, 564, 586, 992, 1497, 1630  
 Lyly, John 900  
 Lynch, Gary 1315, 1390  
 Lynch, John Joseph 379, 755  
 Lynd, Robert 33  
 Lynd, Robert Wilson 448  
 Lysaght, Sidney R. 1315, 1380  
 Lyttleton, R. A. 660, 1315
- M**  
 MacArthur, Robert H. 1075, 1315  
 Macartney, Frederick T. 473  
 Macaulay, Robert B. 568  
 Macaulay, Rose 1265  
 Macaulay, Thomas Babington 71, 595, 725  
 MacCready, Paul 1476  
 MacDonald, George 551



- Macdonald, Sharon 1352  
 MacFadden, Bernard 545  
 Macfie, Ronald Campbell 137, 142, 615, 886, 938, 992, 1316, 1512  
 Mach, Ernst 16, 137, 206, 281, 352, 441, 489, 497, 533, 637, 647, 660, 676, 725, 840, 893, 923, 992, 1033, 1083, 1093, 1129, 1161, 1193, 1242, 1251, 1316, 1353, 1358, 1656, 1687, 1728  
 Mach, Ernst 1609  
 Machen, Arthur 1403  
 Machover, Maurice 647  
 Mackay, Charles 112, 416, 1568  
 Mackenzie, Colin 247  
 Mackin, J. Hoover 451  
 MacLane, Saunders 810, 840  
 Maclaurin, Colin 726, 993, 1083  
 Maclaurin, W. R. 705  
 MacLeish, Archibald 50, 1149, 1493, 1701  
 MacLennan, Hugh 1475  
 MacLeod, G. Preston 553  
 MacLeod, Ken 1058  
 MacPhail, Sir Andrew 1102  
 Macpherson, James 1553  
 Macquer, Pierre Joseph 230, 1358  
 MacRobert, Alan 164, 1218  
 Macvey, John W. 1480  
 Macy, Arthur 1033  
 Maddox, John Royden 164, 360, 387, 936, 1194  
 Maeterlinck, Maurice 473, 687, 1493  
 Maffei, Paolo 1317  
 Magendie, Francois 1317  
 Magna Carta 191  
 Magnus, Albertus 1057  
 Magueijo, Joao 1239  
 Mahadeva, M. 958  
 Maier, N. R. F. 533  
 Mailer, Norman 336, 426, 693  
 Maimonides, Moses 441, 1129, 1609  
 Maine, Sir Henry 647  
 Maisey, John 50, 710  
 Majone, G. 1383  
 Makarov, Oleg 1487  
 Malcolm, Andrew H. 620  
 Malin, David 112  
 Malin, Michael 1154  
 Mallarme, Stephane 341  
 Mallove, Eugene F. 798, 1251, 1491  
 Malmer, Mats P. 1663  
 Malthus, Thomas Robert 1163, 1609  
 Mamet, David 503  
 Mandela, Nelson 1222  
 Mandelbrot, Benoit 1317  
 Mandino, Og 1513  
 Manfreda, Margurite Lucy 1023  
 Mangan, James Clarence 95  
 Manilius, Marcus 286, 1471  
 Manin, Yu I. 1202  
 Mann, Charles C. 1120, 1598  
 Mann, Thomas 138, 247, 324, 369, 767, 840, 926, 938, 1050, 1071, 1553, 1631  
 Mannheim, Karl 708  
 Manning, Henry Parker 602  
 Manning, P. E. 900  
 Manning, Richard 993  
 Mansfield, Katherine 33  
 Mansfield, Lord, William Murray 212  
 Mao Zedong 1568  
 Mara Corday 1317  
 Marcellus 705  
 Marcet, Jane Haldimand 1405  
 Marcet, Mrs. Jane Haldimand 296  
 March, Robert H. 1317  
 Marconi, Guglielmo 705  
 Marcus, Adrienne 1114  
 Marcy, Geoffrey 1141  
 Margalef, Ramón 385  
 Margenau, Henry 321, 956, 1317, 1406  
 Marguerite of Valois 1390  
 Margulis, Lynn 28, 474, 638, 767, 1006, 1317  
 Marinatos, Spyridon 485  
 Maritain, Jacques 1129, 1317  
 Mark, Herman F. 1223  
 Mark O'Brian 1445  
 Marlowe, Christopher 22, 726, 1142  
 Marquesas Islanders 1697  
 Marquis, Don 56, 61, 62, 64, 474, 798, 1687, 1705  
 Marschall, Laurence A. 112, 1033  
 Marsh, George Perkins 993, 1464  
 Marsh, O. C. 564  
 Marshall, Alfred 385, 533, 705, 1317, 1538, 1595  
 Marshall, T. H. 448  
 Marsland, Douglas 1033  
 Martel, Yann 1441  
 Marten, Michael 977  
 Martial (Marcus Valerius Martialis) 1585  
 Martin, Calvin Luther 742  
 Martin, Charles-Noël 47, 170, 1487, 1623  
 Martin, Florence Holcomb 910  
 Martin, Jr., Thomas L. 778  
 Martin, M. 130  
 Martin, Thomas Commerford 704  
 Martin, Walter 900  
 Martinson, Harry Edmund 31  
 Marton, Ladislaus 1048  
 Marvell, Andrew 602  
 Marvin, Ursula 1149  
 Marx, Carl M. 926  
 Masefield, John 767

- Masini, Count Vincenzo 400  
 Maslow, A. H. 1423  
 Mason, Frances 993, 1647  
 Mason, James 1317  
 Mason, Rick 1631  
 Mason, William 417  
 Massey, Raymond 282  
 Massey, William A. 211  
 Massinger, Philip 25, 1102, 1207, 1237, 1560  
 Masson, David 1149, 1688  
 Masters, Dexter 218, 1183  
 Masters, William H. 1376  
 Mathematical Sciences Education Board 199, 276  
 Mather, Cotton 291, 369, 900, 1059, 1102, 1639  
 Mather, Increase 18  
 Mather, John C. 164  
 Mather, Kirtley F. 726, 755, 768, 1362, 1390, 1420  
 Mathews, Albert P. 768  
 Mathews, G. B. 691  
 Matsen, F. Albert 1318  
 Matthew, William Diller 1060, 1609  
 Matthews, Albert 8  
 Matthews, J. A. 1499  
 Matthews, L. 635  
 Matthews, Marian 1023  
 Mattingly, P. F. 430  
 Maturin, Charles R. 792  
 Maugham, W. Somerset 24, 900  
 Mauldin, Bill (William) Henry 750  
 Maunder, Edward Walter 267, 1471, 1589  
 Maury, Matthew Fontaine 533, 1261, 1455, 1456, 1717, 1722  
 Maxim, Hiram S. 225  
 Maxwell, Gavin 543  
 Maxwell, James Clerk 138, 192, 346, 446, 497, 555, 574, 632, 750, 776, 840, 934, 938, 948, 1019, 1218, 1257, 1318, 1414, 1418, 1428, 1441, 1480, 1493, 1499, 1538, 1619, 1726  
 May, Donald C. 489  
 May, Robert M. 374  
 May, Rollo 696  
 Mayer, Joseph 1441  
 Mayer, Julius Robert von Joseph 632  
 Mayer, Robert 1553  
 Mayes, Jr., Harlan 1609  
 Maynard Smith, John 474  
 Mayo, Charles Horace 200, 484, 900, 1023, 1102, 1137, 1441, 1638  
 Mayo, John 1609  
 Mayo, William J. 247, 360, 484, 533, 639, 676, 900, 917, 1074, 1423, 1561  
 Mayow, John 786  
 Mayr, Ernst 175, 441, 474, 576, 711, 737, 931, 1067, 1251, 1367, 1497, 1569, 1572  
 Mazlish, Bruce 787  
 Mazur, Barry 840, 1019, 1022  
 McAleer, Neil 1688  
 McArthur, Peter 30, 34, 533, 705  
 McBirney, Alexander R. 1712  
 McCabe, Joseph 372, 768, 1390  
 McCarthy, Mary 534, 1318  
 McCloskey, D. N. 1522  
 McCloud, James 476  
 McCord, David 1268  
 McCormack, Thomas J. 568  
 McCrea, William Hunter 298  
 McCullers, Carson 324  
 McCullough, David 417  
 McCune, Francis K. 426  
 McDuff, Dusa 841  
 McElwee, Tom 544  
 McEwan, Ian 726  
 McGee, Jr., H. A. 230  
 McGinn, Colin 190  
 McGonagall, William 191  
 McGregor, James 52  
 McKay, Christopher 1717  
 McKee, Christopher F. 321, 1613  
 McKenzie, John L. 1390  
 McKibben, Bill 318, 993  
 McKuen, Rod 81  
 McLaughlin, Mignon 334  
 McLennan, Deborah A. 1067  
 McLennan, Evan 993  
 McLuhan, Eric 907  
 McLuhan, Marshall 907, 1318  
 McMenamin, Dianna 564  
 McMenamin, Mark 564  
 McNeil, I. Joseph 632  
 McNemar, Quinn 1268  
 McPhee, John 593, 595  
 McReynolds, J. W. 699  
 McShane, E. J. 699  
 Mead, George H. 489, 1228  
 Mead, Margaret 84, 1318  
 Meadows, Dennis L. 1583  
 Meadows, Donella H. 1583  
 Mechnikov, Ilya 679  
 Medawar, J. S. 476  
 Medawar, Sir Peter Brian 170, 175, 276, 294, 307, 314, 327, 360, 476, 497, 626, 647, 668, 676, 693, 878, 1033, 1062, 1199, 1218, 1234, 1251, 1318, 1367, 1372, 1400, 1409, 1414, 1418, 1423, 1441, 1468, 1609, 1657  
 Mehlberg, Henry 1631  
 Meitzen, August 1538  
 Meixner, J. 1619  
 Melancon, Robert 200

- Melandri, E. 1380  
Meldola, R. 993  
Mellanby, Kenneth 1403  
Mellor, J. W. 321, 558, 841  
Melnechuk, Theodore 1215  
Melrose, A. R. 952  
Melville, Herman 20, 53, 71, 104, 192, 247, 372, 564, 629, 961, 993, 1044, 1047, 1156, 1319, 1362, 1372, 1455, 1553, 1639, 1644, 1688, 1703  
Mencke, J. B. 841  
Mencken, H. L. (Henry Louis) 112, 291, 300, 435, 534, 615, 628, 660, 878, 900, 993, 1056, 1072, 1102, 1129, 1319, 1390, 1442, 1476, 1609, 1703  
Mendeléeff, Maria 1428  
Mendeleyev, Dmitry 247, 360, 497, 647, 683, 886, 1078, 1319, 1442  
Mendés, Michel 841  
Menzel, Donald H. 1419  
Mephisto 1129  
Merchant, Carolyn 1405  
Mercier, André 1378  
Merck, George 901  
Meredith, George 948, 1034, 1320  
Meredith, Owen (Edward Robert Bulwer-Lytton, 1st Earl Lytton) 206, 238, 246, 290, 779, 975, 1176, 1276, 1504, 1641  
Meredith, Patrick 1089  
Merezhkovskii, Konstantine 1564, 1609  
Mermin, Norman David 191, 1114  
Mernissi, Fatima 1390  
Merrill, William 586  
Merriman, Gaylord M. 778  
Merritt, Dixon Lanier 42  
Mersenne, Marin 13  
Merton, Robert King 360  
Merton, Thomas 784  
Merz, John Theodore 218, 841  
Metrodorus of Chios 513  
Metropolis, Nicholas C. 1375  
Metsler, William Joseph 632  
Metz, William D. 404  
Meunier, M. S. 911  
Meydendauer, A. 926  
Meyer, Adolf 1102  
Meyer, Agnes 1183, 1320  
Meyer, Walter 841  
Meyers, Jr., G. J. 1538  
Meyerson, Emile 405, 559, 750  
Miall, Andrew 934  
Miall, L. C. 534  
Michalson, Carl 615  
Michell, John 180  
Michelson, Albert Abraham 750, 1114, 1353  
Michener, James A. 417, 556, 577, 1194, 1712  
Middendorf, W. H. 705  
Middleton, Thomas 19  
Midgley, Mary 575, 1218  
Miksch, W. F. 1525  
Milgrom, Mordehai 316  
Mill, John Stuart 22, 206, 750, 841, 993, 1166, 1320  
Millay, Edna St. Vincent 382, 534, 551  
Miller, G. A. 841  
Miller, Henry 226, 280  
Miller, Henry George 931  
Miller, Hugh 20, 79, 206, 302, 305, 379, 564, 586, 596, 676, 687, 695, 758, 798, 942, 1062, 1137, 1142, 1234, 1380, 1713  
Miller, Jr., G. Tyler 1050  
Miller, Jr., Walter M. 379  
Miller, Kenneth R. 476, 1391  
Miller, Perry 798  
Miller, Robert C. 1455  
Miller H. 1102  
Millikan, Robert Andrews 278, 360, 392, 615, 1129, 1320, 1391, 1425, 1657  
Mills, Enos A. 1640  
Milne, A. A. (Alan Alexander) 30, 180, 361, 542, 554, 660, 1577, 1640  
Milne, Alan Alexander 379  
Milne, Edward Arthur 451, 1320  
Milton, John 13, 95, 99, 152, 209, 218, 226, 268, 513, 545, 551, 707, 726, 919, 934, 945, 994, 1044, 1047, 1092, 1463, 1513, 1589, 1631, 1644, 1724  
Minale, Marcello 507  
Minelli, A. 375  
Miner, Virginia Scott 776  
Minkowski, Hermann 699, 1493  
Minnaert, M. 1034  
Minnick, Wayne C. 1234  
Minot, George R. 693, 726, 901  
Minto, Walter 726, 841, 1688  
Mirowski, P. 842  
Mishima, Yukio 1044  
Misner, Charles W. 159, 1631  
Mitchell, Margaret 253, 417, 1719  
Mitchell, Maria 6, 112, 123, 184, 223, 504, 561, 676, 687, 726, 750, 910, 1034, 1039, 1320, 1405, 1442, 1513, 1589  
Mitchell, Silas Weir 361, 497  
Mittag-Leffler, Gosta 842  
Mittasch, Alwin 247  
Mitton, Simon 1223  
Mizner, Wilson 1251  
Modjeski, Ralph 842  
Moeller, Therald 236  
Mohapatra, Rabindra 1129  
Moir, David Macbeth 35  
Moissan, Henri 395

- Moleschott, Jacob 556, 994  
 Molière (Jean-Baptiste Poquelin) 781, 1102, 1139, 1142  
 Molloy, Les 1473  
 Momaday, N. Scott 1149  
 Moment, Gairdner B. 330  
 Monboddo, Lord James Burnett 842  
 Monnett, J. 594  
 Monod, Jacques 175, 218, 726, 798, 966, 1320  
 Montagna, William 627, 905  
 Montagu, Ashley 190, 1320  
 Montagu, George 969  
 Montague, C. E. 1149  
 Montague, James J. 396, 939  
 Montessori, Maria 1443  
 Montgomery, Arthur 587  
 Montgomery, H. 1259  
 Montgomery, James 42, 45, 67  
 Montgomery, Lucy Maud 726  
 Montgomery, Robert 994, 1044  
 Mooch 910  
 Moody, Paul 476  
 Moog, Florence 1730  
 Moore, A. D. 307  
 Moore, Anthony R. 668  
 Moore, Benjamin 1391  
 Moore, Dudley 951  
 Moore, George 71, 788  
 Moore, H. P. 1623  
 Moore, James R. 907  
 Moore, John A. 304, 1353, 1391  
 Moore, John N. 349  
 Moore, Marianne 280  
 Moore, Mary 623  
 Moore, Merrill 1102  
 Moore, Patrick 263  
 Moore, Thomas 35, 61, 945, 1513, 1644  
 Mora, P. T. 768  
 Moravcsik, M. J. 1353  
 Mordell, Louis Joel 842, 878  
 Mordida, B. J. 168  
 More, Hannah 1102  
 More, Louis Trenchard 587, 1321  
 Moreland, J. P. 1089  
 Morgan, Charles 727  
 Morgan, Frank 602  
 Morgan, John 901  
 Morgan, Lloyd 1321  
 Morgan, Robert 1138  
 Morgan, Thomas Hunt 1129  
 Morgenstern, Oskar 153, 264, 1369  
 Morison, George S. 417, 426, 1163  
 Morley, Christopher 16, 316, 332, 417, 627, 878  
 Morley, John 1st Viscount Morley of Blackburn 476, 994  
 Moroney, M. J. 150, 330, 620, 1183, 1525, 1538, 1578  
 Morowitz, Harold J. 1619  
 Morris, Desmond 476, 798, 1219  
 Morris, George P. 1644  
 Morris, H. M. 619  
 Morris, Henry 259, 304, 321, 477, 564, 593  
 Morris, Joseph F. 901  
 Morris, Richard 406, 1034, 1631, 1688, 1705  
 Morris, Robert Tuttle 544, 1074  
 Morris, Simon Conway 768, 1061  
 Morrison, A. Cressy 994  
 Morrison, D. E. 1522  
 Morrison, Foster 934  
 Morrison, Jim 939  
 Morrison D. C. 764  
 Morrow, James 1130, 1321  
 Morrow, Jeff 1142  
 Morrow, Lance 1391  
 Morrow, Prince Albert 1495  
 Morse, Harold Marston 842  
 Morton, Henry Vollam 879  
 Morton, Jack A. 307  
 Morton, Oliver 1149, 1154  
 Morton, Ron L. 1498  
 Moscovici, S. 1321  
 Moser, David 1212  
 Moser, Leo 16  
 Moses, L. E. 1523  
 Moss, Lawrence 1460  
 Moss, W. W. 1573  
 Mosteller, Frederick 1267, 1268  
 Motherwell, William 994  
 Motohashi, Yoichi 1172, 1259  
 Mott-Smith, Morton Joseph 632  
 Motto 1321  
 Motz, Lloyd 218, 1443  
 Moulton, Forest Ray 406, 534, 1050, 1234, 1472, 1487, 1554, 1589, 1657  
 Moulton, Lord 1034  
 Moultrie, John 842  
 Moynihan, Sir Berkeley 361, 615  
 Mozans, H. J. (John Augustine Zahm) 1405  
 Mr. Gregory 1538  
 Mr. Silva 375  
 Mr. Spock 1067  
 Muggeridge, Malcolm 477, 768, 1184  
 Muir, John 13, 29, 30, 39, 40, 56, 57, 67, 68, 69, 73, 74, 147, 159, 324, 333, 379, 398, 509, 551, 588, 606, 607, 652, 682, 702, 710, 744, 777, 915, 929, 945, 951, 969, 994, 1149, 1159, 1261, 1264, 1269, 1456, 1458, 1473, 1548, 1554, 1644, 1688, 1713  
 Muir, M. M. Pattison 247, 742  
 Muirden, James 123  
 Mukaiyama, Teruaki 192  
 Mullaney, James 776, 1513, 1590

- Muller, Herbert J. 24, 1321  
 Muller, Hermann Joseph 768, 954  
 Müller, Johannes 1034  
 Müller, Paul 1079  
 Mulliken, R. S. 197  
 Mullis, Kary B. 660  
 Mulock, Dinah Maria (Mrs. Craik) 36  
 Mumford, David 784, 1728  
 Mumford, E. 901  
 Mumford, Lewis 706, 727, 1321  
 Mundell, Carole 1215  
 Munger, Theodore 1321  
 Muppets 1443  
 Murchie, Guy 571, 575, 768, 1493  
 Murdin, Paul 123, 1010  
 Murphy, Michael 1077  
 Murray, Bruce 1155, 1480  
 Murray, Margaret 93  
 Murray, Robert Fuller 417  
 Muses, Charles 842  
 Musser, George 432, 995  
 Myers, Frederic William Henry 727  
 Myers, Norman 1722  
 Myers, Robert J. 708  
 Myrdal, Gunnar 727  
 Myrdal, Sigrid 1405
- N**
- Nabokov, Vladimir 65, 138, 294, 947, 1242, 1631  
 Nahin, Paul J. 1573  
 Nahmias, André 635  
 Nansen, Fridtjof 145, 652  
 Narby, Jeremy 559, 1724  
 Narrator 143  
 Nash, John F. 1623  
 Nash, Ogdan 36, 37, 38, 41, 45, 52, 53, 62, 63, 65, 66,  
 67, 69, 72, 76, 77, 80, 102, 332, 430, 508  
 Nashe, Thomas 324  
 National Academy of Sciences 1443  
 National Geographic Society 268  
 National Society of Professional Engineers 308  
 Navidi, W. C. 933  
 Neal, Patricia 1353  
 Neaves, Lord Charles 477  
 Needham, James G. 175, 769  
 Needham, Joseph 755, 1054, 1321  
 Nehru, Jawaharla 1194  
 Nekrasov, Nikolai 1321  
 Nelkin, Dorothy 304, 1424  
 Nemerov, Howard 1391  
 Nernst, Walther 247, 637  
 Neugebauer, Otto 123  
 Neuman, James R. 1538  
 Neumann, John von 1609  
 Newcomb, Simon 112, 124, 727  
 Newell, A. 1322, 1609  
 Newell, Homer E. 944  
 Newman, H. H. 477  
 Newman, James Roy 199, 315, 560, 573, 686, 691, 834,  
 842, 876, 1065, 1181, 1234, 1568  
 Newman, John Henry 477  
 Newman, Joseph S. 247, 254, 318, 588, 798, 939, 1149,  
 1174, 1648  
 Newman, M. H. A. 843  
 Newman, Michael 1709  
 Newman, Paul 314  
 Newman, Sir George 1074  
 Newman, William I. 514  
 Newton, Roger G. 1322  
 Newton, Sir Charles Thomas 1071  
 Newton, Sir Isaac 144, 330, 361, 441, 498, 534, 556,  
 602, 623, 632, 647, 776, 779, 879, 886, 949, 995,  
 1034, 1040, 1130, 1234, 1480, 1590,  
 1631, 1657, 1688  
 Neyman, Jerzy 441  
 Nicholas Bourbaki 1202  
 Nicholas of Cusa 1566  
 Nicholls, Elizabeth L. 562  
 Nicholson, Jack 615  
 Nicholson, Norman 268, 565, 568, 1701, 1703  
 Nicolle, Charles 441, 1663  
 Niebuhr, Barthold Georg 361  
 Nielsen, Kai 1083  
 Nietzsche, Friedrich 4, 99, 197, 206, 218, 226, 711, 798,  
 843, 1114, 1130, 1194, 1322, 1498, 1610, 1689, 1703  
 Nightingale, Florence 150, 534, 1023  
 Nilson, Lars Fredrik 1204  
 Ninotchka 1443  
 Nirenberg, Marshall W. 1199  
 Nixon, Richard M. 150, 1487  
 Nizer, Louis 1610  
 Nobel, Alfred 361, 915  
 Nobel Prize Medal 1322  
 Noble, D. F. 1578  
 Noble, Edmund 727  
 Noble, Elmer R. 1068  
 Noble, Glenn A. 1068  
 Nolan, James Joseph 1  
 Noll, Ellis D. 1130  
 Noll, Walter 843, 1594, 1595  
 Nordenholt, George F. 843  
 Nordmann, Charles 648, 843  
 Norfolk, Timothy S. 843  
 Norse, Elliot A. 1717  
 North, Roger 96  
 Northrop, Eugene 843  
 Norton, John K. 1563  
 Norton, Robert 1266

Norton, Thomas 13  
 Novalis (Friederich von Hardenberg) 182, 1610  
 Noyes, Alfred 268, 287, 1513, 1590, 1689  
 Nuland, Sherwin B. 369, 1103, 1459  
 Nunn, T. F. 1575  
 Nuttall, Thomas 187, 1159  
 Nye, Bill 24, 268, 588, 596

**O**

O. Henry (William Sydney Porter) 150, 844, 1539  
 O'Brien, Flann 939  
 O'Brien, Katharine 199, 602, 844  
 O'Brien, M. P. 426  
 O'Connor, Flannery 1463  
 O'Donoghue, Michael 1585  
 O'Keefe, J. A. 1264  
 O'Malley, Austin 534, 1561  
 O'Malley, John R. 1072  
 O'Meara, Stephen James 1155  
 O'Neil, William Matthew 1034  
 O'Neill, Eugene 1322  
 O'Neill, Gerard K. 917, 1488  
 O'Rourke, P. J. 995, 1323  
 Oates, Joyce Carol 190, 1689  
 Oberth, Hermann 1322, 1487  
 Obruchev, Vladimir 534, 931  
 Ochoa, Severo 166, 769  
 Ockels, Wubbo 1480  
 Oemler, Marie Conway 193  
 Oersted, Hans Christian 751, 1057, 1730  
 Ogilvie, Sir Heneage 1560, 1561  
 Ogutsch, Edith 90, 641  
 Oken, Lorenz 29, 1735  
 Olah, George A. 248  
 Oldfield, E. 85  
 Oldham, Richard Dixon 844, 1458  
 Olds, Edwin G. 1578  
 Old Woman 1513  
 Oliver, Bernard M. 513  
 Oliver, David 893  
 Oliver, Mary 660, 995  
 Olson, Harry F. 20  
 Olson, S. L. 259  
 Olson, Sigurd F. 1228  
 Olson, Steve 175  
 Oman, John 844, 1130, 1610  
 Onnes, Heike Kamerlingh 891  
 Oort, Jan Hendrik 1513  
 Oparin, Alexander Ivanovich 248, 477, 513, 727,  
 769, 1055  
 Oppenheim, Abraham Naftali 1563  
 Oppenheimer, Frank 742, 1669  
 Oppenheimer, J. Robert 142, 160, 273, 361, 392, 429,  
 489, 503, 534, 546, 569, 667, 706, 727, 751, 769,

798, 844, 995, 1040, 1050, 1114, 1130, 1194,  
 1237, 1243, 1251, 1322, 1353, 1372, 1376, 1407,  
 1467, 1583, 1610, 1703  
 Oreskes, Naomi 727, 934  
 Organisation for Economic Co-Operation and  
 Development 1583  
 Orgel, Irene 615  
 Orland, Harold 1657  
 Orr, Louis 1323  
 Ortega y Gasset, José 1375, 1495, 1669  
 Orton, James 995  
 Orwell, George (Eric Arthur Blair) 1034,  
 1071, 1539  
 Osborn, Fairfield 384  
 Osborn, Henry Fairfield 284, 477, 565, 1063  
 Osborne, John 799  
 Osbourn, E. S. 1577  
 Osiander, Andrew 113, 648  
 Osler, Sir William 24, 175, 181, 184, 248, 256, 273,  
 324, 340, 369, 371, 386, 442, 534, 545, 576, 609,  
 637, 727, 738, 901, 905, 915, 1024, 1035, 1074,  
 1103, 1234, 1323, 1495, 1549,  
 1657, 1669  
 Ostwald, Friedrich Wilhelm 138, 229, 248, 1323  
 Ott, Susan 786  
 Outwater, Alice 68  
 Overhage, Carl F. J. 780  
 Overstreet, Harry Allen 1717  
 Ovid 206, 223, 226, 287, 901, 919, 1104, 1160, 1561,  
 1713  
 Owen, Ed 1035  
 Owen, John 1104  
 Owen, Sir Richard 348  
 Oz 652  
 Ozick, Cynthia 534

**P**

Packard, Norman 226  
 Packe, Christopher 248  
 Page, Jake 961  
 Page, Leigh 1243  
 Page, Ray 844  
 Pagel, Bernard 124  
 Pagels, Heinz R. 406, 751, 769, 844, 995, 1114, 1130,  
 1212, 1229, 1323, 1403, 1419, 1514, 1657, 1664,  
 1669, 1689, 1705, 1710  
 Paglia, Camille 93, 905, 1323  
 Pagnol, Marcel 417  
 Pain, Roger H. 952  
 Paine, Thomas 445, 1084  
 Pais, Abraham 1131  
 Palade, George E. 1669  
 Paley, William 219, 616, 1392  
 Palissy, Bernard 588

- Pallister, William Hales 30, 31, 34, 39, 47, 49, 51, 54, 56, 64, 76, 86, 138, 248, 349, 396, 398, 513, 535, 596, 607, 1091, 1156, 1194, 1323, 1707
- Palmer, Tim 1261
- Palmieri, M. 1229
- Panek, Richard 1590
- Paneth, F. A. 912
- Panofsky, Wolfgang 498
- Panunzio, Constantine 1324
- Papert, Seymour 660, 844, 1237, 1594
- Papoulis, Athanasios 1610
- Pappas of Alexandria 636
- Papperitz, E. 844
- Paracelsus (Theophrastus Phillippus Aureolus Bombastus von Hohenheim) 13, 116, 498, 901, 1104
- Paré, Ambroise 268, 489, 616
- Paretsky, Sara 1560
- Parin, V. V. 1324
- Park, Ruth 301
- Parker, Barry 164, 303, 1689
- Parker, E. N. 791, 1554
- Parker, F. W. 1019
- Parker, Francis Wayland 103
- Parkhurst, D. F. 1522
- Parkington, J. E. 1235
- Parkinson, Cornelia 1547
- Parkinson, James 565, 1068
- Parkinson, John 1104
- Parr, William 369
- Parrot, Max 442, 1074
- Parsons, Talcott 361, 535, 1610
- Parsons, William Barclay 427
- Parton, H. N. 1353, 1375
- Pasachoff, Jay M. 382, 1514
- Pascal, Blaise 184, 206, 448, 616, 648, 687, 691, 799, 844, 879, 1184, 1235, 1262, 1459, 1554, 1568, 1658, 1689, 1705, 1728
- Pascual, Jordan 616
- Pastan, Linda 17
- Pasternak, Boris 919
- Pasteur, Louis 21, 81, 206, 219, 309, 361, 451, 498, 503, 535, 738, 769, 1324, 1351, 1443, 1592, 1610, 1658, 1689
- Pattee, H. H. 769
- Patten, W. 1475
- Patten, William 676
- Patterson, Colin 477
- Patterson, John W. 304
- Pattison, Eliot 336
- Pauli, Wolfgang 6, 392, 569, 616, 1008, 1009, 1212, 1257
- Pauling, Linus 248, 309, 606, 954
- Paulos, John Allen 154, 330, 546, 567, 935, 1019, 1400, 1539
- Pavlov, Ivan Petrovich 190, 345, 498, 535, 667, 728, 739, 769, 902, 914, 969, 1035, 1137, 1204, 1324
- Payne-Gaposchkin, Cecelia 1430
- Payne-Gaposchkin, Celia 287, 676, 1219
- Peabody, A. P. 1252
- Peabody, Francis Weld 261, 369, 902, 1443
- Peacock, R. 303
- Peacock, Thomas Love 51, 1162, 1324, 1571
- Peacocke, Arthur 616
- Peale, Rembrandt 1168
- Pearl, Judea 620, 1184
- Pearse, A. S. 1194, 1444
- Pearson, E. S. 1184, 1539
- Pearson, Karl 295, 498, 535, 676, 751, 845, 879, 1047, 1202, 1245, 1325, 1362, 1407, 1414, 1539
- Peat, D. 1085, 1274
- Peat, F. David 1212
- Peattie, Donald Culrose 155, 175, 253, 433, 478, 568, 770, 912, 995, 1149, 1325, 1496, 1514, 1645, 1689, 1722
- Peebles, Curtis 106, 676
- Peebles, Phillip James Edwin 298
- Peers, John 219, 535
- Peirce, Benjamin 435, 845
- Peirce, Charles Sanders 229, 442, 648, 660, 845, 1019, 1184, 1219, 1235, 1325, 1410, 1426, 1658, 1690, 1707
- Peltier, Leslie C. 268, 287, 1514, 1590
- Pendry, John 1194
- Penjer, Michael 558
- Penman, Sheldon 953
- Penn, Granville 588
- Penrose, Roger 9, 124, 160, 957, 1632, 1658
- Penzias, Arno 124, 1690
- Pepper, Stephen 21
- Percival, Thomas 1104
- Percy, Walker 1467
- Perelman, S. J. (Sidney Joseph) 1444
- Perelman, Sidney Joseph 332, 1563, 1586
- Perfect, D. C. 879
- Perkins, Harry C. 1330
- Perl, Martin 1325
- Perl, Martin L. 660
- Perrett, J. 770
- Perrin, Jean 1539
- Perrin, Noel 73
- Perry, Georgette 1008
- Perry, Lilla Cabot 1713
- Perry, Ralph Barton 1444
- Persius 370
- Perutz, Max F. 1252, 1325
- Petchenik, Barbara Bartz 802
- Peter, Lawrence J. 891
- Peters, Ted 996

- Peterson, Ivars 845, 957, 1075, 1224, 1475  
 Peterson, Roger Tory 42  
 Petit, Jean-Pierre 728, 1610  
 Petrarch (Francesco Petrarca) 902, 996, 1237  
 Petroski, Henry 192, 417, 427, 1114  
 Pettie, George 207  
 Philip Morrison 624  
 Philips, J. D. 602, 845, 1648  
 Phillips, Adam 32  
 Phillips, John 728  
 Phillips, Philip 94  
 Phillips, Wendell 580  
 Philolaus 1019  
 Philpotts, Eden 728  
 Phylis Morrison 624  
 Piaget, Jean 427  
 Picard, Charles Emile 845, 1050  
 Pickering, James Sayre 799  
 Pickering, William H. 418  
 Pickover, Clifford A. 845  
 Piechowski, Otto Rushe 1514  
 Pierce, J. R. 320  
 Pieri, Mario 846  
 Pierpont, James 692, 846  
 Pigford, R. L. 230  
 Pindar, Paean IX 382  
 Pines, David 1131  
 Pinker, Steven 264  
 Pinter, Harold 1703  
 Piozzi, Hester Lynch 1104  
 Pippard, A. B. 1619  
 Pirandello, Luigi 535  
 Pirenne, M. H. 1137  
 Pirie, N. W. 782  
 Pirquet von Cesenatico, C. P. 18  
 Pirsig, Robert M. 275, 321, 498, 602, 648, 1326, 1415, 1583, 1632  
 Pisarev, Dmitry 535  
 Pittendreigh, Jr., W. Maynard 314  
 Pittendrigh, Colin S. 168  
 Planck, Max 153, 201, 361, 432, 447, 490, 498, 535, 543, 561, 632, 648, 660, 677, 709, 751, 776, 996, 1035, 1131, 1184, 1212, 1222, 1326, 1367, 1392, 1444, 1562, 1592, 1594, 1623, 1658  
 Plaskett, J. S. 799  
 Plath, Sylvia 249  
 Plato 103, 124, 182, 197, 219, 300, 370, 382, 499, 603, 616, 649, 679, 879, 891, 949, 1019, 1104, 1164, 1184, 1326, 1405, 1464, 1514, 1554, 1632, 1690  
 Platonov, Andrei 787  
 Platt, John R. 728, 1150, 1202, 1207, 1549  
 Platt, Sir Robert 1252  
 Plattes, Gabriel 1456  
 Plautus 535  
 Playfair, John 565, 588, 596, 607, 752, 923, 1262, 1610, 1632  
 Playfair, William 621, 1540, 1573  
 Pliny (C. Plinius Secundus) 32, 905, 996, 1019, 1475  
 Plotinus 207, 603, 1020, 1632  
 Plum, David 910  
 Plummer, Andrew 249  
 Plutarch 341, 1105, 1265  
 Podolsky, Boris 1326  
 Poe, Edgar Allan 42, 164, 197, 846, 1105, 1194, 1326, 1514, 1658, 1690, 1720, 1725  
 Pohl, Frederik 197, 219  
 Poiani, Eileen L. 846  
 Poincaré, Henri 10, 84, 88, 103, 138, 160, 190, 219, 343, 374, 382, 394, 442, 446, 448, 499, 536, 558, 561, 603, 625, 633, 649, 681, 692, 696, 752, 846, 879, 919, 935, 996, 1035, 1050, 1114, 1131, 1184, 1194, 1257, 1260, 1326, 1362, 1376, 1428, 1444, 1460, 1467, 1480, 1515, 1594, 1610, 1706  
 Poincaré, Lucien 392, 569, 1199  
 Poinot, Louis 1632  
 Poisson, Simeon-Denis 847  
 Polanyi, Michael 362, 536, 661, 752, 847, 1327, 1392, 1415, 1444, 1670, 1690, 1732, 1738  
 Polkinghorne, John 1213, 1392  
 Pollak, Henry O. 848  
 Pollard, William 1150  
 Pólya, George 341, 343, 362, 603, 626, 661, 670, 848, 879, 914, 1174, 1195  
 Polyakov, Alexander 616  
 Polybius 207  
 Pomerance, Carl 1169  
 Pomfret, John 442  
 Pompidou, Georges 573  
 Ponnampertuma, Cyril 770  
 Pontecorvo, Bruno 1008  
 Pontoppidan, Erich 1457  
 Pool, Ithiel de Sola 1353  
 Poovey, Mary 848  
 Pope, Alexander 7, 42, 68, 86, 87, 99, 139, 220, 226, 255, 273, 324, 373, 499, 513, 551, 848, 925, 996, 1020, 1035, 1051, 1092, 1235, 1327, 1493, 1515, 1645, 1690, 1725  
 Pope John Paul II 1392  
 Pope Pius XI 1  
 Pope Pius XII 1378, 1392, 1583  
 Popper, Karl R. 79, 212, 249, 298, 338, 362, 442, 448, 478, 490, 499, 616, 649, 661, 728, 958, 1035, 1089, 1185, 1195, 1219, 1327, 1358, 1363, 1368, 1378, 1392, 1444, 1611, 1670, 1726  
 Porta, John Baptista 790  
 Porter, George 1195, 1351  
 Porter, Roy 902  
 Porterfield, Austin L. 1328



- Portier, Paul 499, 1565  
 Posner, Michael I. 190  
 Poteat, William Louis 1328  
 Potter, Stephen 1074  
 Poullain de la Barre, François 1405  
 Pound, Roscoe 954, 1564  
 Powell, Cecil 296  
 Powers, Henry 917  
 Powers, Richard 1328  
 Pownall, Thomas 1646  
 Poynting, John Henry 254, 649, 729, 752, 770, 907, 935, 996  
 Praed, Winthrop 1328  
 Prakash, Satya 207  
 Pratchett, Terry 13, 29, 617, 667, 776, 1185, 1612  
 Pratt, C. C. 1328  
 Pratter, Frederick 848  
 Prelog, V. 249  
 Prelutsky, Jack 37, 41, 75, 80, 193, 349, 350  
 Prescott, William Hickling 1328  
 President's Science Advisory Committee 694  
 Preston, Richard 1138  
 Preston, Thomas 729  
 Prestwich, Joseph 596  
 Pretorius, D. A. 597  
 Pribram, Karl 1328  
 Price, Bartholomew 848, 1235  
 Price, C. 729  
 Price, Derek John de Solla 1424, 1444, 1540  
 Price, Don K. 1368, 1381  
 Price, P. W. 1053  
 Priest, Graham 661  
 Priestley, J. B. 1612  
 Priestley, Joseph 12, 207, 220, 362, 399, 499, 580, 649, 684, 729, 997, 1328, 1354, 1368, 1659  
 Prigogine, Ilya 338, 617, 886, 1328, 1632, 1690  
 Primas, Hans 249, 1444  
 Prince Philip (Philip Mountbatten), Duke of Edinburgh 1722  
 Prince Philip (Phillip Mountbatten), Duke of Edinburgh 333  
 Pringle, John R. 349  
 Pringle, Thomas 72  
 Pringsheim, Alfred 848, 850, 880, 1612  
 Prior, Matthew 86, 113, 1105, 1185, 1329  
 Pritchett, V. S. 1329  
 Proclus 848, 1020  
 Procter, Bryan Waller 1724  
 Proctor, Richard A. 124, 588, 617, 687, 1709  
 Professor Barnhardt 314  
 Professor Hubert J. Farnsworth 1664  
 Professor Oliver Lindenbrook 1441  
 Proschan, Frank 1540  
 Protheroe, Chester F. 249  
 Proudfit, David Law 478  
 Proust, J. L. 276  
 Proust, Marcel 160, 661, 902, 1646  
 Prout, Curtis 1329  
 Prout, William 249, 397  
 Proverb 629, 1072, 1092, 1105, 1639  
 Proverb, Chinese 1105  
 Proverb, German 1105  
 Proverb, Italian 1105  
 Proverb, Scottish 325  
 Proverb, Spanish 14  
 Prudhomme, Sully 113, 235  
 Prusiner, Stanley B. 1445  
 Pryanishnikov, D. N. 729  
 Ptolemy 113, 1515  
 Puckett, Andrew 1540  
 Pugh, Emerson M. 190  
 Puiseux, P. 923  
 Pulitzer, Joseph 677  
 Pupin, Michael 1150  
 Purcell, Edward 1488  
 Purcell, Rosamond 29, 478  
 Purchas, Samuel (the Younger) 58  
 Putnam, H. 1632  
 Putter, A. 770  
 Puzo, Mario 573, 1540  
 Pycraft, W. P. 176  
 Pyke, Sandra W. 1246, 1421  
 Pynchon, Thomas 150, 375, 1540  
 Pythagoras of Samos 757, 770
- Q**
- Quammen, David 997  
 Quarles, Francis 1106  
 Queneau, Raymond 187, 537, 778, 1165, 1172, 1736  
 Quetelet, Adolphe 150, 1329  
 Quicke, D. L. 711  
 Quine, Willard Van Orman 742, 848, 1132, 1329, 1460  
 Quinet, Edgar 1329  
 Quinton, Anthony M. 282
- R**
- Rabelais, François 1106  
 Rabi, Isidor Isaac 386, 499, 537, 729, 953, 1115, 1132, 1329, 1407, 1426, 1670, 1690, 1703  
 Rabinow, Jacob 707, 1195  
 Rabinowitch, Eugene 799, 1091, 1382  
 Racker, Efraim 362  
 Rae, John A. 418  
 Raether, H. 1084  
 Raichle, Marcus E. 190  
 Raiffa, Howard 23  
 Raine, Kathleen Jessie 249  
 Rainich, G. Y. 1467

- Raju, Poolla Tirupati 153  
 Raleigh, Sir Walter 1593  
 Raman, Chandrasekhar Venkata 160, 949, 997, 1132  
 Ramanujan, Srinivasa 435  
 Ramon y Cajal, Santiago 1445  
 Ramón y Cajal, Santiago 184, 537, 729, 786, 1080,  
 1195, 1403, 1690  
 Ramsay, Sir William 12, 13, 161, 250, 294, 362, 729,  
 1199, 1219, 1329, 1501, 1670  
 Ramsey, Frank Plumpton 1185  
 Ramsey, James B. 1547  
 Rand, Ayn 1690  
 Randall, J. H. 1329  
 Randall, Merle 1619  
 Randi, James 1329  
 Rankin, William H. 945  
 Rankine, William John Macquorn 418, 568, 699, 891  
 Ransom, John Crowe 546  
 Rapoport, Anatol 790, 1066, 1196  
 Rashevsky, Nicolas 176, 1079  
 Raup, David Malcolm 509, 1612  
 Raven, Charles E. 1392  
 Ravetz, J. R. 1329  
 Rawlings, Majorie Kinnan 906  
 Rawnsley, Hardwicke Drummond 418  
 Ray, John 301, 311, 370, 620, 627, 629, 639, 802, 1024,  
 1092, 1106, 1139, 1639  
 Raymo, Chet 124, 262, 677, 730, 799, 1229, 1330,  
 1393, 1415, 1428, 1470, 1515, 1554, 1671, 1691  
 Raymond, Eric S. 1196  
 Ray Stantz 346  
 Read, Herbert 891  
 Read, Herbert Harold 597, 1264  
 Reade, Winwood 478, 617, 1488, 1691  
 Reagan, Ronald W. 1, 442  
 Recorde, Robert 146, 667, 849, 1235, 1252, 1670  
 Reddy, Francis 160  
 Redfern, Martin 597, 1142  
 Redfield, Casper L. 707  
 Redfield, Roy A. 151, 1185  
 Redi, Francesco 161, 770  
 Reed, Ishmael 1691  
 Reed, T. D. 1663  
 Rees, Martin John 113, 139, 1112, 1115  
 Rees, Mina 849  
 Reese, C. L. 230  
 Reeve, F. D. 1229  
 Reeves, Hubert 275, 300, 886, 1697  
 Regnault, Noël 949, 1069, 1578, 1728  
 Reich, Charles A. 1583  
 Reichenbach, Hans 210, 220, 346, 362, 730, 785, 1051,  
 1132, 1185, 1252, 1393, 1494, 1586, 1633, 1659,  
 1691  
 Reid, Constance 880  
 Reid, Thomas 25, 677, 849, 880, 1467  
 Reines, Frederick 1009  
 Reis, Johann Philipp 250  
 Reiser, Anton 1612  
 Reiss, H. 1619  
 Remek, Vladimir 145  
 Remsen, Ira 1691  
 Renan, Ernest 1330, 1363, 1378, 1428, 1659  
 Renard, Jules 902  
 Renard, Maurice 1691  
 Renaudot, Eusébe 396  
 Reswick, J. B. 336  
 Rexroth, Kenneth 784  
 Rey, Hans Augusto 997  
 Reynolds, H. T. 891, 1540  
 Reynolds, Osborne 1373  
 Reynolds, William C. 1330  
 Rhazes 1074  
 Rheticus, Georg Joachim 113  
 Rhinehart, Luke (George Cockcroft) 220  
 Rhodes, Cecil 1515  
 Rhodes, Frank H. T. 537  
 Rice, Laban Lacy 1393  
 Rich, Adrienne 919, 1406  
 Richards, Dickinson W. 1612  
 Richards, Ellen Henrietta Swallow 250  
 Richards, Ivor Armstrong 1330, 1445  
 Richards, Mary Caroline 677  
 Richards, Theodore William 143, 250, 957, 1330, 1691  
 Richardson, Lewis 687  
 Richardson, Moses 849  
 Richardson, Owen Willans 1132  
 Richardson, Samuel 23, 1024, 1330  
 Richet, Charles 23, 250, 649, 730, 997, 1252, 1269,  
 1331, 1358, 1368, 1408, 1445, 1612, 1659  
 Richter, Charles 1458  
 Richter, Curt P. 1256  
 Richtmyer, Floyd Karker 362  
 Rickard, Dorothy 400  
 Ricklefs, R. 1707  
 Rickover, Hyman G. 151, 433, 1584  
 Ridley, B. K. 624, 1163  
 Ridley, Matt 181, 580, 1331  
 Riemann, Bernhard 278  
 Riggs, Arthur Stanley 799  
 Riley, James Whitcomb 39, 61, 63, 379, 969, 1554  
 Rilke, Ranier Maria 287, 1515  
 Rindler, Wolfgang 1243, 1691  
 Rindos, David 1368  
 Riordan, Michael 316, 1229  
 Ritchie, Arthur David 280, 328, 730, 1378  
 Ritsos, Yannis 341  
 Rivers, Joan 626  
 Rivers, Pitt 362

- Robb, Alfred Arthur 139, 556  
 Robbins, Herbert 815, 1087  
 Robbins, R. Robert 160  
 Robbins, Tom 945  
 Roberts, Catherine 176, 478  
 Roberts, Michael 1091, 1132  
 Roberts, W. Milnor 490  
 Robertson, Howard P. 499  
 Robertson, Percival 565, 588  
 Robinson, Arthur H. 802  
 Robinson, Arthur L. 1213  
 Robinson, Edwin Arlington 113  
 Robinson, Geoffrey 605  
 Robinson, Howard A. 1115  
 Robinson, James Harvey 730, 1252, 1363  
 Robinson, Lewis Newton 1547  
 Robinson, Sir Robert 1331  
 Robinson, Victor 902, 1059, 1150  
 Rodbell, Martin 770  
 Roddenberry, Gene 1488  
 Roe, Anne 1354, 1445  
 Roe, Jr., E. D. 568  
 Roebing, John 192  
 Roelofs, Howard Dykema 1393  
 Rogers, Eric 1115, 1243  
 Rogers, G. F. C. 427  
 Rogers, Jr., Hartley 1066  
 Rogers, Will 370, 573, 621, 1540, 1547  
 Rohault, Jacques 207, 220, 223  
 Rohrich, Fritz 1578  
 Roller, Duane H. D. 435, 722, 748, 1031, 1303  
 Rolleston, George 997  
 Rollins, R. C. 1575  
 Romains, Jules 629, 902  
 Romanoff, Alexis Lawrence 182, 311, 537, 629, 902,  
 1235, 1252, 1331, 1368, 1541, 1578, 1612, 1659  
 Röntgen, Wilhelm Conrad 499, 849, 1132, 1732  
 Roosevelt, Franklin Delano 273, 1024, 1072  
 Roosevelt, Theodore 328  
 Root, R. K. 176  
 Rorty, Richard 887, 1115  
 Roscoe, Henry E. 139, 1078  
 Rose, Steven Peter Russell 166  
 Rosenbaum, R. A. 849  
 Rosenblatt, Roger 103  
 Rosenfeld, A. H. 1009, 1692  
 Rosenthal-Schneider, Ilse 1430  
 Ross, John 1620  
 Ross, Sir Ronald 792, 945, 1331, 1363  
 Rosseau, Jean-Jacques 207  
 Rosseland, Svein 923, 1039  
 Rossetti, Christina Georgina 40, 551, 1044  
 Rossi, Hugo 334, 1730  
 Rossman, Joseph 542, 707, 730  
 Rostand, Jean 176, 1358  
 Roszak, Theodore 1196, 1331, 1445  
 Rota, Gian-Carlo 170, 184, 625, 849, 850, 880, 1066,  
 1186, 1612  
 Roth, V. Louise 1557  
 Rothman, Milton A. 683, 730, 1445  
 Rothman, Tony 82, 139, 325, 500, 633, 1213, 1243,  
 1332, 1445, 1612, 1621, 1691  
 Rothschild, Lord Nathaniel Mayer 1409  
 Rous, Francis 325  
 Rouse, Irving 259  
 Rousseau, Jean-Jacques 433  
 Roux, Joseph 1332  
 Rowan-Robinson, Michael 667, 1590  
 Rowland, Henry Augustus 139, 752, 923, 1424, 1550  
 Rowling, J. K. 338, 1166  
 Roy, Gabrielle 1463  
 Royce, Josiah 687, 730  
 Rozeboom, W. W. 1522  
 Rózsa, Péter 850  
 Rubin, Harry 211, 1332  
 Rubin, Vera 543, 1691  
 Rubinstein, Anton 681  
 Rucker, Rudy 692, 1091  
 Rucker, Rudy (Rudolph von Bitter Rucker) 298  
 Rudberg, Eric Gustaf 280  
 Ruderman, M. A. 1009, 1691  
 Rudloe, Jack 80  
 Rudner, Richard 22  
 Rudwick, Martin J. S. 589, 1063  
 Rudzewicz, Eugene 63  
 Ruelle, David 367, 1115  
 Ruffini, Remo 180  
 Rukeyser, Muriel 139  
 Rumford, Benjamin 500  
 Rumsfeld, Donald 1703  
 Runyon, Damon 220  
 Runyon, Richard P. 1534  
 Ruse, Michael 330, 478, 1332, 1445  
 Rush, J. H. 771  
 Rushton, John Phillipe 1446  
 Ruskin, John 96, 99, 193, 194, 542, 952, 1332, 1458  
 Russell, Bertrand 406  
 Russell, Bertrand Arthur William 3, 79, 103, 125, 201,  
 207, 273, 321, 448, 479, 537, 603, 617, 677, 701,  
 730, 752, 757, 771, 784, 787, 799, 849, 850, 887,  
 891, 914, 929, 941, 1012, 1020, 1051, 1066,  
 1077, 1084, 1132, 1163, 1166, 1188, 1196, 1203,  
 1219, 1235, 1243, 1245, 1332, 1350, 1363, 1379,  
 1401, 1415, 1419, 1541, 1592, 1613, 1633, 1659,  
 1672, 1692, 1701, 1717, 1732  
 Russell, Cheryl 442  
 Russell, Henry Norris 997, 1039, 1115, 1196  
 Russell, L. K. 1733

- Russell, Peter 1515  
 Russell, Richard Joel 605  
 Russell, Sir E. John 500  
 Russell, Sir Edward John 1477  
 Russen, David 1488  
 Russo, Richard 941  
 Rutherford, Ernest 139, 362, 392, 396, 406, 500, 1012, 1269, 1403, 1502  
 Rutherford, Mark (William Hale White) 1554  
 Ryder-Smith, Roland 1590  
 Ryle, Gilbert 788  
 Ryle, Martin 125
- S**
- Saaty, Thomas L. 436  
 Sabatier, Paul 250  
 Sabbagh, K. 1259, 1736  
 Sabin, Albert 1446  
 Sabloff, Jeremy 91  
 Sacks, Oliver W. 370, 396, 629, 902, 1074  
 Sackville-West, V. 800  
 Saffman, P. G. 1662  
 Safonov, V. 363  
 Sagan, Carl 14, 82, 106, 125, 180, 191, 212, 223, 261, 268, 287, 300, 307, 309, 342, 406, 451, 479, 500, 513, 514, 548, 572, 575, 617, 639, 649, 661, 708, 710, 731, 753, 802, 914, 928, 997, 1020, 1055, 1115, 1150, 1172, 1204, 1207, 1213, 1219, 1257, 1332, 1373, 1375, 1393, 1401, 1446, 1470, 1475, 1488, 1515, 1554, 1564, 1584, 1621, 1659, 1664, 1670, 1692, 1697, 1725  
 Sagan, Dorion 28, 474, 638, 767, 1006, 1317  
 Sage, M. 547  
 Saint-Hilaire, Étienne Geoffroy 506  
 Saint Augustine of Hippo 561, 1106, 1633  
 Saint Avvaiyar 731  
 Sakaki, Nanao 325  
 Sakharov, Andrei 514, 800  
 Salam, Abdus 635  
 Salamone, Frank 82, 291  
 Salisbury, J. Kenneth 418  
 Salmon, Merrilee H. 90  
 Salsburg, David S. 1522, 1546  
 Salter, William T. 171  
 Salthe, Stanley N. 171  
 Salvadori, Mario 275  
 Salzberg, Hugh W. 927  
 Salzberg, Paul 308  
 Sammonicus, Serenus 903  
 Samuel, Arthur L. 788  
 Samuels, Ernest 1541  
 Samuelson, Bengt, I. 731  
 Samuelson, Paul A. 1167  
 Samuelsson, Bengt I. 363  
 Sanborn, Kate 29  
 Sand, George 696  
 Sand, George (Amantine-Lucile-Aurore Dupin) 418  
 Sandage, Allan 113, 572, 1133, 1333, 1692  
 Sandburg, Carl 103, 1020, 1071, 1456  
 Sandell, E. B. 6  
 Sanderson, R. T. 1078  
 Sands, Matthew 612  
 Sands, Matthew L. 88, 372, 390, 404, 435, 555, 673, 683, 719, 746, 775, 823, 1069, 1210, 1413, 1618, 1662, 1680  
 Sanger, Margaret 178  
 Santayana, George (Jorge Augustín Nicolás Ruiz de Santillana) 226, 300, 617, 731, 851, 887, 1333, 1373, 1613, 1633, 1692  
 Sapp, Jan 1565  
 Sappho 40, 945  
 Sarewitz, Daniel 739, 1252  
 Sarnak, P. 1260, 1736  
 Sarnoff, David 1252, 1333  
 Sarpi, Fra Paolo 949  
 Sarton, George 250, 502, 851, 880, 1199, 1358, 1525  
 Sarton, May 1051  
 Sartre, Jean-Paul 160, 1186  
 Saslaw, William C. 572  
 Sattler, R. 1659  
 Saunders, W. E. 509, 997  
 Savage, D. E. 1548  
 Savage, Jay Mathers 479  
 Savage-Rumbaugh, Sue 105, 1053  
 Savory, Theodore 961  
 Sawyer, Walter Warwick 851  
 Saxe, John Godfrey 1036  
 Sayer, Lewis L. 256  
 Sayers, Dorothy L. 113, 162, 537, 997, 1613  
 Sayre, G. Armington 185  
 Scalera, Mario 1253  
 Scaliger, Joseph 598  
 Scarlett, Earle P. 903  
 Scatchard, George 1333  
 Schaaf, Fred 1556  
 Schaefer, Bradley E. 1472  
 Schaefer, Jack 74  
 Schaffer, E. A. 479  
 Schaller, George B. 73  
 Schawlow, Arthur 114  
 Scheele, Carl Wilhelm 250  
 Schegel, Richard 1613  
 Schenck, Jr., Hilbert 699  
 Schiaparelli, G. V. 1155  
 Schickel, Richard 1637  
 Schiebinger, Londa 1025, 1333  
 Schild, Alfred 1066, 1253

- Schiller, Ferdinand Canning Scott 220, 363, 784, 1186, 1334, 1613, 1693
- Schlegel, Friedrich 1133
- Schlesinger, Frank 114
- Schlichter, Dean 852
- Schmidt, Frank L. 1522
- Schmidt, O. Y. 1199
- Schmitz, Jacqueline T. 1024
- Schneer, Cecil J. 537, 1334
- Schneider, Don 114
- Schneider, Herman 1150
- Schneider, Nina 1150
- Schölzer, Ludwig 1541
- Schön, Donald A. 1253, 1613
- Schopenhauer, Arthur 104, 220, 677
- Schramm, David N. 316, 321, 1613
- Schreiber, Georg 379
- Schreiber, Hermann 379
- Schrieber, Hermann 997
- Schrire, Carmel 90
- Schrödinger, Erwin 140, 254, 392, 500, 667, 694, 753, 756, 771, 782, 852, 891, 998, 1066, 1133, 1213, 1334, 1354, 1401, 1408, 1424, 1459, 1470
- Schubert, Hermann Cäsar Hannibal 852
- Schuchert, C. 537
- Schuffe, J. A. 1578
- Schukarev, A. N. 1240
- Schumacher, Ernst Friedrich 788, 1467, 1584
- Schuster, Sir Arthur 84, 406, 1726
- Schützenberger, Marcel-Paul 852
- Schuyler, Montgomery 192
- Schwartz, David 379
- Schwartz, John 363, 1334
- Schwarzschild, Martin 753
- Schweitzer, Albert 49, 53, 1060
- Schweizer, Karl W. 1359
- Sciama, Dennis 935, 1243
- Scott, Chas F. 427
- Scott, Dave 108
- Scott, Sir Walter 145, 220, 597, 1106
- Scott Cary 486, 689, 1469
- Scottie 18
- Scotty 1133
- Scripps, Edwin W. 617
- Scriven, Michael 504, 756
- Scrope, George Poulett 207, 589, 1150, 1713
- Seab, C. G. 620
- Seares, Frederick H. 301
- Sears, Francis Weston 432
- Sears, Paul Bigelow 176, 998
- Seaton, G. L. 1525
- Second World War Health Slogan 301
- Sedgewick Seti 1151
- Sedgwick, Adam 589, 952
- Sedwizoj, Michal 373
- Seebach, D. 1570
- Seegal, David 1106
- Seeger, Peggy 418
- Seeger, Raymond J. 1613
- Seely, Bruce E. 418
- Segal, Erich 1541
- Seegerstrale, Ullica 264
- Seifert, H. S. 1620
- Seifriz, William 1334, 1446
- Seignobos, Charles 1219
- Selden, John 1106
- Selye, Hans 221, 308, 314, 363, 784, 917, 998, 1036, 1446, 1671
- Selzer, Richard 781, 1469, 1470, 1560, 1562
- Sendivogius, Michael 1660
- Seneca (Lucius Annaeus Seneca) 96, 268, 370, 634, 708, 852, 903, 998, 1106, 1516, 1728
- Serge, Corrado 881, 1428
- Serge, Lang 852
- Serling, Rod 677
- Serres, Michel 1199
- Servetus, Michael 786
- Service, Robert William 145, 1516, 1704
- Serviss, Garrett P. 945, 1516
- Seton, Ernest Thompson 731
- Severinus, Petrus 505, 731
- Seward, A. C. 1264
- Seward, John 732
- Sexton, Anne 32, 66, 67, 223, 1151, 1456
- Shadwell, Thomas 311, 370, 852, 1560
- Shaffer, Peter 151
- Shaftesbury, Anthony Ashley Cooper 160
- Shakespeare, William 10, 14, 37, 38, 39, 40, 41, 43, 44, 51, 58, 59, 70, 71, 78, 87, 107, 114, 125, 151, 181, 194, 207, 213, 221, 226, 269, 292, 311, 325, 341, 370, 374, 379, 386, 418, 442, 506, 514, 546, 551, 578, 621, 628, 667, 681, 688, 757, 779, 781, 784, 792, 852, 887, 903, 910, 945, 949, 998, 1020, 1036, 1051, 1068, 1074, 1084, 1092, 1106, 1139, 1162, 1174, 1186, 1202, 1235, 1257, 1269, 1463, 1472, 1516, 1554, 1586, 1623, 1633, 1639, 1704, 1719, 1733
- Shaler, Nathaniel Southgate 208, 380, 742, 1151
- Shamos, Morris H. 537
- Shapere, Dudley 538, 1089
- Shapiro, Harry L. 1334
- Shapiro, Karl Jay 1541
- Shapiro, Paul 63
- Shapiro, Robert 451, 763, 771, 1335
- Shapley, Harlow 114, 125, 140, 227, 300, 396, 708, 800, 853, 1142, 1469
- Sharp, David 65
- Sharpe, Tom 294

- Shaw, Alan 178, 682, 1548  
 Shaw, George Bernard 4, 7, 162, 171, 177, 197, 213,  
 250, 255, 294, 301, 318, 363, 370, 392, 418, 436,  
 479, 490, 514, 538, 565, 617, 629, 678, 792, 853,  
 903, 926, 967, 998, 1064, 1066, 1196, 1200,  
 1203, 1207, 1219, 1243, 1335, 1393, 1428, 1541,  
 1562, 1613, 1639, 1660  
 Shaw, James B. 853  
 Shaw, William R. 434  
 Shchatunovski, Samuil 881  
 Sheckley, Robert 1446  
 Sheeham, William 1155  
 Shelah, Saharon 282  
 Sheldrick, Daphne 284  
 Shelley, Mary 251, 732, 946, 1335, 1446, 1646  
 Shelley, Percy Bysshe 60, 114, 221, 269, 380, 552,  
 607, 634, 692, 887, 946, 1044, 1159, 1205, 1335,  
 1693, 1713, 1729  
 Shenstone, W. A. 1714  
 Shepherd, Alan 108  
 Shepherd, Linda Jean 1660  
 Sheridan, Richard Brinsley 1106  
 Shermer, Michael 732, 1335  
 Sherrington, Sir Charles 211, 480, 771, 1007  
 Sherrod, P. Clay 125, 1516  
 Sherwood, Thomas 1186  
 Shewhart, Walter Andrew 427, 559  
 Shimony, Abner 1066  
 Shindler, Tom 1713  
 Shipman, T. 96  
 Shlain, Leonard 1373  
 Shoemaker, Eugene 106  
 Shoemaker, Sydney 229  
 Sholander, Marlow 343, 803  
 Shore, Jane 1472  
 Shrady, George 1424  
 Shu, Frank H. 1336  
 Shulman, Max 695  
 Shulman, Milton 881  
 Shute, John 96  
 Shute, Nevil 419  
 Sidgwick, N. V. 235  
 Siegel, Eli 105, 140, 406, 442, 538, 604, 661, 753, 853,  
 931, 1142, 1336, 1480, 1693  
 Siekevitz, P. 168  
 Sigerist, Henry E. 363, 669, 1562  
 Sigma Xi 448  
 Sigurdsson, Haraldur 1446  
 Silberling, N. J. 22  
 Silesius, Angelus 1634  
 Silk, Joseph 114, 165, 402, 1693  
 Silliman, G. S. 910  
 Sillman, Benjamin 125, 732  
 Silone, Ignazio 380  
 Silver, Brian L. 140, 251, 574, 732, 887, 1220, 1336,  
 1359, 1373, 1401, 1447, 1614  
 Simes, James 634  
 Simmonds, Sophia 166  
 Simmons, Charles 262, 342, 370, 629  
 Simmons, George F. 853  
 Simon, Anne W. 1268  
 Simon, H. 1196  
 Simon, Herbert Alexander 327, 363, 1196, 1336, 1672  
 Simonson, Roy 1474  
 Simpson, George Gaylord 71, 171, 177, 480, 565, 771,  
 800, 1054, 1061, 1089, 1336, 1502, 1572, 1575  
 Simpson, Michael A. 1424  
 Simpson, N. F. 1197  
 Sindermann, Carl J. 1406  
 Singer, Charles 771, 892, 1337  
 Singer, June 1704  
 Singer, Kurt 1116  
 Singh, Jagjit 1698  
 Sinnott, E.W. 771  
 Sinsheimer, Robert L. 1447  
 Sir Joseph 94, 914  
 Sir Joseph Whemple 1071  
 Sissman, Louis Edward 1107  
 Sizzi, Francisco 1153  
 Skinner, B. F. (Burrhus Frederick) 1550  
 Skinner, Burrhus Frederick 1416  
 Skinner, Cornelia Otis 481  
 Skinner, Frank W. 429  
 Skolimowski, Henryk 1416, 1614  
 Skwara, T. 566  
 Slater, John C. 1614  
 Sleator, William 566  
 Slichter, Chas. S. 419  
 Slobodkin, Lawrence B. 1467  
 Slonim, Morris James 151, 1268  
 Slosson, Edwin E. 184, 399, 753, 853, 1337, 1614  
 Smart, Christopher 99, 1555  
 Smedley, F. E. 538  
 Smellie, William 962  
 Smiles, Samuel 259  
 Smit, Eefke 1495  
 Smith, Adam 1337  
 Smith, Adam (George J. W. Goodman) 1020  
 Smith, Bertha Wilcox 47  
 Smith, Betty 251  
 Smith, Beverly 1250  
 Smith, David 1229  
 Smith, David Eugene 853  
 Smith, E. E. 1067  
 Smith, George Otis 538, 1467  
 Smith, Godfrey 924  
 Smith, Goldwin 589  
 Smith, Henry J. S. 104, 604, 1133

- Smith, Henry Preserved 1337  
Smith, Homer W. 433, 1253, 1447  
Smith, J. B. L. 51  
Smith, John Pye 589  
Smith, Langdon 30, 481  
Smith, Logan Pearsall 732, 1480, 1516, 1547, 1693  
Smith, Miles 608  
Smith, R. B. 427  
Smith, Reginald H. 1542  
Smith, Robert Angus 140  
Smith, Robertson 650  
Smith, Sydney 104, 140, 1337  
Smith, Theobald 363, 732, 1253  
Smith, W. B. 854  
Smith, Walter Chalmers 251  
Smith, Willard A. 427  
Smith, William 566  
Smith, William Jay 76  
Smithers, Sir David 200  
Smokler, H. E. 1182  
Smolin, Lee 180, 1337  
Smollett, Tobias George 539, 903, 924, 1107  
Smoot, George 165, 556, 1472, 1698  
Smullyan, Raymond 17, 107, 618, 957  
Smuts, Jan Christiaan 772, 1693  
Smuts, Jan Christian 1660  
Smyth, Francis Scott 371  
Smyth, H. D. 1374  
Smyth, Nathan A. 998, 1337  
Smythe, Daniel 58, 910, 1517  
Snedecor, G. W. 1525  
Snelson, Kenneth 140  
Snicket, Lemony (Daniel Handler) 1717  
Snow, Charles Percy 251, 401, 419, 539, 753, 1134, 1337, 1376, 1401, 1430, 1447, 1584  
Snyder, Carl H. 732  
Snyder, Gary 168, 434  
Snyder, Solomon 500  
Sobel, Dava 621  
Sober, Elliott 256  
Sockman, Ralph W. 732  
Soddy, Frederick 140, 255, 396, 406, 732, 739, 1337  
Södergran, Edith 669  
Sollas, William Johnson 589, 597  
Solzhenitsyn, Aleksandr Isayevich 428, 881  
Somerville, Mary 125, 279, 618, 634, 854, 1337, 1476  
Sommerfield, Arnold 436, 776, 1620  
Sontag, Susan 384, 669  
Sophocles 181, 892, 935, 1224, 1584  
Sorokin, Pitirim A. 1338  
Soulé, Michael E. 1584  
Sousa, Wayne 978  
South, Robert 1186  
Southerne, Thomas 639  
Southgate, Theresa 1164  
Spallanzani, Lazzaro 1447  
Spark, Muriel 1338  
Spaulding, Albert C. 90, 94  
Spearman, Charles 892  
Speiser, A. 854  
Spencer, Herbert 481, 566, 635, 661, 732, 772, 999, 1081, 1089, 1338, 1363, 1374, 1380, 1428, 1457  
Spencer, Lilian White 288, 289, 290  
Spencer, Theodore 887  
Spencer-Brown, George 428, 854, 1236, 1338, 1595, 1660  
Spengler, Oswald 854, 1542  
Spengler, Sylvia J. 167  
Spenser, Edmund 41, 127, 803, 999, 1517, 1646, 1693, 1698  
Sperry, Roger Wolcott 1393  
Spilhaus, Athelstan 1045  
Spinoza, Baruch de 203  
Sporn, Philip 428  
Sprat, Thomas 706  
Squire, John Collings 800  
St. Bernard of Clairvaux 1646  
St. Clair, George 953  
St. John, Nicholas 7  
Stabler, E. Russell 855  
Stace, C. 1575  
Stace, Walter Terence 1394  
Stackman, Elvin 449  
Stalin, Joseph 419, 1542  
Stallo, John Bernard 406  
Stallone, Sylvester 855  
Stamaty, Mark Alan 1542  
Stamp, Josiah 151, 321, 1525, 1542  
Standage, Tom 1142  
Standen, Anthony 177, 235, 392, 776, 784, 892, 1116, 1134, 1447  
Stanhope, Charles 618  
Stanier, R. Y. 481  
Stanislaus, Leszczynski (Stanislaus I) 1338  
Stansfield, William D. 1338, 1415  
Stanton, Elizabeth Cady 1107  
Stapledon, Olaf 1213, 1238, 1394, 1517  
Stapp, Paul 25  
Starkey, W. L. 419  
Starling, E. H. 542  
Starling, Ernest Henry 1138  
Starr, Paul 903  
Starr, Victor P. 1555  
Stassen, Harold E. 419  
Statius, Publius 287  
Stedman, Edmund Clarence 140  
Steef, Duncan 1725  
Steele, Joel Dorman 407, 618, 949, 999

- Steen, Lynn Arthur 10  
 Steensen, Niels 160  
 Stein, Gertrude 1520  
 Steinbeck, John 104, 171, 650, 733, 800, 855, 904,  
     1036, 1220, 1646  
 Steiner, Rudolf 1621  
 Steinhardt, Paul 1682  
 Steinman, D. B. 192  
 Steinmetz, Charles Proteus 428, 855  
 Stekel, Wilhelm 1542  
 Stenger, Victor J. 500, 733, 1009, 1040, 1213, 1215,  
     1338, 1401, 1494, 1614, 1620  
 Stengers, I. 1328  
 Sterling, John 1646  
 Stern, S. Alan 1693  
 Sterne, Laurence 442, 650, 733, 791, 855, 1036, 1339,  
     1464, 1542  
 Sterrett, The Right Reverend Frank W. 419  
 Stetson, Harlan T. 443  
 Steve Banning 90  
 Stevens, Peter S. 1075  
 Stevens, Rosemary 1496  
 Stevenson, Adlai E. 140, 384, 999, 1584  
 Stevenson, Robert Louis 419, 539, 630, 1010, 1107,  
     1339, 1456, 1542, 1614, 1634, 1729  
 Steward, J. H. 1339  
 Stewart, Alan 151  
 Stewart, Dugald 855, 881  
 Stewart, Ian 618, 661, 733, 855, 881, 935, 1036, 1069,  
     1173, 1202, 1220, 1253, 1260, 1339, 1670  
 Stewart, R. W. 261  
 Stigler, Stephen M. 321, 1542  
 Stinton, D. 661  
 Stockbridge, Frank B. 171, 772  
 Stocking, Martha 935  
 Stoddard, Richard Henry 1044  
 Stoker, Bram 29, 1339  
 Stokes W. 1547  
 Stoll, Clifford 114  
 Stoller, Robert 254  
 Stone, David 1468  
 Stone, John 702  
 Stone, Marshall H. 856  
 Stone, Peter Bennet 1043  
 Stone, Richard O. 537  
 Stone, Samuel John 556  
 Stoney, George Johnstone 1020, 1557  
 Stoppard, Tom 17, 22, 140, 151, 322, 445, 539, 561, 618,  
     742, 1045, 1186, 1200, 1460, 1555, 1578, 1665  
 Stott, Henry G. 428  
 Stout, Rex 1542  
 Straus, Bernard 371  
 Strauss, Maurice B. 364, 1717  
 Streatfield, Mr. Justice Geoffrey 539  
 Street, Arthur 911  
 Streeter, B. H. (Burnett Hillman) 1394  
 Strehler, Bernard 325  
 Strindberg, August 21  
 Strindberg, Johann 917  
 Strong, Lydia 558, 1563  
 Struik, Dirk J. 856  
 Strunsky, Simeon 1542  
 Strutt, John William (Lord Rayleigh) 279, 397, 449,  
     577, 848, 1116, 1339  
 Struve, Otto 126  
 Stuart, A. 1536  
 Stuart, Copans A. 710  
 Student (William Sealy Gossett) 1188  
 Stuessy, Tod F. 1575  
 Stukeley, William 380  
 Stumpf, LaNore 1139  
 Sturluson, Snorri 1698  
 Sturtevant, A. H. 578  
 Sudarshan, E. C. 1174  
 Sudarshan, George 1612, 1621  
 Suess, Eduard 292, 1634  
 Sufi Creation Myth 1698  
 Suidas 341  
 Suits, C. G. 1363  
 Sukoff, Albert 1020  
 Sullivan, Arthur 439, 463, 527, 790, 824, 1065, 1180,  
     1268, 1553, 1603, 1638  
 Sullivan, John William Navin 3, 10, 177, 393, 733, 856,  
     1134, 1339, 1363, 1374, 1416  
 Sullivan, Louis Henry 99  
 Sullivan, Walter 1693  
 Süskind, Patrick 229  
 Sussmann, Hector 1614  
 Sutherland, Jr., Earl W. 1253  
 Sutton, Christine 977  
 Swann, Donald 631  
 Swann, William Francis Gray 580, 707, 856, 881, 999,  
     1339, 1693  
 Swartz, Norman 146  
 Swedenborg, Emanuel 1142  
 Swenson, Jr., Lloyd S. 501, 1340  
 Swift, Jonathan 70, 96, 114, 269, 688, 706, 733, 856,  
     881, 999, 1036, 1107, 1155, 1464, 1555, 1586,  
     1671  
 Swigert, Jack 108  
 Swimme, Brian 1694  
 Swinburne, Richard 1634  
 Swings, Pol 1472  
 Sydenham, Thomas 371, 904  
 Sylvester, James Joseph 21, 281, 293, 338, 449, 604,  
     699, 703, 706, 742, 857, 858, 859, 881, 961,  
     1036, 1067, 1173, 1202, 1204, 1224, 1459, 1468,  
     1481, 1578, 1594



- Syminges, John 544  
 Synge, John L. 650, 681, 733, 858, 881, 889, 941,  
 1020, 1494, 1614  
 Szasz, Thomas 311, 904  
 Szego, Gábör 858  
 Szent-Györgyi, Albert 211, 364, 407, 733, 772, 1054,  
 1197, 1224, 1253, 1447  
 Szilard, Leo 539, 1477
- T**
- Tabb, John Banister 39, 67, 290, 1458  
 Tagore, Rabindranath 785, 1011, 1142, 1407, 1517, 1698  
 Taine, Hippolyte 1151  
 Tait, Peter Guthrie 326, 887, 1448  
 Talbot, Michael 278, 1694  
 Tannery, Paul 1359  
 Tansley, A. G. 384, 539  
 Tarbell, Ida 547  
 Tasso, Torquato 269  
 Tate, Allen 1416  
 Tatishchev, Vasilii Nikitich 1340  
 Taton, René 364  
 Tatum, Edward 575, 1197  
 Taylor, A. W. 256  
 Taylor, Alfred Maurice 1448  
 Taylor, Angus E. 364, 444  
 Taylor, Ann 48  
 Taylor, Anne 1517  
 Taylor, Bayard 145, 552, 1044, 1517, 1646  
 Taylor, Calvin W. 707  
 Taylor, E. S. 278, 327, 428  
 Taylor, Edwin F. 1494  
 Taylor, Isaac 707  
 Taylor, Jeremy 1107  
 Taylor, John 1162  
 Taylor, Richard E. 1215  
 Taylor, Rod 18  
 Taylor, Walter W. 90, 94, 337, 1663  
 Tazieff, Haroun 1713, 1714  
 Tchekhov, Anton 1542  
 Teague, Jr., Freeman 1468  
 Teale, Edwin Way 56, 185, 325, 999, 1036  
 Teall, J. J. Harris 539, 678, 1340  
 Teall, Sir J. J. Harris 1614  
 Teasdale, Sara 288, 910, 1517  
 Teeple, John E. 229, 251  
 Teilhard de Chardin, Pierre 208, 275, 481, 887, 1055,  
 1134, 1142, 1151, 1394, 1660  
 Television Introduction 178  
 Teller, Edward 377, 407, 548, 858, 1256, 1340, 1468,  
 1671  
 Teller, Wendy 377, 548, 1340  
 Teller, Woolsey 618, 800, 1694  
 Temple, Frederick 618, 1340, 1394  
 Temple, G. 1340  
 Tenenbaum, G. 1173  
 Teng Mu 514  
 Tennant, F. R. 1416  
 Tennyson, Alfred (Lord) 37, 39, 43, 44, 67, 126, 141,  
 156, 221, 223, 259, 287, 289, 326, 481, 569, 572,  
 733, 910, 946, 999, 1044, 1057, 1143, 1151,  
 1157, 1266, 1340, 1401, 1457, 1461, 1481, 1517,  
 1555, 1646, 1694, 1713, 1729  
 Terborgh, John 166, 1498  
 Terence 221, 539, 1047, 1253  
 Teresi, Dick 190  
 Termier, Pierre 293, 758  
 Tertullian 1  
 Tesla, Nikola 141, 295, 887  
 Thackeray, William Makepeace 1646  
 Thagard, Paul 662, 695  
 Thaxter, Celia 43  
 Thayer, John H. 1156  
 The Arabian Nights 43  
 The Bible 25, 57, 221, 259, 284, 380, 382, 501, 544,  
 739, 777, 910, 925, 1021, 1036, 1107, 1186, 1245,  
 1253, 1456, 1472, 1517, 1647, 1698, 1724  
 The Editors 1543  
 The Federated American Engineering Society 428  
 The Hon. Mrs. Ward 1518  
 Theiler, Max 1734  
 Thesiger, Ernest 501  
 The X-Files 574, 772, 1134, 1481, 1634  
 Thiele, T. N. 1036  
 Thierry, Paul Henri, Baron d'Holbach 221, 800, 949, 999  
 Thom, René 604, 858, 882, 1340  
 Thomas, Dylan 777  
 Thomas, E. R. 1132  
 Thomas, Lewis 57, 65, 211, 325, 376, 443, 482, 506,  
 578, 679, 702, 742, 801, 859, 904, 1037, 1151,  
 1254, 1340, 1402, 1429, 1448, 1472, 1562, 1571,  
 1710  
 Thomas, R. S. 515  
 Thompson, A. R. 1341  
 Thompson, Dick 1714  
 Thompson, Elihu 539, 1254  
 Thompson, Francis 115, 208, 1060, 1518, 1694  
 Thompson, Hunter S. 141  
 Thompson, Jennifer 1672  
 Thompson, Jennifer Trainer 1568  
 Thompson, Silvanus P. 184, 199, 882, 1037  
 Thompson, Sir D'Arcy Wentworth 38, 235, 352, 490,  
 559, 859, 888, 926, 947, 1052, 1093, 1165  
 Thompson, W. R. 1571  
 Thompson, William Robin 1037  
 Thomson, J. Arthur 229, 251, 274, 402, 462, 482, 619,  
 636, 695, 696, 782, 888, 1000, 1053, 1341, 1394,  
 1409, 1419, 1481, 1564

- Thomson, James 44, 269, 287, 624, 630, 639, 641, 662, 1000, 1499, 1518, 1710
- Thomson, Sir George 501, 678, 733, 1342, 1368, 1416, 1660
- Thomson, Sir George Paget 10, 393, 1718
- Thomson, Sir Joseph John 364, 388, 446, 447, 888, 1116, 1243
- Thomson, Thomas 251, 949
- Thoreau, Henry David 21, 36, 51, 52, 74, 96, 115, 126, 184, 208, 221, 251, 274, 325, 326, 364, 386, 431, 434, 436, 443, 509, 539, 552, 619, 678, 733, 739, 859, 919, 952, 969, 1000, 1037, 1044, 1107, 1152, 1168, 1205, 1342, 1363, 1379, 1380, 1429, 1468, 1473, 1488, 1518, 1543, 1555, 1584, 1634, 1647, 1694, 1719, 1721, 1729
- Thorn, John 1543
- Thorne, Kip S. 159, 180, 346, 393, 636, 785, 905, 1038, 1167, 1241, 1254, 1342, 1448, 1481, 1494, 1518, 1631, 1695
- Thring, Meredith Wooldridge 420, 428
- Thucydides 221
- Thudichum, J. L. W. 1052
- Thurber, James 197, 322, 371, 388, 681, 946, 1343, 1525
- Thurlow, Lord Edward, 1st Baron Thurlow 1001
- Thurston, William Paul 859
- Thurstone, Louis Leon 1197, 1543
- Tibshirani, Robert J. 1532
- Tiffany, Lewis 177
- Till, Irene 704
- Tillich, Paul 141, 1394
- Tillotson, John 1187
- Tillyard, E. M. W. 1380, 1566
- Timiryazev, K. A. 650, 734
- Ting, Samuel C. C. 1448
- Tinker, John F. 105
- Tinkler, Keith J. 605
- Tipler, Frank 1045, 1175, 1489
- Tippett, L. C. 322, 1707
- Titchener, Edward Bradford 274, 501, 753
- Todhunter, Isaac 126, 860
- Toepffer, Rodolphe 590
- Toffler, Alvin 1162, 1187, 1584
- Tolkien, J. R. R. 1448
- Tolman, Edward Chance 503
- Tolman, R. C. 298
- Tolstoy, Alexei 946
- Tolstoy, Leo 199, 208, 222, 269, 311, 556, 688, 753, 860, 1343, 1660
- Tombaugh, Clyde 678, 1143
- Tomlinson, C. 300
- Tomlinson, Henry Major 882
- Tomonaga, Sin-Itiro 1001
- Toogood, Hector B. 1590
- Topsell, Edward 48, 58, 66
- Torrance, Thomas F. 1089
- Torrey, Ray Ethan 482
- Toulmin, Stephen 662, 1071, 1089, 1116, 1167, 1448, 1615, 1729
- Towne, Lisa 291
- Townes, Charles H. 1698
- Townsend, Joseph 590
- Townson, Robert 252, 281, 1205
- Toynbee, Arnold J. 1090, 1343, 1376, 1395, 1660, 1694
- Traube, Moritz 400
- Trautman, Andrzej 436
- Travers, Pamela Lyndon 1518
- Tredgold, Thomas 428
- Trefethen, Joseph M. 590
- Trefil, James 1213, 1220
- Trevelyan, George Macaulay 482, 1518
- Trevelyan, George Otto 860
- Trevor, J. E. 252
- Trilling, Lionel 669, 1229
- Trimble, George S. 1421
- Trimble, V. 1694
- Trivers, Robert 169
- Trollope, Anthony 1543, 1660
- Trotter, Wilfred 26, 662, 1419
- Trotter, William 734
- Trudeau, Edward 312
- Trudeau, Richard J. 860
- Truesdell, Clifford 1134, 1566, 1578, 1594, 1595, 1620
- Trumbull, John 17, 126
- Truzzi, Marcello 1203
- Tsiolkovsky, Konstantin Eduardovich 515, 1476, 1481, 1550, 1590
- Tucker, Abraham 662
- Tucker, Albert W. 860
- Tucker, Karen 734
- Tucker, Wallace 734
- Tucker, Wilson 1343
- Tudge, Colin 1343
- Tufte, Edward R. 621
- Tukey, John W. 22, 443, 860, 1012, 1164, 1526, 1543, 1579
- Tumin, Melvin 308
- Tupper, Kerr Boyce 1108
- Tupper, Martin Farquhar 443
- Turgenev, Ivan 235, 1001
- Turing, Alan 343
- Turnbull, Charles D. 961
- Turnbull, Herbert Westren 860
- Turner, H. H. 269, 449, 1359
- Turner, Michael S. 165, 1615, 1694
- Turner, William 1159
- Turney, John 1061
- Turok, Neil G. 298

- Tuttle, Hudson 1001, 1634, 1709  
 Twain, Mark (Clemens, Samuel Langhorne) 706, 707, 743  
 Twain, Mark (Samuel Langhorne Clemens) 29, 35, 36, 45, 48, 57, 62, 67, 69, 70, 71, 73, 77, 82, 86, 106, 115, 126, 151, 224, 269, 287, 290, 326, 331, 333, 348, 349, 350, 364, 371, 380, 401, 451, 482, 490, 501, 540, 548, 590, 593, 607, 619, 627, 630, 652, 662, 694, 777, 790, 860, 904, 927, 962, 1001, 1047, 1063, 1076, 1157, 1159, 1168, 1223, 1260, 1262, 1343, 1364, 1448, 1468, 1501, 1518, 1543, 1560, 1586, 1615, 1647, 1714, 1729  
 Tymoczko, Thomas 1203  
 Tyndall, John 141, 155, 407, 503, 540, 590, 678, 780, 949, 1395  
 Tyron, E. P. 1694
- U**  
 Ulam, Stanislaw 177, 861, 1134, 1452  
 Umbgrove, J. H. F. 590  
 Umov, N. A. 407  
 Union Carbide and Carbon 1343  
 United Nations Treaty on the Exploration and Use of Space 1058  
 University of California, Berkeley 1449  
 Unsold, Albrecht 1223  
 Updike, John 84, 165, 346, 348, 573, 619, 772, 888, 919, 1009, 1084, 1476, 1519, 1555, 1698, 1720  
 Upgren, Arthur 1472  
 Upton, Winslow 114  
 Ure, Andrew 1052  
 Urey, Harold Clayton 1343, 1501, 1635  
 US Army Corps of Engineers 420  
 Uspenskii, Petr Demianovich 346  
 Uzor 1660
- V**  
 Vaihinger, Hans 141, 1660  
 Valentine, Alan 365  
 Valentinus, Basilius 397  
 Valéry, Paul 540, 781, 1343, 1374, 1395, 1419, 1494, 1568  
 van't Hoff, Jacobus Henricus 252, 709, 1056  
 van Beneden, P. J. 1068  
 van Bergeijk, W. A. 166, 772  
 van de Hulst, H. C. 1501  
 van de Kamp, Peter 443  
 van der Gracht, W. A. 1063  
 van der Post, Laurens 1544  
 van der Riet Wooley, Sir Richard 1489  
 van Dine, S. S. 1592  
 van Fraassen, Bas C. 1090, 1615  
 van Gogh, Vincent Willem 548, 688, 742, 1519  
 van Belmont, Jean-Baptista 252, 1717  
 van Hise, Charles R. 590, 597  
 van Leeuwenhoek, Antony 80, 734, 917, 1661  
 van Noordwijk, A. J. 1255  
 van Sant, Gus 1135  
 Van Sloan, Edward 1556  
 Varese, Edgar 1449  
 vas Dias, Robert 1481  
 Vash 1344  
 Vaughan, Henry 445, 1519  
 Veblen, Oswald 604, 861, 882, 1594  
 Veblen, Thorstein 274, 322, 1254  
 Vehrenberg, Hans 1590  
 Velikovskiy, Immanuel 678  
 Venn, John 151, 861  
 Verhoeven, Cornelis 1725  
 Vernadskii, Vladimir Ivanovich 365, 1344, 1449  
 Verne, Jules 198, 365, 396, 420, 506, 591, 929, 946, 1344, 1456, 1489, 1719  
 Vernon, A. G. 1704  
 Verworn, M. 650  
 Vesalius, Andreas 1496  
 Vezzoli, Dante 1591  
 Victim, A. 430  
 Vidal, Gore 1056  
 Viereck, George S. 371, 861  
 Vincenti, Walter G. 336, 1664  
 Virchow, Rudolf Ludwig Karl 371, 540, 543, 578, 904, 1072, 1108, 1220, 1344, 1395, 1421  
 Virgil 126, 208, 269, 444, 910, 1021, 1635, 1714  
 Vitaliano, Dorothy 201  
 Vitousek, Peter Mooney 1152  
 Vitruvius 96  
 Vivilov, N. I. 1570  
 Vizinczey, Stephen 1152  
 Vogel, Steven 171  
 Vogt, Carl 191, 963  
 Volkov, Evgenii I. 934  
 Vollmer, James 420  
 Voltaire (François-Marie Arouet) 126, 330, 559, 604, 678, 754, 861, 1001, 1108, 1143, 1152, 1187, 1344  
 Volterra, Vito 1617  
 von Baer, Carl Ernst 1344  
 von Baeyer, Adolf 490, 501, 1001  
 von Baeyer, Hans Christian 141, 734, 940, 1001, 1135, 1214  
 von Bertalanffy, Ludwig 278, 1368  
 von Bitter Rucker, Rudy 1481  
 von Braun, Wernher 515, 619, 624, 679, 681, 1254, 1481, 1489, 1491, 1730  
 von Brücke, Ernst 1586  
 von Bubnoff, S. 662, 1264  
 von Buch, L. 734, 1063  
 von Clausewitz, Carl 1187

- von Ebner-Eschenbach, Marie 669, 1108  
 von Euler, Hans 252  
 von Frisch, Karl 552, 1344, 1449  
 von Goethe, Johann Wolfgang 99, 104, 181, 314, 326,  
 365, 443, 501, 637, 650, 698, 734, 759, 862, 882,  
 904, 914, 929, 1001, 1037, 1045, 1053, 1055,  
 1116, 1135, 1160, 1236, 1344, 1354, 1364, 1368,  
 1408, 1421, 1550, 1570, 1571, 1615, 1640, 1695  
 von Haller, Albrecht 688  
 von Helmholtz, Hermann 365, 388, 407, 443, 515, 540,  
 663, 735, 754, 777, 862, 888, 893, 1236, 1364,  
 1635  
 von Humboldt, Alexander 270, 541, 556, 742, 773, 924,  
 1037, 1063, 1160, 1187, 1345  
 von Karman, Theodore 420  
 von Lenard, Philipp E. A. 365  
 von Liebig, Justice 1051  
 von Liebig, Justus 6, 155, 235, 252, 365, 767, 1005,  
 1037, 1200, 1222, 1254, 1369  
 von Lindemann, Louis Ferdinand 141  
 von Lommel, Eugen 1410  
 von Meyer, Ernst 252  
 von Mises, Ludwig 1408  
 von Mises, Richard 908, 1187, 1544  
 von Neumann, John 153, 264, 432, 636, 862, 935, 1369  
 von Schelling, Friedrich Wilhelm Joseph 252, 1003  
 von Schlegel, Friedrich 504, 863, 1380  
 von Siemens, Werner 365, 1003  
 von Weizsäcker, Carl Friedrich (Baron) 142, 1135  
 von Zittel, Karl Alfred 591  
 Vooley, Hollis R. 863  
 Voorhees, Irving Wilson 684  
 Vyasa 1635
- W**
- Wächtershäuser, Günter 758, 1055  
 Waddell, John Alexander Low 428  
 Waddington, Conrad Hal 735, 924, 967, 1345, 1374,  
 1615, 1707  
 Wade, Nicholas 1145, 1239, 1275, 1426  
 Waismann, Friedrich 863, 1021  
 Waite, A. E. 399  
 Wakefield, Priscilla 187  
 Waksman, Selman A. 915, 1256, 1548  
 Walcott, Charles D. 593, 1003  
 Walcott, Derek 115, 1544  
 Wald, George 483, 501, 593, 773, 940, 1116, 1229,  
 1345, 1449, 1575  
 Walgate, Robert 1229  
 Walis, Claudia 209  
 Walker, Eric A. 420, 429  
 Walker, John 735, 1003  
 Walker, Kenneth 334, 667, 743, 914, 1200, 1220, 1671  
 Walker, Marshall 213, 1564  
 Walker, Marshall John 559, 935, 1187, 1544  
 Walker, Ruth A. 743  
 Wall, Hubert Stanley 863  
 Wallace, Alfred Russel 35, 82, 444, 504, 509, 591, 663,  
 735, 801, 967, 1055, 1155, 1262, 1498, 1661  
 Wallace, David Rains 483  
 Wallace, Henry A. 1377  
 Wallace, Lew 161  
 Wallace, Robert C. 142  
 Waller, William H. 506  
 Wallin, Ivan E. 155, 483, 967, 1564  
 Walsh, John E. 330  
 Walshe, Sir F. M. R. 1449  
 Walters, Marcia C. 950  
 Walther, Hans 882  
 Walther, Johannes 336  
 Walton, Izaak 51, 60, 63, 630, 864, 1718  
 Walz-Chojnacki, Grey 160  
 Wang, Chamont 156, 1526, 1544  
 Ward, Artemus (Charles Farrar Browne) 889  
 Ward, Barbara 384  
 Ward, Edward 420  
 Ward, Fred 108  
 Ward, Henshaw 888  
 Ward, Lester Frank 444, 1003  
 Ward, Peter D. 1160, 1203  
 Warner, Charles Dudley 1003  
 Warner, Sylvia Townsend 198, 605, 864, 1161, 1568  
 Warrain, Francis 605  
 Warren, Henry White 127, 450, 777  
 Warren, Robert Penn 790, 1708  
 Washburn, Mark 1155  
 Washington, Henry S. 259  
 Waterman, Alan T. 1345  
 Watson, Alfred N. 444  
 Watson, David Lindsay 1345  
 Watson, James D. 483, 575, 773, 1345  
 Watson, Janet 1264  
 Watson, Lyall 566  
 Watson, Sir William 1060, 1562  
 Watts, Alan Wilson 275, 282, 326, 483, 667, 773, 1004,  
 1460  
 Watts, Isaac 288  
 Waugh, Evelyn 333, 1544  
 Weaver, Jefferson Hane 1443  
 Weaver, Tom 1556  
 Weaver, Warren 177, 695, 743, 864, 1345, 1429  
 Webb, Charles Henry 1045  
 Webb, Jack 541  
 Webb, Jimmy 1058  
 Webb, Mary 57  
 Webber, Charles Wilkins 1004  
 Weber, Max 663, 1346, 1430  
 Weber, Robert L. 1254

- Webster, Arthur Gordon 344  
 Webster, John 19, 864, 1108  
 Wegener, Alfred 293, 606, 1661  
 Weidlein, Edward Ray 663, 924, 1419  
 Weierstrass, Karl 882  
 Weigall, Arthur Edward 90, 94, 1072  
 Weil, André 864, 882  
 Weil, Simone 17, 161, 557, 619, 864, 1197, 1346, 1419, 1449, 1519, 1635, 1661  
 Weinberg, Alvin Martin 781, 1449, 1579  
 Weinberg, Gerald M. 198  
 Weinberg, R. A. 940  
 Weinberg, Steven 165, 365, 502, 883, 924, 1070, 1135, 1229, 1346, 1402, 1615, 1661, 1695, 1698  
 Weiner, Jonathan 261, 1496  
 Weingarten, Violet 709, 1464  
 Weisburd, Stefi 308, 509  
 Weismann, August 651  
 Weiss, Paul A. 940, 1346, 1450  
 Weisskopf, Victor Frederick 314, 393, 663, 736, 935, 1090, 1116, 1220, 1254, 1346, 1359, 1402, 1419, 1426, 1450  
 Weisz, Paul B. 171, 1045, 1416  
 Welch, Lew 1671  
 Weldon, Fay 165  
 Weller, Stuart 801  
 Wellington, Arthur Mellen 429  
 Wells, Carolyn 71, 75, 79, 1254  
 Wells, H. G. (Herbert George) 3, 94, 142, 143, 200, 252, 270, 333, 346, 407, 483, 515, 541, 566, 570, 663, 678, 773, 788, 864, 911, 927, 950, 1004, 1006, 1037, 1072, 1135, 1152, 1236, 1255, 1264, 1347, 1359, 1364, 1411, 1416, 1421, 1429, 1450, 1489, 1519, 1526, 1544, 1555, 1579, 1616, 1635, 1637, 1701  
 Welsh, Joan I. 18  
 Welty, Eudora 669  
 Werner, Alfred 252  
 West, Jessamyn 541  
 West, Mae 7, 315  
 West, Philip 236  
 Westaway, Frederic William 865, 1037  
 Westbroek, Peter 21  
 Westfall, Richard S. 580  
 Weston-Smith, Miranda 665  
 Weyl, Hermann 127, 153, 297, 502, 605, 754, 756, 785, 865, 883, 888, 1004, 1173, 1229, 1243, 1347, 1379, 1450, 1481, 1568, 1593, 1661, 1729  
 Whaling, Thornton 1395  
 Wharton, Edith 1695  
 Wharton, William 605  
 Whatley, Richard 541  
 Wheeler, Edgar C. 1351  
 Wheeler, Hugh 1586  
 Wheeler, John Archibald 161, 165, 180, 278, 293, 326, 393, 486, 624, 663, 678, 754, 758, 785, 1004, 1037, 1038, 1116, 1135, 1167, 1214, 1230, 1255, 1347, 1481, 1494, 1635, 1695  
 Wheeler, Sir Mortimer 90, 94, 344, 485  
 Wheeler, William Morton 29, 169, 430, 1707, 1737  
 Wheelock, John 1165  
 Wheelock, John Hall 1380  
 Whetham, Sir William Cecil Dampier 866, 1347  
 Whewell, William 10, 252, 281, 328, 366, 444, 490, 541, 557, 591, 605, 624, 651, 663, 736, 754, 866, 917, 963, 1267, 1347, 1359, 1374, 1395, 1450, 1616, 1661, 1726  
 Whipple, E. P. 580  
 Whipple, Fred L. 1152, 1489  
 Whipple, George H. 25, 1661  
 Whitcomb, J. 619  
 White, Andrew Dickson 1395  
 White, Arthur 1203  
 White, Bailey 1264  
 White, Gilbert 32, 34, 187, 696, 1056, 1708  
 White, H. E. 1500  
 White, Henry Kirke 288, 1635  
 White, Henry S. 1616  
 White, J. F. 736  
 White, Leslie Alvin 1348  
 White, Stephen 1117  
 White, Terence Hanbury 48  
 White, Timothy 483  
 White, William Frank 866, 883, 1545  
 White, William Hale (Mark Rutherford) 127  
 Whitehead, Alfred North 3, 22, 68, 87, 104, 177, 274, 281, 298, 328, 344, 347, 366, 371, 386, 393, 444, 483, 502, 541, 651, 663, 683, 688, 695, 698, 700, 706, 736, 754, 773, 777, 779, 785, 801, 866, 888, 892, 962, 963, 1004, 1012, 1038, 1051, 1077, 1084, 1090, 1093, 1135, 1187, 1200, 1203, 1207, 1230, 1236, 1244, 1348, 1354, 1360, 1364, 1369, 1396, 1408, 1420, 1450, 1482, 1545, 1566, 1593, 1616, 1624, 1636, 1705  
 Whitehead, Hal 127  
 Whitehead, J. H. C. 861  
 Whitesides, George M. 390, 775, 937, 1049, 1227  
 Whitman, Walt 34, 115, 142, 227, 270, 288, 506, 557, 950, 1005, 1045, 1057, 1070, 1072, 1152, 1380, 1472, 1482, 1519, 1555, 1695  
 Whitney, Willis Rodney 231, 314, 1255, 1364, 1450, 1704  
 Whitrow, G. J. 678, 1636  
 Whittaker, R. H. 711  
 Whittaker, Sir Edmund 624  
 Whittier, John 420  
 Whyte, A. Gowans 570, 1136, 1501  
 Whyte, Lancelot Law 541, 801, 958, 1187, 1348

- Wickenden, W. E. 421  
 Wickham, Anna (Edith Alice Mary Harper) 1569  
 Wiechert, Emil 1695  
 Wieland, Heinrich O. 253  
 Wiener, Norbert 384, 432, 449, 543, 570, 868, 883,  
 1117, 1136, 1354, 1403, 1451  
 Wiesner, Jerome Bert 1197  
 Wiggins, Lynda 659  
 Wigglesworth, Sir Vincent B. 366  
 Wightwick, George 96  
 Wigner, Eugene Paul 127, 421, 432, 703, 756, 868,  
 1136, 1236, 1348, 1526, 1545  
 Wikström, J. E. 1451  
 Wilber, Ken 484  
 Wilcox, Ella Wheeler 60, 552, 928, 1520  
 Wilczek, Frank 1136  
 Wildavsky, A. 1288  
 Wilde, Oscar 94, 99, 145, 152, 161, 227, 333, 490, 542,  
 552, 664, 681, 709, 773, 1005, 1067, 1188, 1220,  
 1349, 1396, 1458, 1520, 1579, 1593, 1661  
 Wilder, Raymond L. 3, 868  
 Wilder, Thornton 341, 669, 1188, 1451  
 Wiles, Andrew 545, 868  
 Wiley, E. O. 581  
 Wiley, Harvey W. 253  
 Wiley, Jr., John P. 263  
 Wiley, R. B. 415  
 Wilf, Alexander 1451  
 Wilford, John Noble 105, 349  
 Wilford, Noble John 361  
 Wilkins, Bishop John 548  
 Wilkins, John 1489, 1662  
 Wilkins, Maurice 1585  
 Willerding, Margaret F. 868  
 Willey, Gordon R. 90, 94, 684  
 Williams, Carol 552  
 Williams, Charles 868, 1021  
 Williams, Dafydd (Dave) Rhys 946  
 Williams, G. H. 591  
 Williams, Horatio B. 868  
 Williams, L. Pearce 1360  
 Williams, Sarah 1520  
 Williams, Tennessee 1705  
 Williams, W. 1243  
 Williams, W. H. 347  
 Williams, William Carlos 904  
 Williamson, Marianne 711  
 Willis, Bailey 292  
 Willis, Connie 1407  
 Willis, John Christopher 484  
 Willis, Nathaniel Parker 42  
 Willm, Pierre 1454  
 Willstätter, Richard 366, 502, 1005, 1360  
 Wilmot, John (2nd Earl of Rochester) 1699  
 Wilson, David Scofield 434, 1005  
 Wilson, Edmund 679  
 Wilson, Edward O. 54, 57, 65, 73, 167, 171, 178, 384,  
 434, 449, 484, 619, 664, 736, 754, 954, 957, 969,  
 1068, 1081, 1349, 1402, 1451, 1616, 1662  
 Wilson, Edwin B. 914, 1545  
 Wilson, J. A. 91  
 Wilson, John 1266  
 Wilson, John Tuzo 293, 1161  
 Wilson, Jr., E. Bright 1038, 1197, 1255, 1257  
 Wilson, Logan 1424  
 Wilson, Paul A. 95, 97  
 Wilson, Robert Q. 308  
 Wilson, Sir Daniel 1168  
 Wiltshire, John 669  
 Winchell, Alexander 270, 591, 1005, 1152, 1482, 1616  
 Winkler, C. 230  
 Winne, Harry A. 421  
 Winsor, Dorothy A. 421, 429  
 Winsor, Frederick 557, 569, 868  
 Wintrobe, Maxwell M. 635  
 Wisconsin Society of Ornithology 41  
 Wisdom, John O. 1616  
 Wise, William 349, 351  
 Wissler, C. 91  
 Witt, Otto N. 739, 1476  
 Wittgenstein, Ludwig Josef Johann 97, 99, 184, 198,  
 230, 366, 517, 542, 580, 651, 664, 688, 785, 868,  
 883, 950, 1220, 1349, 1411, 1452, 1591, 1624,  
 1636, 1671  
 Wittig, Georg 1255  
 Wodehouse, P. G. 301, 344  
 Wöhler, Friedrich 1005, 1038, 1051, 1053, 1704  
 Wohlforth, Charles 261, 625  
 Wolcot, John 301  
 Wolf, Fred Alan 394, 573, 692, 1214  
 Wolfe, Humbert 915  
 Wolfe, Steven 1491  
 Wolfe, Thomas 1464  
 Wolfenden, John Frederick 1727  
 Wolfowitz, J. 1545  
 Woll, Matthew 1502  
 Wolpert, Lewis 274, 505, 574, 936, 1349, 1402, 1416,  
 1452  
 Wonnacott, Ronald J. 1545  
 Wood, John George 57, 917  
 Wood, Robert William 45, 77, 78, 431  
 Woodbridge, Frederick James Eugene 1005, 1616, 1671  
 Woodford, F. Peter 1501  
 Woodger, Joseph Henry 169, 178, 322, 1054, 1616  
 Woodson, Thomas T. 82, 192, 421  
 Woodward, Robert Burns 1570  
 Woodward, Robert Simpson 591, 1188  
 Woolf, Virginia 333, 669, 869

- Woolgar, S. 1407  
 Woolley, Richard 1264  
 Woolley, Sir Charles Leonard 345, 546, 1424, 1469  
 Woosley, Stan 1556  
 Wooten, Henry 194  
 Wordsworth, William 29, 40, 44, 46, 59, 115, 142, 181, 373, 381, 382, 552, 597, 605, 892, 1005, 1045, 1108, 1255, 1349, 1364, 1374, 1520, 1591, 1647, 1729  
 Wren, Sir Christopher 352, 1489  
 Wright, Charles R. A. 1579  
 Wright, Chauncey 542, 1090, 1349, 1662  
 Wright, Frances 736, 1236  
 Wright, Frank Lloyd 97, 100, 788, 869, 1349, 1468  
 Wright, Harold Bell 421  
 Wright, Helen 314  
 Wright, Jim 778  
 Wright, Orville 366  
 Wright, R. D. 1038  
 Wright, Robert 967  
 Wright, Thomas 115, 146, 303, 352, 366, 573, 664, 869, 919, 1006  
 Wright, Wilbur 444  
 Writer undetermined 193  
 Wu, Chien-Shiung 162  
 Wurtz, Charles Adolphe 253, 1617  
 Wyatt, Mrs. James 100  
 Wycherley, William 1207  
 Wyllie, Peter J. 1079  
 Wyndham, John 1617  
 Wynne, Annette 1737  
 Wynter, Dr. 1169  
 Wysong, R. L. 142
- X**  
 Xenophanes 1555
- Y**  
 Yalow, Rosalyn 802, 1197  
 Yang, Chen Ning 1051, 1214, 1255, 1569  
 Yates, Frances 1349, 1522, 1545  
 Ya Vilenkin, N. 692  
 Yavne, Moshe 1014  
 Yeats, William Butler 1230, 1255, 1520, 1636, 1702  
 Yentsch, Clarice M. 1406  
 Yeo, R. 1562  
 Yogananda, Paramahansa 1006  
 Yorke, James 227  
 Young, Arthur 371, 1108  
 Young, Edward 115, 270, 288, 445, 889, 904, 1006, 1520  
 Young, John 108  
 Young, John Wesley 869  
 Young, John Zachary 3  
 Young, Joshua 777, 950  
 Young, Louise B. 773, 801, 1152, 1167, 1238, 1456, 1696  
 Young, Michael Dunlop 169  
 Young, Roland 38, 42, 62, 66, 68, 70, 75  
 Young, Thomas 1047  
 Young John Zachary 191, 957, 1007, 1452  
 Yourcenar, Marguerite 703, 801  
 Yudowitch, K. L. 12  
 Yukawa, Hideki 803  
 Yule, G. U. 1526
- Z**  
 Zagier D. 1173  
 Zamyatin, Yevgeny 343, 952, 1735  
 Zebrowski, George 688, 1636, 1696  
 Zee, Anthony 624, 777, 1214, 1381, 1569  
 Zeeman, Pieter 1735  
 Zeilberger, Doron 869  
 Zelazny, Roger 869  
 Zeldovich, Yakov Borisovich 165, 297, 619  
 Zelinsky, Wilbur 1402  
 Zener, Clarence 421  
 Zevi, Bruno 91, 97, 100  
 Zihlman, Adrienne 1245  
 Ziliak, S. T. 1522  
 Ziman, John M. 372, 620, 736, 1136, 1349, 1354, 1408, 1424, 1617, 1664  
 Zimmerman, E. C. 372  
 Zimmerman, Michael 1417  
 Zinkernagel, Rolf M. 1221, 1349  
 Zinsser, Hans 371, 502, 1038, 1350  
 Zirin, Harold 1556  
 Zirker, Jack B. 383  
 Zolynas, Al 1117  
 Zoman, John M. 1239  
 Zubrin, Robert 1482  
 Zukav, Gary 1136  
 Zuni Creation Myth 1699  
 Zwicky, Fritz 1591